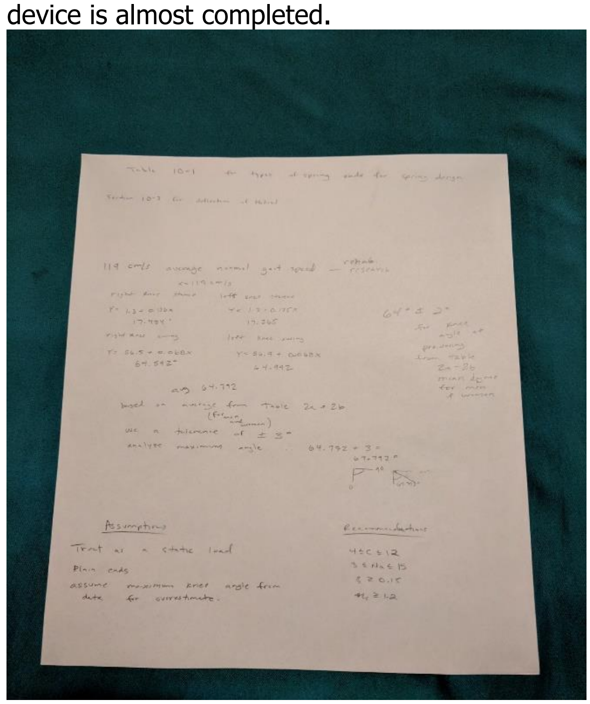
ACTION ITEMS

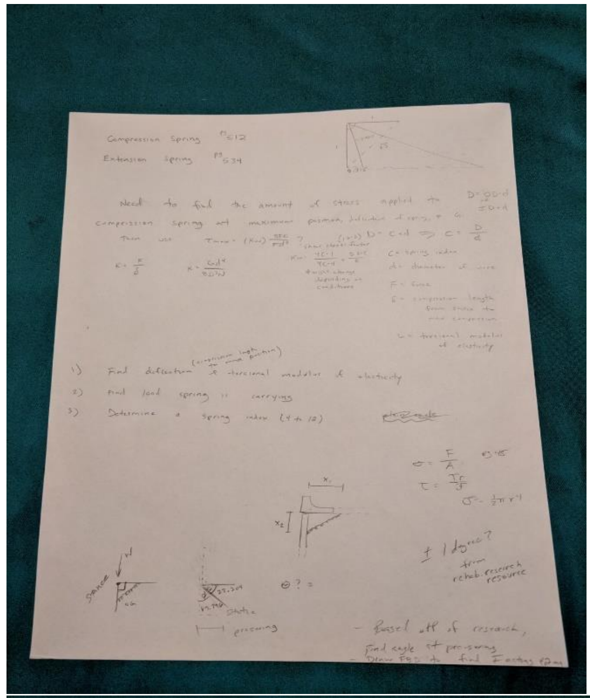
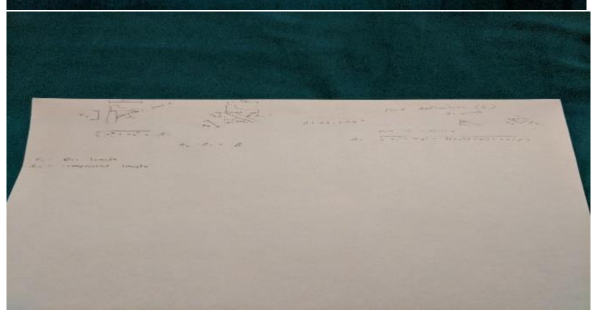
TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, February 4th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Dominic Kristich

Action Item	Date Due	Date Completed	Result/Proof of Completion
Determine spring specifications for design	February 6th	In Progress	The math for determining the springs to be used for the device is almost completed. 

			 
Revisions for the Midpoint Report	February 18th	In Progress	I will begin revisions of the report this week. The goal is to have it completed by February 18th, making steady progress over the next couple weeks.
Structural Analysis of System	March 1	In Progress	The idea behind this concept is to make a few assumptions so that the system can be treated as a beam supported by a vertical column. This will allow a structural analysis to be done of the system as a whole. We will be able to determine what kind of load will be applied to the device and if it is strong enough to withstand that load.

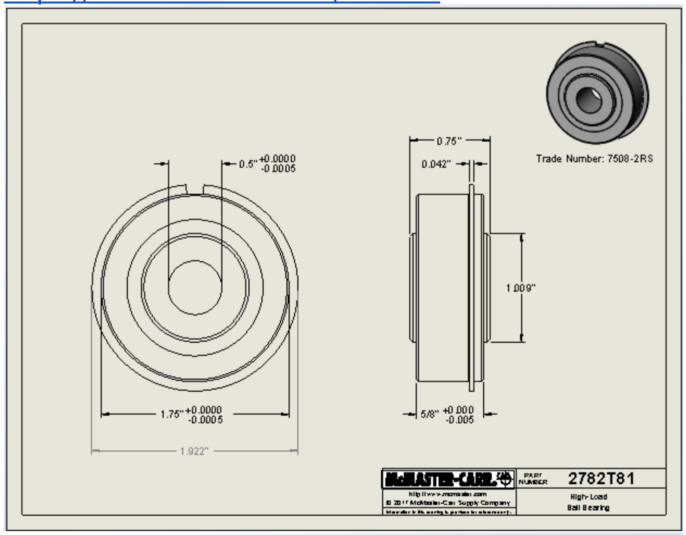
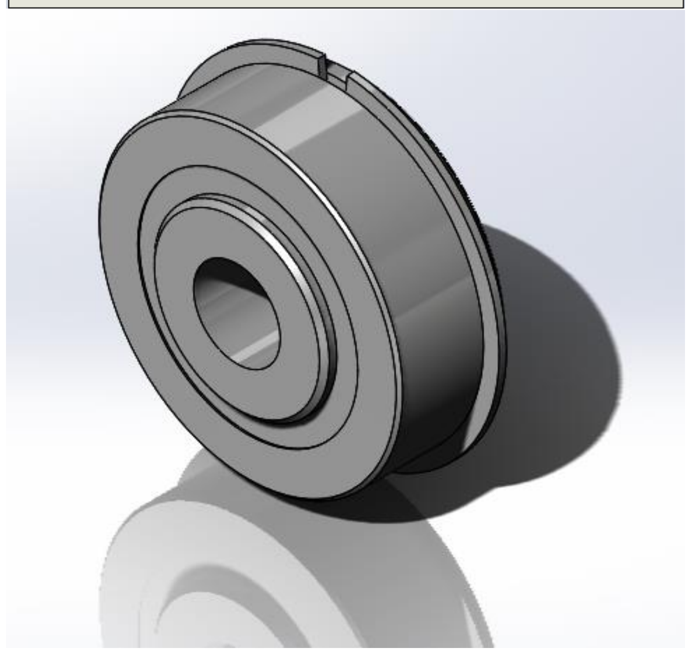
Team Member: Ebrahim Hubail

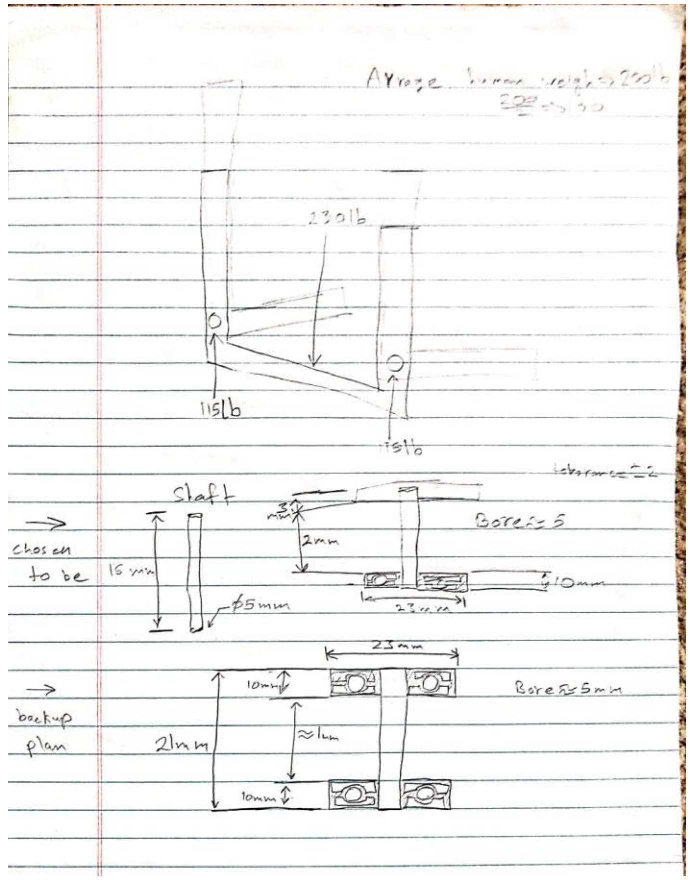
Action Item	Date Due	Date Completed	Result/Proof of Completion

Meet with Dr.Tester about the BiOM Attachment	February 4th	January 31st	I have met with Dr.Tester and he referred me to Hanger Clinic. I set an appointment with a prosthetist and i asked him if he could help me buy the BiOM attachment and he gave me three attachments. 
Choose the Right Aluminum Tube to Purchase	February 4th	February 3rd	Link to purchase the Pylon: https://www.metalsdepot.com/aluminum-products/aluminum-round-tube Part# T3R114065 Part# T3R114125
Shoulder Bolt Technical Analysis	February 18th	In Progress	The report will analyze forces and stresses developed in the shoulder bolt joint. Bolts are installed with a preload that ensures the joint members remain clamped and in compression throughout the life of the joint. The analysis will also calculate and determine the optimum preload value and specified as a percentage of the bolt material's tensile yield strength and the bolt stiffness. The total tensile force on the bolt is due to two components: the preload force and the applied tensile load. The values of these components for each portion of the bolt load curve will be calculated.

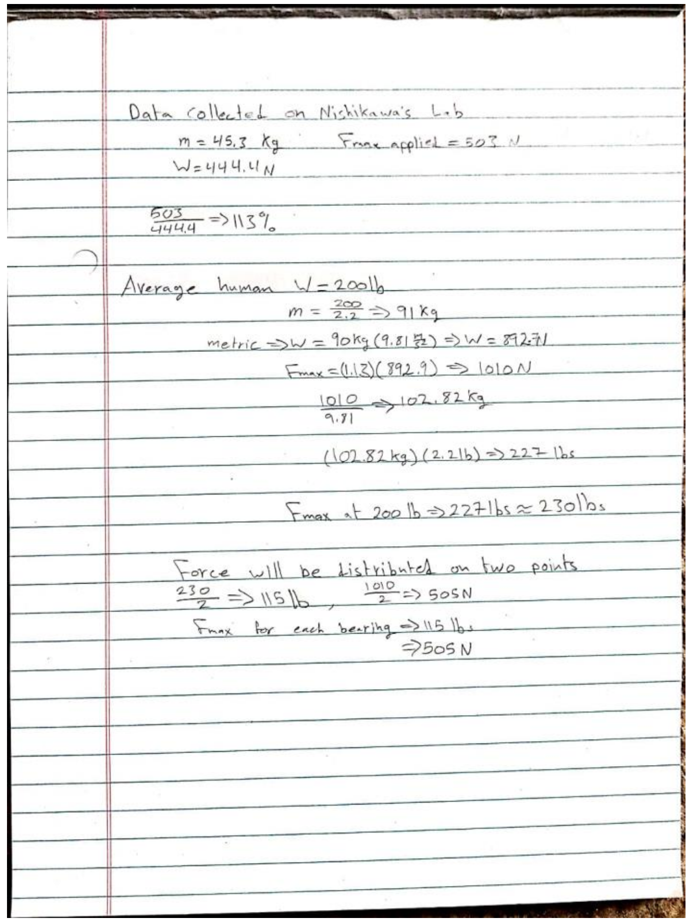
Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion

Choose the Right Bearing to Purchase & update Bearing CAD Part.	February 4th	February 3rd	Link to purchase Bearing- Part Number 2782T81 https://www.mcmaster.com/2782t81  
Complete Bearing Technical Analysis	March 1st	In progress	Calculation of Radial Force Applied to the Bearing. Waiting for Mcmaster carr to email me back the Life Rating of the Beating that we are going to use to complete calculation.

230lb
115lb
115lb
Shaft
chosen
to be
15mm
ø5mm
2mm
Bore ≈ 5
ø10mm
23mm
backup
plan
21mm
10mm
≈1mm
Bore ≈ 5mm

Data collected on Nishikawa's Lab

$m = 45.3$ Kg F_{max} applied $= 503$ N

$W = 444.4$ N

$\frac{503}{444.4} \Rightarrow 113\%$

Average human $W = 200$ lb

$m = \frac{200}{2.2} \Rightarrow 91$ Kg

metric $\Rightarrow W = 90\text{kg}(9.81 \frac{m}{s^2}) \Rightarrow W = 892.9$ N

$F_{max} = (1.13)(892.9) \Rightarrow 1010$ N

$\frac{1010}{9.81} \Rightarrow 102.82$ Kg

$(102.82\text{ kg})(2.2\text{lb}) \Rightarrow 227$ lbs

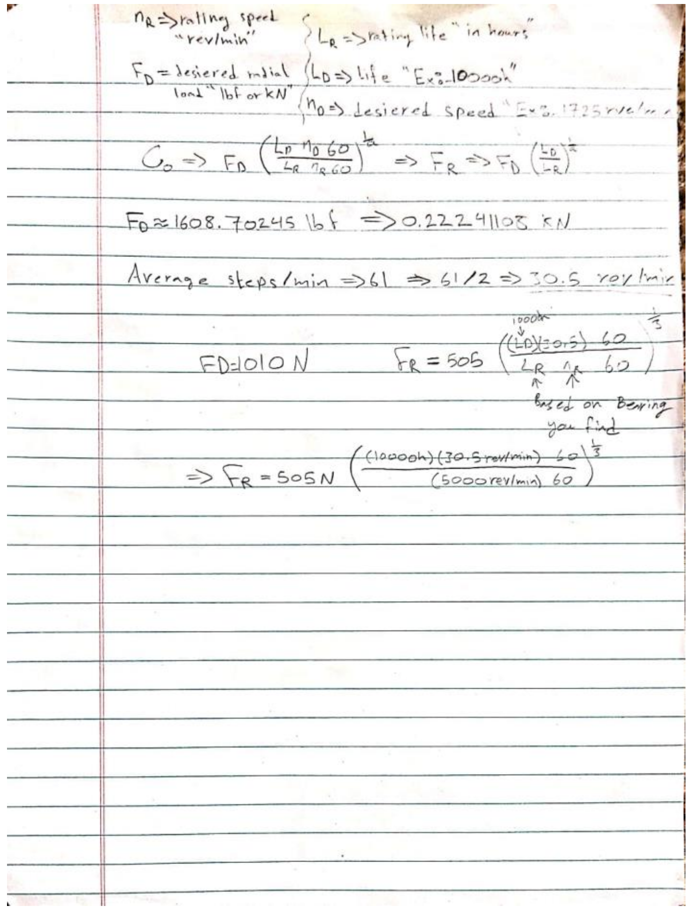
F_{max} at 200 lb $\Rightarrow 227$ lbs ≈ 230 lbs

Force will be distributed on two points

$\frac{230}{2} \Rightarrow 115$ lb , $\frac{1010}{2} \Rightarrow 505$ N

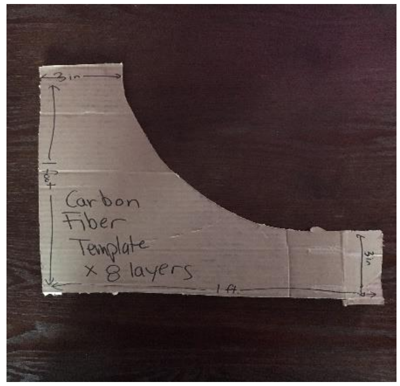
F_{max} for each bearing $\Rightarrow 115$ lbs

$\Rightarrow 505$ N

			 n_R => rating speed "rev/min" L_R => rating life "in hours" F_D = desiered radial load "lbf or kN" L_D => life "Ex: 10000h" n_D => desiered speed "Ex: 1725 rev/min" $C_0 \Rightarrow F_D \left(\frac{L_D n_D 60}{L_R n_R 60}\right)^{\frac{1}{a}} \Rightarrow F_R \Rightarrow F_D \left(\frac{L_D}{L_R}\right)^{\frac{1}{a}}$ $F_D \approx 1608.70245$ lbf => 0.22241103 kN Average steps/min => 61 => 61/2 => 30.5 rev/min FD=1010 N $F_R = 505 \left(\frac{(L_D)(30.5)\ 60}{L_R\ n_R\ 60}\right)^{\frac{1}{3}}$ (1000h; Based on Bearing you find) $\Rightarrow F_R = 505N \left(\frac{(10000h)(30.5 rev/min)\ 60}{(5000 rev/min)\ 60}\right)^{\frac{1}{3}}$
Look for help from Dr.Ciocanel regarding Technical Analysis	February 1st	Jan 29th	Referred me to use Ball Bearings, Because we only Have radial force applied to the point where we are going to install the bearings.

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Result/Proof of Completion

Make carbon fiber template for lay-up process	February 4th	February 3rd	
Layup carbon fiber	February 11th	Not Complete	I could not complete this task due to the team missing an item in the previous order. I am currently in contact with the company to retrieve the item as soon as possible.
Complete analysis on U-bar system to determine how many layers of carbon fiber will be needed per the specified loading	February 4th	In progress	This task requires more time than expected. Here is an update on the progress so far: • Determine loading on the U-bar Complete • Determine stress on the U-bar Complete • Ask graduate student and Dr. Penado about how to calculate yield stress of carbon fiber depending on the orientation of the fibers In progress • Set up stress equation Complete • Solve stress equation to determine the minimal thickness of carbon fiber needed to support given load. Incomplete • Determine how many layers are needed per the thickness of carbon fiber. Incomplete
Second Purchase Order	February 6th	February 4th	Since I was unable to layup carbon fiber, I completed the purchase request for this coming week. The team will require more materials by February 11th to stay on track.

			BiOM Prosthesis Adapter Bill of Materials

Vendor	Web address	Description	catalog #/part #/SKU	qty	cost/qty	overall cost
Rock West Composites	https://www.rockwestcomposites.com/materials-tools/vacuum-bagging-materials/tapes/3009-d	Vacuum bag sealant tape 1/2"x30 ft roll	3009-D	1	$9.99	$9.99
Amazon	https://www.amazon.com/SeatPost-Aluminium-Seatpost-Cannondale-Specialized/dp/B017TPUHJC/ref=sr_1_18?i	bike clamp with ID ranging between 31.75mm and 25 mm ODIER Bike Bicycle Quick Release SeatPost Clamp	N/A	1	$8.29	$8.29
McMaster-Carr	https://www.mcmaster.com/aluminum-tubing	small aluminum tubing : wall thickness of 0.065" with OD of 1" and 1 foot long	9056K75	1 ft	$11.31	$11.31
McMaster-Carr	https://www.mcmaster.com/aluminum-tubing	larger aluminum tubing : wall thickness of 0.065" with OD of 1.25" and 1 foot long	9056K76	1 ft	$13.08	$13.08
McMaster-Carr	https://www.mcmaster.com/standard-ball-and-roller-bearings	bearings: sealed with extended inner ring. Shaft diameter of 0.25", Inner Ring OD 0.313"	6384K342	2	$9.88	$19.76
McMaster-Carr	https://www.mcmaster.com/shoulder-bolts	shoulder bolts : 0.25" OD and 3/4" long. Thread size of 10-24	91259A540	4	$1.19	$4.76
McMaster-Carr	https://www.mcmaster.com/hex-locknuts	Locknuts : 6061 aluminum threadsize of 10-24.	95856A225	1 pkg	$4.04	$4.04
Unable order due to incomplete technical analysis		extension spring				
Unable to order due to incomplete technical analysis		compression spring				
McMaster-Carr	https://www.mcmaster.com/springs	smaller compression spring : 0.375" long, ID of 0.256" compression spring	9657K265	1 pkg	$10.50	$10.51

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. Complete Bearing Technical Analysis [~3 hours] 2. Help Leah Manufacture cuffs from thermoplastic (3) [~2 hours] 3. Update Website [~1 hour]	1. February 11th 2. February 11th 3. February 7th
Ebrahim Hubail	1. Work on Shoulder Bolt Technical Analysis [~4 hours] 2. Help Leah Manufacture cuffs from thermoplastic (3) [~2 hours]	1. February 11th 2. February 18th
Dominic Kristich	1. Complete Analysis to Determine Spring Specifications [~2 hours] 2. Complete up to 75% of report revisions[~3 hours]	1. February 6th 2. February 11th
Leah Liebelt	1. Manufacture cuffs from thermoplastic (3) [~2 hours] 2. Complete U bar analysis [~4 hours]	1. February 11th 2. February 11th

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, February 11th, 2019 5:30pm

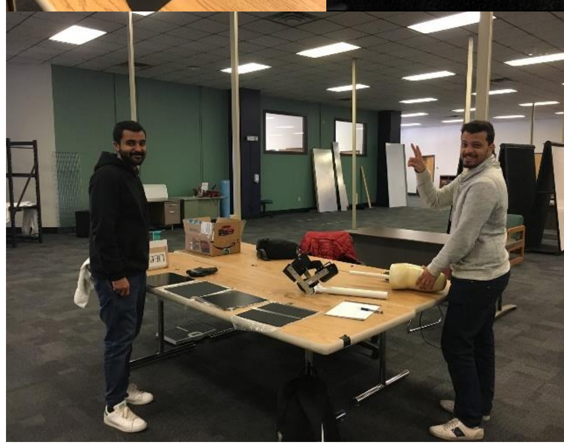
The following are the Action Items from last week:

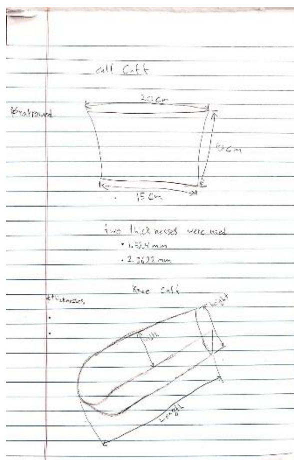
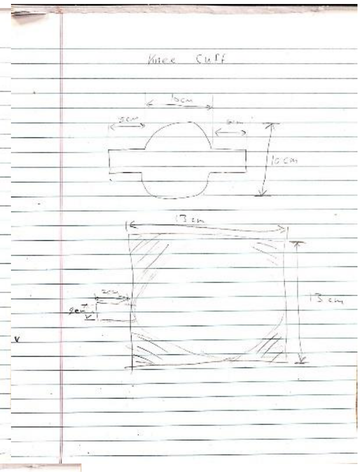
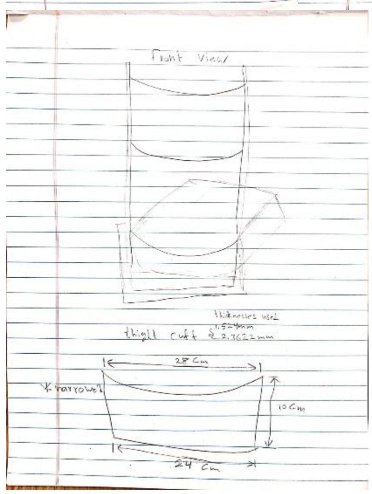
Team Member: Dominic Kristich

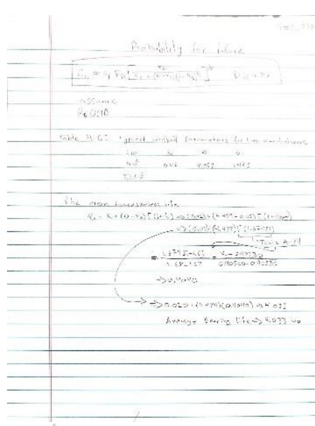
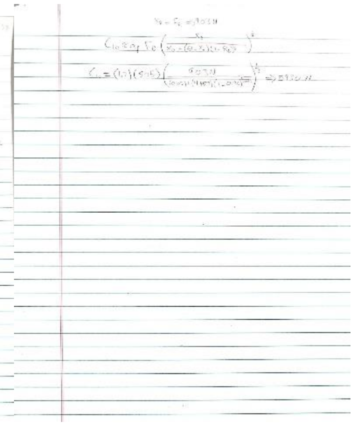
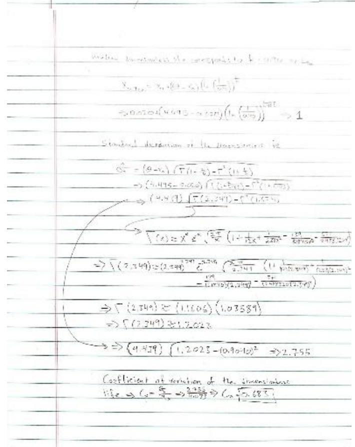
Action Item	Date Due	Date Completed	Result/Proof of Completion
Complete spring analysis	Feb 6th	Not Yet Completed	No progress made this past week.
Complete 75% of report revisions	Feb 18th	Not Yet Completed	No progress made this past week.
Structural Analysis of System	March 1	In Progress	No progress made this past week.

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
Website Update	February 8th	February 6th	**Updated:** • Meeting Minutes • BOM

			• Added Action Items and submitted website check-1 link to website: https://www.cefns.nau.edu/capstone/projects/ME/2018/18F1_BIOMAdapter/
Manufacture calf cuffs, thigh cuffs, and knee brace from thermoplastic	February 11th	February 8th	  

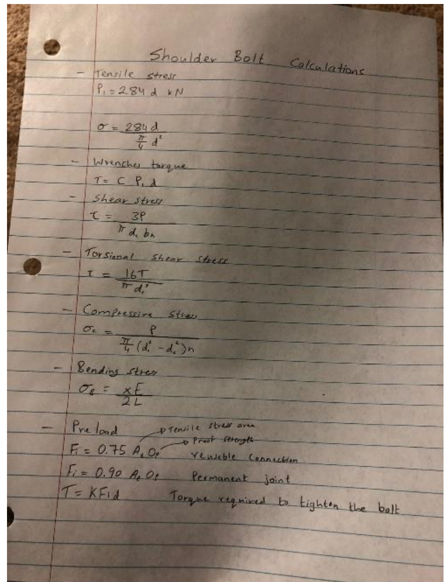
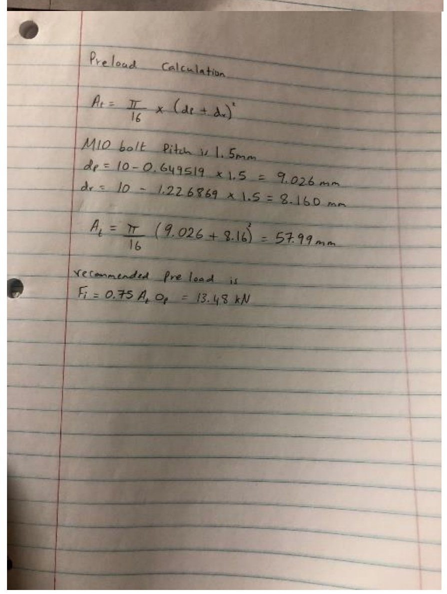
			
Bearing Technical Analysis	March 1st	In Progress	The Weibull Parameters are assumptions based on [1]Shigley's Mechanical Engineering Design, 9th or 10th Eds., R.G. Budynas & J.K. Nisbett, McGraw-Hill, 9th Edition 2011. I have Contacted Mcmaster carr regarding the values that are required to complete the analysis, they have referred me to the manufacturer of the bearing that we have ordered from them" http://www.rbcbearings.com", unfortunately I couldn't find the particular values that I was looking for, I have taken a step forward and emailed the engineer that has built that particular bearing and haven't gotten a response from him yet. $$R = \exp\left[-\left(\frac{x - x_0}{\theta - x_0}\right)^b\right] \quad (11\text{–}4)$$ where the three parameters are[1] x_0 = guaranteed, or "minimum," value of x θ = characteristic parameter. For rolling-contact bearings, this corresponds to the 63.2121 percentile value of x b = shape parameter that controls the skewness. For rolling-contact bearings, $b \approx 1.5$ calculations based on Shigley's book numbers:

			   For next week: • Convert to metric units • Try to reach out to the bearing manufacturer • Double check on all calculations • Make the drawings more clear

Team Member: Ebrahim Hubail

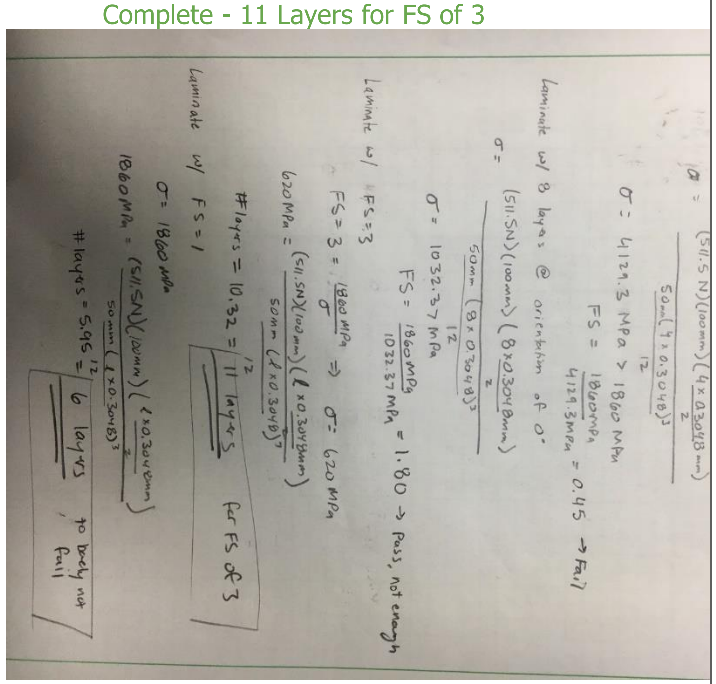
Action Item	Date Due	Date Completed	Result/Proof of Completion

Manufacture calf cuffs, thigh cuffs, and knee brace from thermoplastic	February 11th	February 8th	  
Shoulder Bolt Technical Analysis	March 1st	In Progress	This is the start up of my technical analysis, i made a research and figured out the equations that i am going to use from Shigley's Mechanical Engineering Design, 10th edition book.

			 Shoulder Bolt Calculations - Tensile stress $P_t = 284\,d$ kN $\sigma = \frac{284 d}{\frac{\pi}{4} d^2}$ - Wrenches torque $T = C P_t d$ - Shear stress $\tau = \frac{3P}{\pi d_c b n}$ - Torsional shear stress $\tau = \frac{16T}{\pi d_c^3}$ - Compressive stress $\sigma_c = \frac{P}{\frac{\pi}{4}(d^2 - d_c^2) n}$ - Bending stress $\sigma_B = \frac{xF}{2L}$ - Preload → tensile stress area → proof strength $F_i = 0.75 A_t \sigma_p$ Reusable connection $F_i = 0.90 A_t \sigma_p$ Permanent joint $T = K F_i d$ Torque required to tighten the bolt  Preload Calculation $A_t = \frac{\pi}{16} \times (d_p + d_r)^2$ M10 bolt Pitch is 1.5mm $d_p = 10 - 0.649519 \times 1.5 = 9.026$ mm $d_r = 10 - 1.226869 \times 1.5 = 8.160$ mm $A_t = \frac{\pi}{16}(9.026 + 8.16)^2 = 57.99$ mm recommended pre load is $F_i = 0.75 A_t \sigma_p = 13.48$ kN

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion

Manufacture calf cuffs, thigh cuffs, and knee brace from thermoplastic	February 11th	February 8th	~ 3 hours	 
Complete analysis on U-bar system to determine how many layers of carbon fiber will be needed per the specified loading	February 11th	February 10th	~ 4 hours	Tasks within Action Item: • Determine loading on the U-bar Complete • Determine stress on the U-bar Complete • Ask graduate student and Dr. Penado about how to calculate yield stress of carbon fiber depending on the orientation of the fibers Complete - use Promal Program - 1860 MPa • Set up stress equation Complete • Solve stress equation to determine the minimal thickness of carbon fiber needed to support given load. Complete • Determine how many layers are needed per the thickness of carbon fiber. Complete - 11 Layers for FS of 3  σ = (511.5 N)(100mm)(4 x 0.3048mm / 2) / (50mm (4 x 0.3048)^3 / 12) σ = 4129.3 MPa > 1860 MPa FS = 1860MPa / 4129.3MPa = 0.45 → Fail Laminate w/ 8 layers @ orientation of 0° σ = (511.5N)(100mm)(8 x 0.3048mm / 2) / (50mm (8 x 0.3048)^3 / 12) σ = 1032.37 MPa FS = 1860MPa / 1032.37 MPa = 1.80 → Pass, not enough Laminate w/ FS = 3 FS = 3 = 1860 MPa / σ ⇒ σ = 620 MPa 620MPa = (511.5N)(100mm)(ℓ x 0.3048mm / 2) / (50mm (ℓ x 0.3048)^3 / 12) # layers = 10.32 ≈ 11 layers for FS of 3 Laminate w/ FS = 1 σ = 1860 MPa 1860MPa = (511.5N)(100mm)(ℓ x 0.3048mm / 2) / (50mm (ℓ x 0.3048)^3 / 12) # layers = 5.96 ≈ 6 layers to barely not fail

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Dominic Kristich	1. Complete Spring Analysis [~2 hours] 2. Complete 75% of report revisions [~3 hours]	1. February 15th 2. Due date 2
Abdulla Ghayeb	1. Complete Bearing Technical Analysis [~3 hours] 2. Lay-up and Manufacture Carbon Fiber Side Supports (with Ebrahim and Leah) [~4 hours]	1. March 1st 2. February 18th
Ebrahim Hubail	1. Complete Shoulder Bolt Technical Analysis [~3 hours] 2. Lay-up and Manufacture Carbon Fiber Side Supports (with Abdulla and Leah) [~4 hours]	1. March 1st 2. February 18th
Leah Liebelt	1. Lay-up and Manufacture Carbon Fiber Side Supports (with Ebrahim and Abdulla) [~7 hrs]	1. February 18th

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, February 18th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Dominic Kristich

Action Item	Date Due	Date Completed	Result/Proof of Completion
Spring Analysis	-	-	N/A
Report Revisions	-	-	N/A

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
pylon machining	February 18th	February 16th	The two pylons that we have ordered was a perfectly fit into each others which indicates that the sizes was accurate. moreover, the clamp suited the large pylon which will only require the team to cut small part from the top so the clamp can compress on the pylon and apply the required stress to hold in place. The only issue was that the small pylon thickness cant fit in to the attachment of the BiOM. the BiOM attachment ID=30mm, the small pylon OD=31.7mm. when the pylon was machined down to OD=30.095mm, L=32. It have fitted the attachment. which concludes that the pylon is ready to be installed where it is just missing the attachment part to the U-shaped carbon fiber and to be attached with the springs.

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Task have been Done By: Abdulla Ghayeb and Ebrahim Hubail, with the help of one of the 98C Lab Instructor.

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<tr>
<td>Bearing Technical Analysis</td>
<td>February 18th</td>
<td>February 15th</td>
<td>

<u>Final Calculations:</u>

radial Force ⇒ $C_0 = F_D \left(\frac{L_D n_D 60}{L_R n_R 60}\right)^{\frac{1}{a}}$ ---- (1)

Radial Force $(F_R) = 903N$

the mean dimensionless life

$\mu_x = x_0 + (\theta - x_0)\Gamma\left(1+\frac{1}{b}\right)$ ---- (2)

Average Bearing Life ⇒ $(\mu_x) = 4.033\ L_{10}$

Coefficient of variation of the dimensionless life $C_x = \frac{\sigma_x}{\mu_x}$ .... (5)

$C_x = 0.683$

Probability for failure

$C_{10} \approx a_f F_D \left(\frac{x_D}{x_0 + (\theta - x_0)(1-R_D)^{\frac{1}{b}}}\right)^{\frac{1}{a}}$ .... (6)

Probability for failure $(C_{10}) = 5930N$

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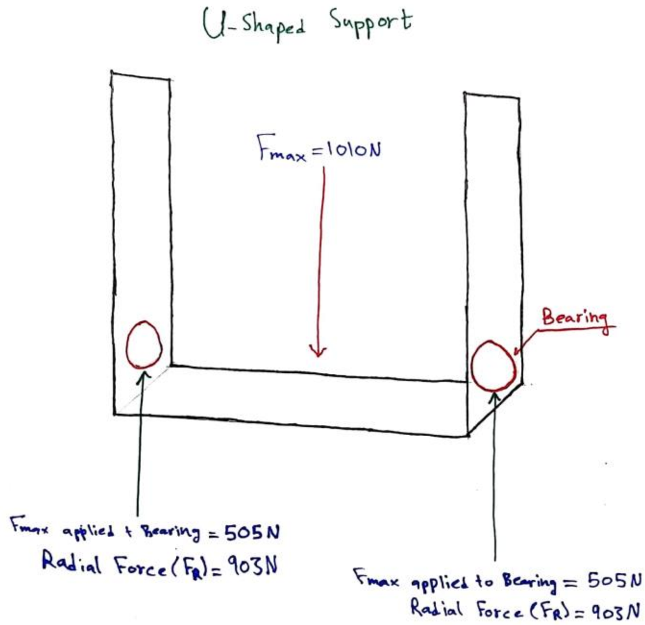
			<u>Drawing of Analysis:</u>  Drawing has been modified to be clearer and labeled with an explanation to the values. **<u>Manufacturer e-mail:</u>** Unfortunately the manufacturer did not replied to the e-mail that was sent out on February 9th. Values will remain as Shigley's book uses them on explaining chapter-11.

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion

Shoulder Bolt Technical Analysis	February 18th	February 16th	(see below)

shoulder bolt joint analysis

References Mailings Review View Help Tell me what you want to do

Introduction

Forces and stresses developed in shoulder bolt joint

There are various types of stresses that are developed in screw fasteners as a result of initial tightening and external load. It is very crucial to determine the stresses in screw fastening as a result of both static and dynamic loading so that their dimensions can be determined. During the designing of static loading it is important to know both the initial tightening and external loadings. The schematic presentation of the shoulder bolt joint is presented in figure 1 below.

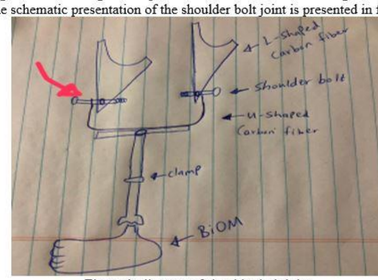


Figure 1: diagram of shoulder bolt joint

When a nut is tightened over a screw following there are five major stresses that are induced as follows:

Tensile stresses due to stretching of the bolt

Bolts are normally designed based on the factor of direct tensile stress with a large factor of safety. The initial tension in the bolt is estimated by use of empirical relation P_1=284 d kN, where the nominal bolt diameter d is given in mm. The major significance of making this relation is making the joint leak proof. Since the initial stress is inversely proportional to square of the diameter bolts which have a smaller diameter like M16 or M8 may fail during the first time of tightening. In such instances, there must be use of torque wrenches in the application of the known load. This can be shown by use of the following equation:

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$$\sigma = \frac{284d}{\frac{\pi}{4}d^2} \text{ .... (i) [1].}$$

In the wrenches torque is given by:

T= C P1d .... (ii) [1]

where, C is a constant that is dependent on coefficient of friction at the joining surfaces, P is tightening up load and d is the bolt diameter.

Shear stress across threads

This is shown by use of the following equation.

$$\tau = \frac{3P}{\pi d_c bn} \text{ .... (iii) [1]}$$

Where, T is the torque and d_c the core diameter.

Torsional shear stress

This is experienced at the threads and it is due to frictional resistance. This is shown by use of the following equation.

$$\tau = \frac{16T}{\pi d_c^{\,3}} \text{ .... (iv) [1]}$$

Where, d is the core diameter; b is the base width of the thread and n is the number of threads that shares the load as a result of frictional resistance at the threads.

Compressive stress on the threads

It is also known as crushing stress and it normally occurs when the surfaces under the bolt head or nut are not in a perfect manner normal to the axis of the bolt.

$$\sigma_c = \frac{P}{\frac{\pi}{4}\left(d_0^{\,2} - d_c^{\,2}\right)n} \text{ .... (v) [1]}$$

Bending stress

In case the underside of the bolt and the bolted part are not parallel, the bolt may be subjected to bending. In this regard, the bending stress may be given by the following equation:

$$\sigma_B = \frac{xE}{2L} \text{ .... (vi) [1]}$$

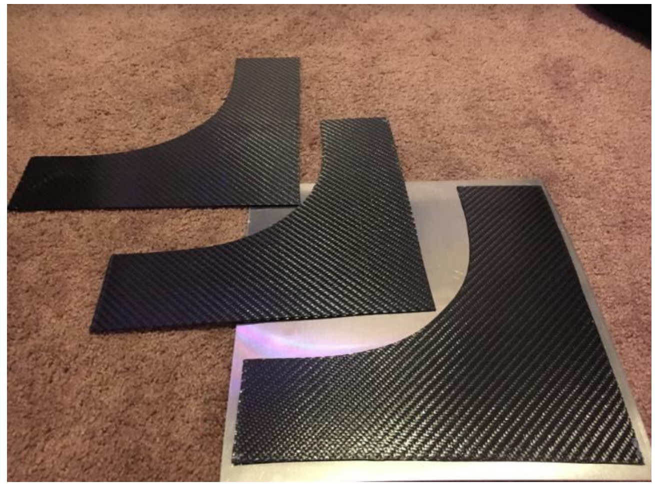
Where, x is the variation in height between the extreme corners of the bolt head, E is the young's modulus, and L is the length of the bolt head shank.

Preload

			• I typed a rough draft in a word doc for my technical analysis and added equations. • I am going to meet with Dr. Trevas this week to discuss with him about the calculations so i work with the right numbers.

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Carbon Fiber leg support layup	February 18th	February 16th	~3 hrs	 8 layers of prepreg carbon fiber were stacked in preparation of the hardening process. **Task have been completed by: Abdulla Ghayeb, Ebrahim Hubail, and Leah Liebelt.**

Harden the Carbon Fiber epoxy in the leg support layup	February 18th	February 16th	~3 hrs	 Carbon fiber after epoxy hardened. Unfortunately, about 3 layers of carbon fiber delaminated from the other 5 layers in one set of leg supports. The other had a slight delamination in 1 outer layer. The cause of delamination is known to be a plastic adhesive between the layers in one set, and not enough pressure applied to the second set during hardening, causing one layer to delaminate in a small section.

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Dominic Kristich	1. Find dimensions for compression spring and expansion spring that attaches to pylon and leg support. 2. Complete 25% of report revisions to prepare for midpoint report submission. 3. Complete another 25% of report revisions to prepare for midpoint report submission. 4. Conduct research on structural analysis of prosthetics for benchmarking of technical analysis.	1. February 18th 2. February 21st 3. February 22nd 4. February 24th
Abdulla Ghayeb	1. Complete Bearing Technical Analysis • Apply equations to MATLAB. [~4 hr] 2. Layup U shaped carbon fiber [~2 hr]	1. February 24th

		2. February 24th
Ebrahim Hubail	1. Complete Shoulder Bolt Technical Analysis • Calculations [~3 hr] 2. Layup U shaped carbon fiber [~2 hr]	1. February 24th 2. February 24th
Leah Liebelt	1. Epoxy two delaminated sheets of carbon fiber back together and harden again. Apply touch-up epoxy to carbon fiber plate to prevent delamination & help finish final product. [~1 hr] 2. Clean up edges of carbon fiber plates using Dremel [~2 hr] 3. Correct calculations for U shaped carbon fiber piece, integrate into the technical analysis report [~1.5 hr] 4. Layup U shaped carbon fiber [~2 hr] 5. Harden U shaped carbon fiber [~2 hr]	1. February 19th 2. February 19th 3. February 22nd 4. February 24th 5. February 25th

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, February 25th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
Bearing Technical Analysis • Apply equations to MATLAB	February 25th	February 21st	I have coded my equations and implemented it into MATLAB to get the results in neet form for the Bearing Technical Analysis. **<u>MATLAB:</u>** clc clear all % DATA collected on Nishikawa's lab fprintf('Data Collected on Nishikawa''s lab\n') m = 45.3; % mass is 45.3 Kg F_max_app = 503; % Maximum Force Applied W = 444.4; % W is 444.4N Ratio = F_max_app/W; fprintf('Mass = %.1f (kg) , Maximum Force Applied = %.2f(N) \n',m,F_max_app) fprintf('W = %.2f(N), ',W) fprintf('Ratio = %0.2f %%\n',Ratio*100) % Required from Customer, Average Human Weight Wavg = 200; % Average Weight in lbs mavg = Wavg/2.2; % mass in Kg, for average human g = 9.81; % gravitational Constant W = mavg*g; % Weight of average human Fmax = Ratio*W; % Maximum Force Calculated fprintf('\n\nFor an average Human \n') fprintf('Mass = %.2f (kg)\n',mavg) fprintf('Weight = %.2f (N)\n',W) fprintf('Fmax = %.2f (N)\n',Fmax) % Force applied will be distributed on two bearings Fmax_each_bearing = Fmax/2;

			fprintf('\n\nFmax for each bearing = %.2f(N)\n',Fmax_each_bearing)
			
			Fd = Fmax_each_bearing;
			Ld = 10000; % Life Desired
			nd = 61/2; % Speed Desired, average person steps per minute
			Lr = 3.2 *10^6; % Life rating given from the seller
			FR = Fd *(((Ld*nd*60)/Lr)^(1/3));
			fprintf('Radial Force (FR) = %0.1f(N)\n',FR)
			
			% Assume Rd = 0.90
			Rd = 0.90;
			Xo = 0.02;
			O = 4.459;
			b = 1.483;
			% From Table A-34, Integration
			% Intg = 1+1/b
			Intg = 0.9040;
			% now putting in Eq-2
			mu_x = Xo +(O-Xo)*Intg;
			fprintf('mu_k = %.3f\n',mu_x)
			% Medium Dimension less life corresponds to R = 0.90 Or L90
			R= 0.90;
			X_0_90 = Xo +(O-Xo)*((log(1/R))^(1/b));
			fprintf('X_0.90 = %0.0f\n',X_0_90)
			% Standard deviation of the dimension life
			% define integral from the table
			% Intg (1+2/b)
			
			Int_2_349 = 1.2023;
			Intg_2 = 0.9040;
			% now sigmax
			sigma_x = (O-Xo)*sqrt(Int_2_349 - Intg_2^2);
			fprintf('\nStandard Deviation = Sigma_x = %.4f \n',sigma_x)
			
			% coefficient of variation
			Cx = sigma_x/mu_x;
			fprintf('Cx = %.3f \n',Cx)
			
			% Now For probability of Failure
			af = 1.2;
			a = 3;
			Xd = FR;
			C10 = af*Fd* (((Xd)/(Xo + (O-Xo)*((1-Rd)^(1/b))))^(1/a));
			fprintf('C10 = %.0f\n',C10)
			
			Results:

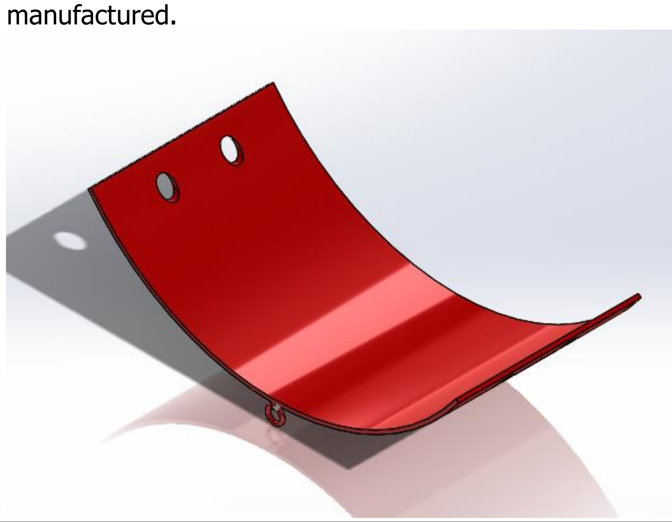
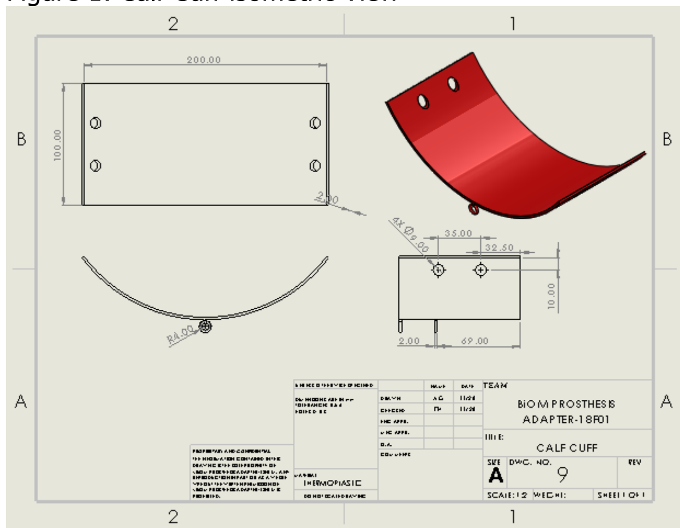
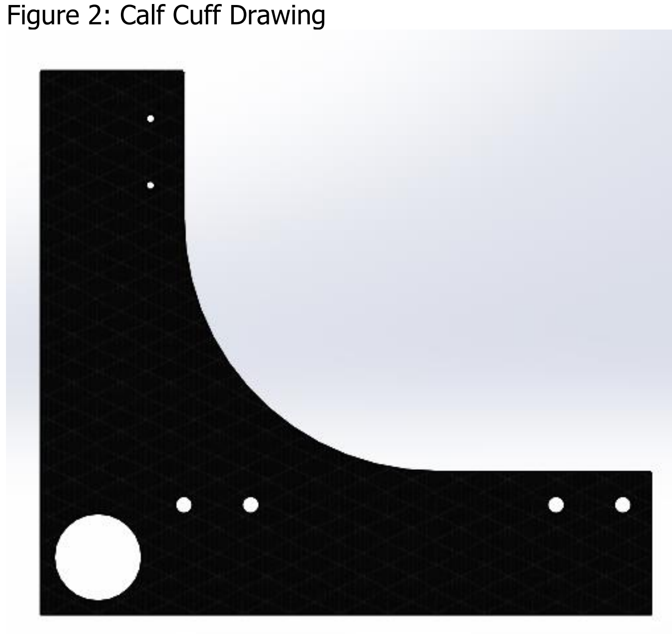
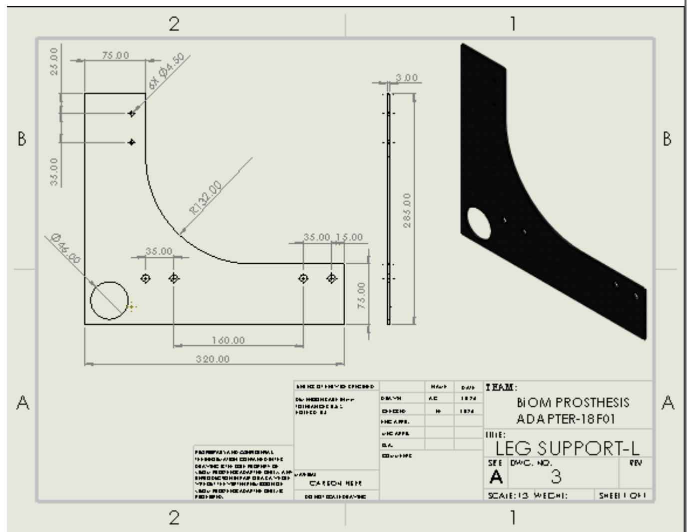
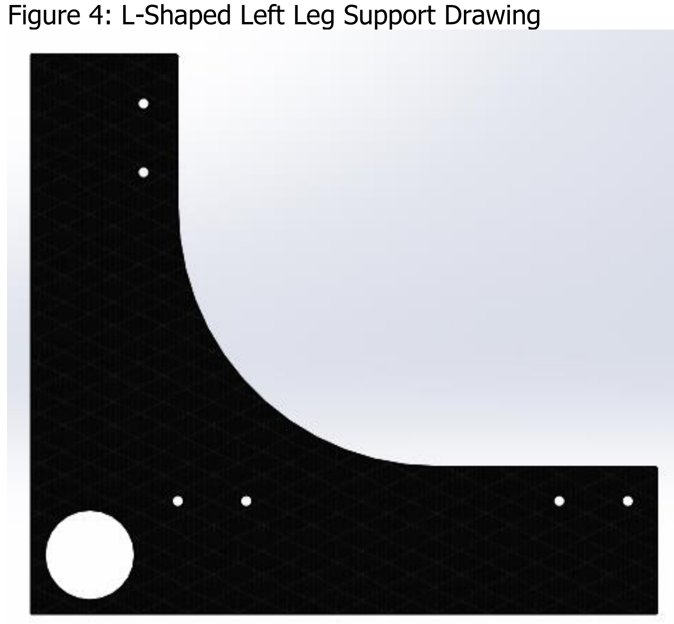
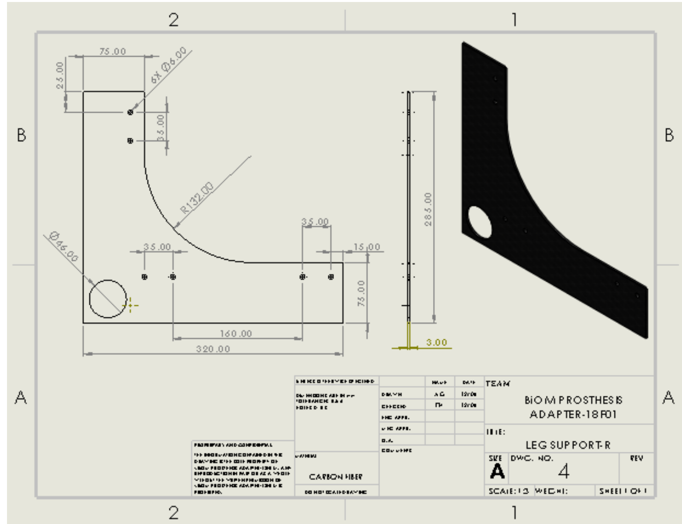
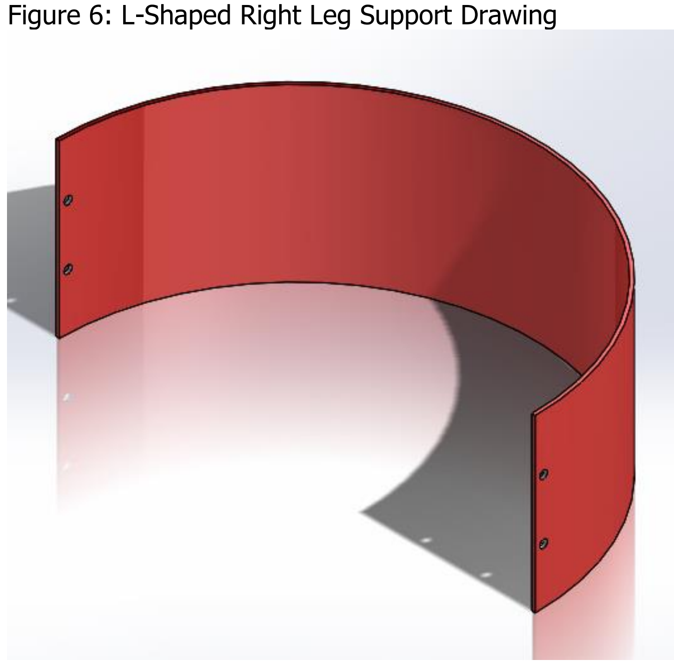
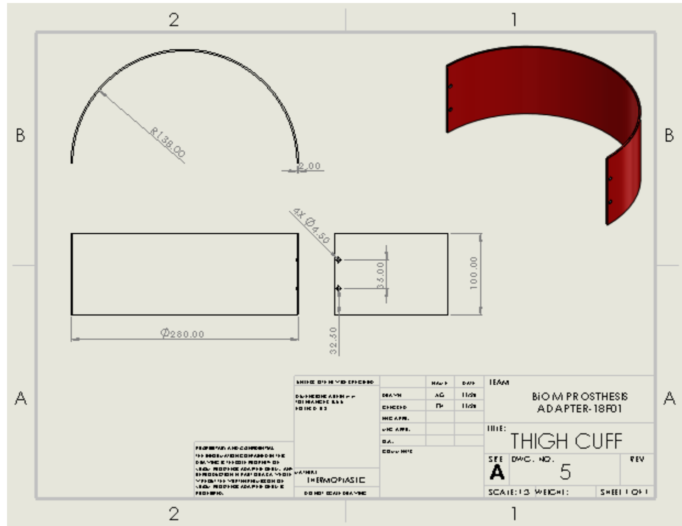
			Data Collected on Nishikawa's lab Mass = 45.3 (kg) , Maximum Force Applied = 503.00(N) W = 444.40(N), Ratio = 113.19 % For an average Human Mass = 90.91 (kg) Weight = 891.82 (N) Fmax = 1009.42 (N) Fmax for each bearing = 504.71(N) Radial Force (FR) = 902.6(N) mu_k = 4.033 X_0.90 = 1 Standard Deviation = Sigma_x = 2.7546 Cx = 0.683 C10 = 5934
CAD Package Update	February 25th	February 23rd	The CAD Model that We have built in the Fall semester have to be updated, du to changes in dimensions and adding new components to the final device. The main issue on updating the CAD model was that most of the mates in the final assembly have been discarded. to fix this problem, the final Assembly should be reassembled because fixing it would take more time. this task would take a long time. Although the due date of submitting the final CAD package this semester is on April 29th. For this week, as a start the thigh cuff, Calf cuff, and L-Shaped Left & Right Side Support have been updated to current dimensions that the team have determined and manufactured. 

			Figure 1: Calf Cuff isometric View  Figure 2: Calf Cuff Drawing  Figure 3: L-Shaped Left Side Support Front View

			 Figure 4: L-Shaped Left Leg Support Drawing  Figure 5: L-Shaped Right Leg Support Front View

			 Figure 6: L-Shaped Right Leg Support Drawing  Figure 7: Thigh Cuff isometric View

			 Figure 8: Thigh Cuff Drawing

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion

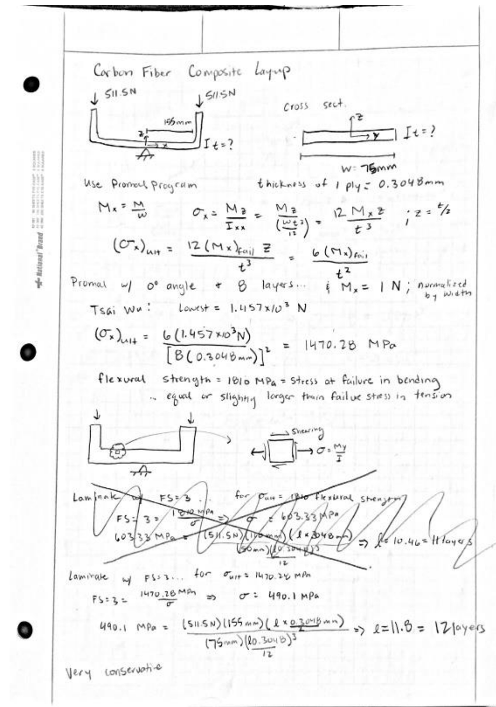
Complete Shoulder Bolt Technical Analysis	February 25th	February 24th	**Preload** The total tensile force on the bolt is due to two components namely: the preload force and applied tensile load. Preload can be described as a form of tension that is placed on the bolt by the nut but not as a result of the load [3]. It is normally applied to the connection by stretching the fastener to a certain value of torque. Torque is described as the turning moment of a nut, and is normally expressed as the product that is exerted and the length of the lever arm. There are numerous variables that are associated with the torque and therefore a safety factor is calculated to determine torque value which will lead to production of a clamp load which is lower than the yield point of that fastener. It is always crucial to ensure that, the preload does not exceed the maximum load by 15%. In normal circumstances, bolts are tightened through application of torque to the nut and this makes the bolt to stretch. On the other hand, the stretching leads to bolt tension, which is normally referred to as preload, that is, the force that holds a joint together. High preload tension is of great significance since it helps in keeping the bolts tight, increases the strength of a joint, leads to generation of friction between parts to resist shear and improves fatigue resistance of connections that are bolted. In order to measure the bolt tension, a torque meter is used. The preload can be determined at two levels as follows: In the case of reusable connection, the preload can be determined by: $F_i = 0.75 A_t \sigma_p$ .... (vii) [2] In the case of permanent joint, the preload can be determined by: $F_i = 0.90 A_t \sigma_p$ .... (viii) [2] Where, A_t is the tensile stress area of the bolt (m2) and σ_p is the proof strength of the bolt (N/m2) After determining the preload, the torque required to tighten the bolt can be estimated by use of the following equation: $T = KF_i d$ .... (ix) [2] Where T is wrench torque (N m); d is nominal bolt diameter (m), F_i is preload (N), and K is constant. However, the value of K is dependent on the material and size of the bolt and hence the variation which is evidenced. For instance, in case of zinc plated steel bolts, lubricated steel bolts, cadmium plated steel bolts, the constant K is 0.2, 0.18, and 0.16 respectively. **calculation of preload** In this case an assumption is made that M10 bolt will be used which has a proof stress of low carbon steel bolt material of 310 MPa. In order to determine the preload on the load on the bolt, the following formula s applied. $A_t = \frac{\pi}{16} \times (d_p + d_r)^2$ The pitch for M10 bolt is 1.5mm. $d_p = 10 - 0.649519 \times 1.5 = 9.026$ mm $d_r = 10 - 1.226869 \times 1.5 = 8.160$ mm $A_t = \frac{\pi}{16}(9.026 + 8.16)^2 = 57.99$ mm^2 Therefore, the recommended preload is $F_i = 0.75 A_t \sigma_p = 13.48$ kN **Appropriate bolt stiffness** Every bolted joint has its uniqueness and there is need to determine the optimum tightening for each application through careful experimentation. When a bolt is properly tightened it is stretched such that it operates like a very ridged spring pulling joining surfaces together. The Therefore, the recommended preload is $F_i = 0.75 A_t \sigma_p = 13.48$ kN **Appropriate bolt stiffness** Every bolted joint has its uniqueness and there is need to determine the optimum tightening for each application through careful experimentation. When a bolt is properly tightened it is stretched such that it operates like a very ridged spring pulling joining surfaces together. The torque which is the rotation of the bolt at some instance results to tension which is equivalent to stretching. There are a variety of factors that influence the amount of tension that normally occurs when a certain amount of tightening torque is applied. The first factor is the diameter of the bolt. For instance, a lot of force is required to tighten a 3/4-10 bolt than a 318-16 bolt since it has a larger in diameter. There is also the factor of the grade of the bolt. In this regard, a lot of force is required to stretch an SAE Grade 8 bolt compared to a SAE Grade 5 bolt since the former has a greater material strength. The third factor is the coefficient of friction or the "nut factor which is an indicator that smoother, harder, and slicker bolting surfaces like bearing surfaces and threads, require less torque to stretch a bolt as opposed to softer, stickier and rougher surfaces [3]. However, there is need to make an evaluation so as to determine the optimum tightening torque since the K factor in this formula is always an estimation. In this regard, the most commonly used bolting K factors include: 0.22 for zinc plated bolts, 0.20 for plain finished bolts, and 0. 0.10 for highly lubricated bolts. In order for the fastener to get a longer length there is material that is donated by the part of the bolt. In this case that material will come from the threads, which are considered to be the weakest points of the bolt. A part of the threaded portion of the bolt wall will experience a reduction of area and will "neck out", leading to creation of a "dog bone" appearance [4]. This change in stress area considerably weakens the bolt hence stretching it even further. This is crucial since it results to a decrease in the clamping load. In case the operator exerts additional stretching, the bolt will eventually break when its tensile point is reached. The rough draft is mostly completed i need to check on my work and write down an introduction and conclusion. • Preload calculations Complete • Bolt stiffness calculations Complete • Check on the calculations In progress

			• Complete the write up and organize the report In progress
Team Meeting Update	-	-	All team members **Abdulla Ghayeb, Ebrahim Hubail, and Leah Liebelt** met on Friday and we have updated the team charter roles. • The team have considered a second thought about the pylon and to purchase carbon fiber pylon from Rockwest composites. Since they already have telescoping system pylons, which would help us cut the weight of our final device and to increase the durability of the pylon.

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion

Epoxy two delaminated sheets of carbon fiber back together and harden again. Apply touch-up epoxy to carbon fiber plate to prevent delamination & help finish final product. [~1 hr]	February 19th	February 18th	1 hr	
Clean up edges of carbon fiber plates using Dremel [~2 hr]	February 19th	February 19th	2 hrs	

Correct calculations for U shaped carbon fiber piece, integrate into the technical analysis report [~1.5 hr]	February 22nd	February 22nd	0.75 hrs	
Layup U shaped carbon fiber [~2 hr]	February 24th	February 22nd	1.5 hr	

Carbon Fiber Composite Layup

511.5N 511.5N 155mm $I_t = ?$ cross sect. z y $I_t = ?$ w: 75mm

Use Promal Program thickness of 1 ply = 0.3048mm

$M_x = \frac{M}{w}$ $\sigma_x = \frac{Mz}{I_{xx}} = \frac{Mz}{\left(\frac{wt^3}{12}\right)} = 12\frac{M_x z}{t^3}$; $z = t/2$

$(\sigma_x)_{ult} = \frac{12(M_x)_{fail} z}{t^3} = \frac{6(M_x)_{fail}}{t^2}$

Promal w/ 0° angle + 8 layers... & $M_x = 1$ N ; normalized by width

Tsai Wu: Lowest = 1.457×10^3 N

$(\sigma_x)_{ult} = \frac{6(1.457 \times 10^3 N)}{[8(0.3048mm)]^2} = 1470.28$ MPa

flexural strength = 1810 MPa = stress at failure in bending
.. equal or slightly larger than failure stress in tension

shearing $\sigma = \frac{My}{I}$

~~Laminate w/ FS = 3 ... for σ_{ult} = 1810 flexural strength~~
~~FS = 3 = $\frac{1810 MPa}{\sigma}$ ⇒ σ = 603.33 MPa~~
~~603.33 MPa = $\frac{(511.5N)(150mm)(\ell \times .3048mm)}{(50mm)\frac{(\ell 0.3048)^3}{12}}$ ⇒ ℓ = 10.46 = 11 layers~~

Laminate w/ FS = 3 ... for σ_{ult} = 1470.28 MPa

FS = 3 = $\frac{1470.28 MPa}{\sigma}$ ⇒ σ = 490.1 MPa

490.1 MPa = $\frac{(511.5N)(155mm)(\ell \times \frac{0.3048}{2} mm)}{(75mm)\frac{(\ell 0.3048)^3}{12}}$ ⇒ ℓ = 11.8 = 12 layers

very conservative

Harden U shaped carbon fiber [~2 hr]	February 25th	February 23rd	3 hrs	
75% of Final Proposal Report Corrections	-	February 24th	1.5 hrs	I had extra time this week to complete part of the Final Proposal Report Corrections. This item was not an action item for last week, but was to be an action item in the future. I went through and completed all report corrections up until chapter 5.2, and inserted comments for other sections that needed to be completed. If you would like proof of completion, I can email a revised copy of the report and the corrections to you.

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. Complete Bearing Technical Analysis • Organize the Report and complete the write up to submit it by due date. [~4] 2. Update the CAD Package [~3 hr] • U-shaped Support + Drawing • Shoulder bolt of bearing + Drawing	1. March 1st 2. March 2nd
Ebrahim Hubail	1. Complete Shoulder Bolt Technical Analysis [~4 hr] • Check the calculations. • Complete report write up and organizing. 2. Work with Abdulla on updating the CAD Package [~3 hr] • Lock nut + Drawing • Velcro Straps + Drawing	1. March 1st 2. March 2nd

Leah Liebelt	1. Dremel U bar carbon fiber edges [~1 hr] 2. Write up technical analysis report [~4 hr] 3. Finish Final Proposal Rewrite [~1 hr] 4. Write section 7 of midpoint report [~2 hr]	1. February 27th 1. March 1st 2. March 3rd 3. March 4th

ACTION ITEMS

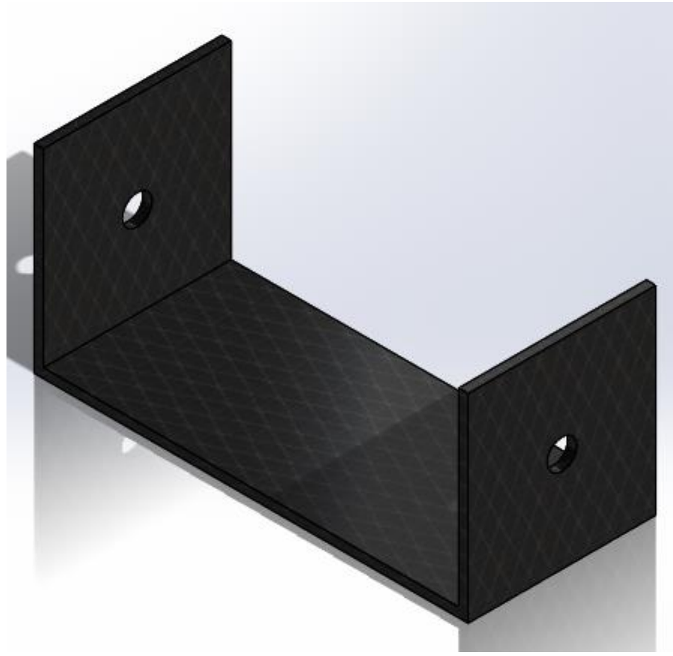
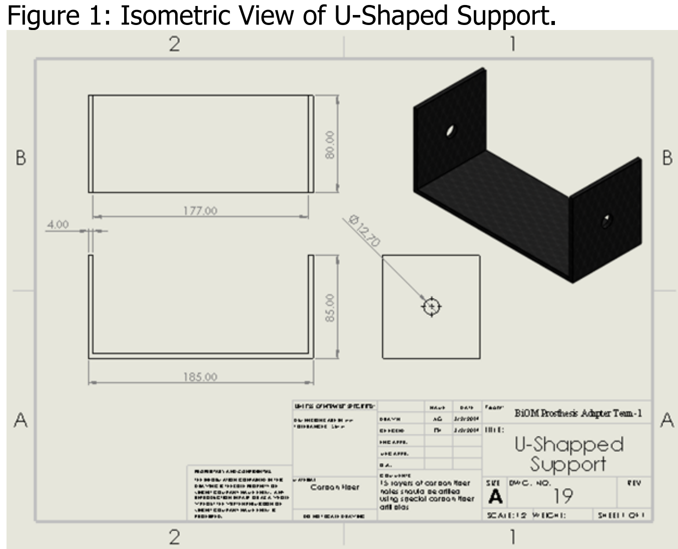
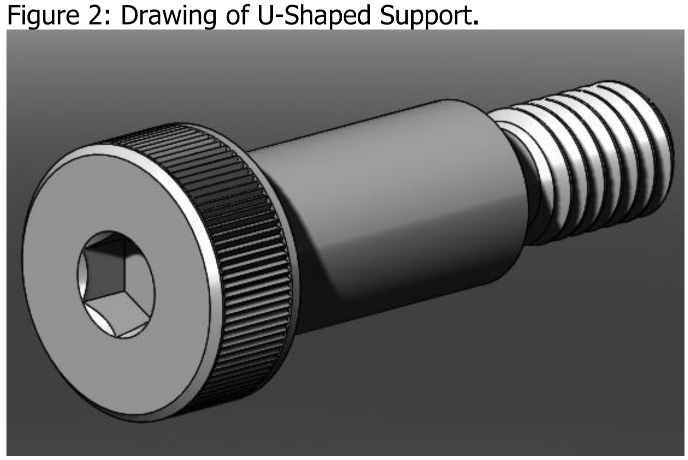
TEAM: F18 BiOM Prosthesis Adapter

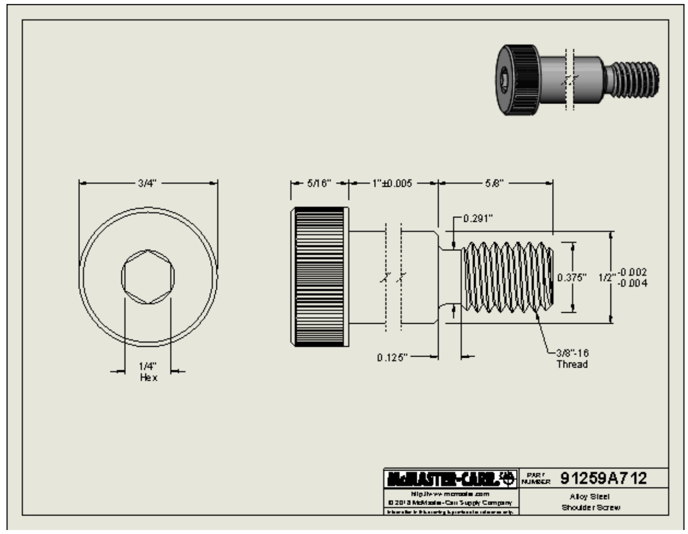
Due Date:
Monday, March 4th, 2019 5:30pm

The following are the Action Items from last week:

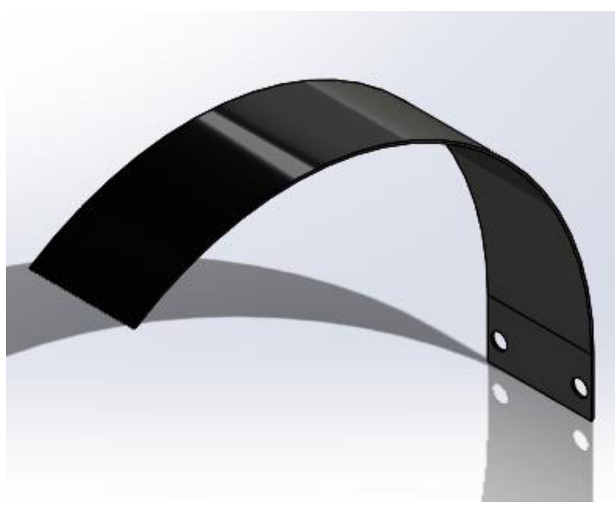
Team Member: Abdulla Ghayeb

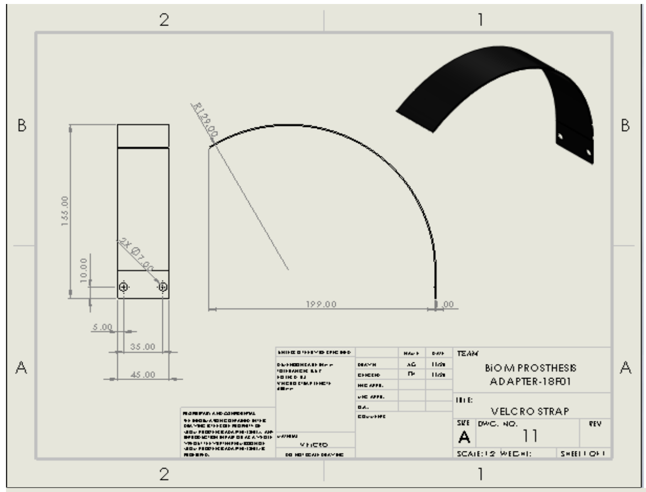
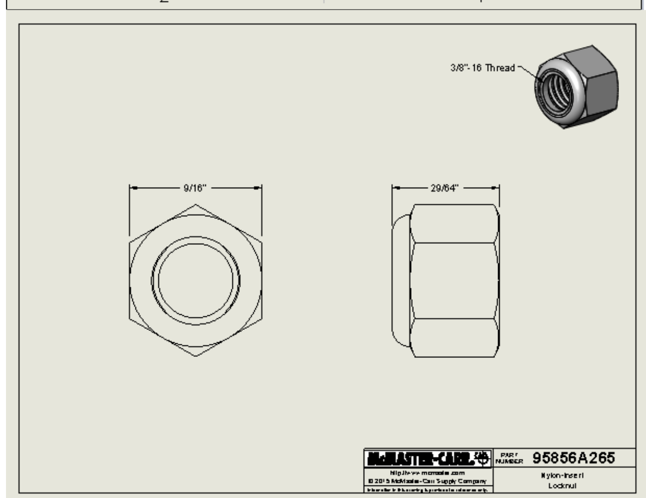
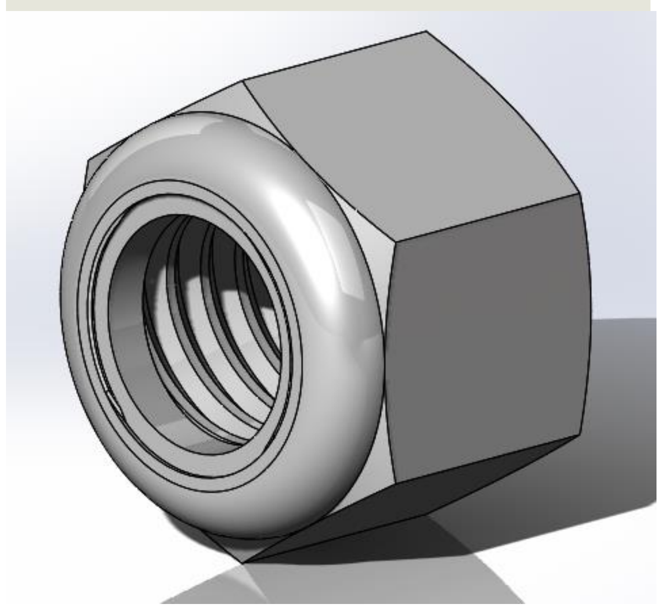
Action Item	Date Due	Date Completed	Result/Proof of Completion
Bearing Technical Analysis • Complete and submit Technical Analysis	March 1st	March 1st	Completed Technical Analysis write-up and Organized the formatting and submitted on time. (Document is too large to fit for proof, 14 pages)
CAD Package Update	March 4th	March 3rd	Updates in CAD Package: • U-shaped Support + Drawing • Shoulder bolt of bearing + Drawing • Exploded View Drawing Sub-Numbering to match BOM U-Shaped Support: Note: Drilling Holes to be determined once the team receives the attachment from the U-shaped to the Pylon, Order have been Placed by Ebrahim.

			 Figure 1: Isometric View of U-Shaped Support.  Figure 2: Drawing of U-Shaped Support.  Figure 3: Shoulder Bolt Purchased through mcmaster.

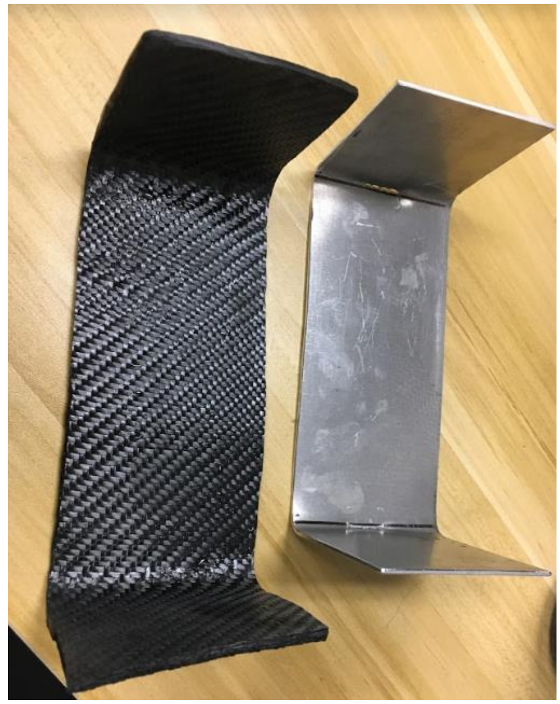
			 Figure 4: Shoulder Bolt Drawing.

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion
Complete Shoulder Bolt Technical Analysis	March 1st	March 1st	Submitted the file to BBlearn.
CAD Package Update - Velcro Straps + Drawing - Lock nut + Drawing	March 2nd	March 2nd	

			 R129.00 155.00 10.00 5.00 35.00 45.00 199.00 BIOM PROSTHESIS ADAPTER-18F01 VELCRO STRAP DWG. NO. 11 SCALE:1:2  3/8"-16 Thread 9/16" 29/64" PART NUMBER 95856A265 Nylon-Insert Locknut 

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Dremel U bar carbon fiber edges [~1 hr]	February 27th	February 27th	1.5 hr	
Write up technical analysis report [~4 hr]	March 1st	March 1st	4.5 hr	See Bblearn.
Finish Final Proposal Rewrite [~1 hr]	March 3rd	March 2nd	3 hr	Contact me for proof of complete report revision. Document is too long for proof.
Write section 7 of midpoint report [~2 hr]	March 4th	March 4th	1.5 hr	Contact me for proof of completion. Document is too long for proof.

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. Update the CAD Package [~4 hr] • L-Shaped Support holes dimensions, Resize and Print on A3 to Leah For punching Holes. • Springs determined to be used for motion. • Rockwest attachment • Rockwest clamp • Look for the foot attachment Grabcad. • If all parts below the U-Shaped are done Start the new assembly.	1. March 11th
Ebrahim Hubail	1. Drill holes in Thermoplastic cuffs 2. Attach the velcro straps to the cuffs 3. Attach the cuffs to the L shaped carbon fiber	1. March 9th 2. March 9th 3. March 9th
Leah Liebelt	1. Write Abstract for UGRADS submission [0.5 hr] 2. Drill holes in L shaped carbon fiber component [3 hr] 3. Drill holes in U-bar carbon fiber component [2 hr] 4. Review Midterm Report & edit as needed [2 hr] 5. Complete Midterm powerpoint presentation [2h hr]	1. March 4th 2. March 7th 3. March 7th 4. March 8th 5. March 10th

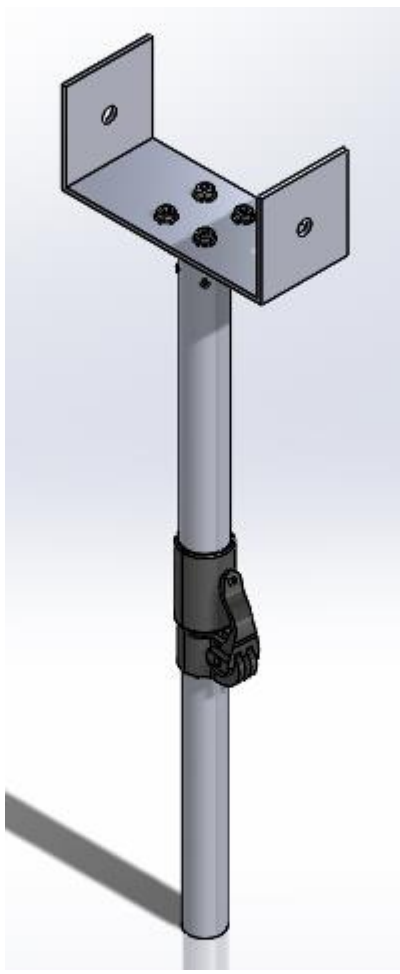
ACTION ITEMS

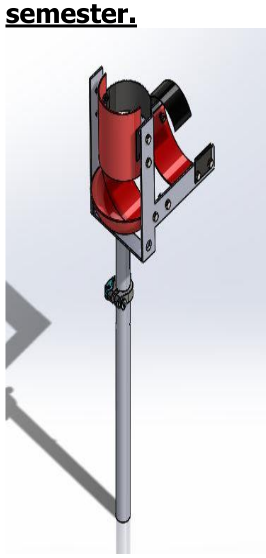
TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, March 11th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
CAD Package Update	March 11th	March 6th	 Figure 1: New Assembly of the device Start-up.

			The start-up of the assembly have included all the parts that we have already from the bottom part of the device. The pylon length have been not determined yet, it should be done after the testing procedure. to secure the mounting plate in place I had to find the right Bolts and Nuts through Mcmaster all links are provided below to be ordered. extra length was required on the screws that should secure Mounting Plate to the pylon with the same pitch “6-32.” link is provided below to order 6-32x1/2” screw to ensure that it will hold properly in place. Clamp drawing is requested from manufacturer to be included in the final CAD package. **Note: All parts in the assembly might change through the semester.**  Figure 2: Screenshot from previous CAD design. As shown in Figure 2 the clamp differs from the new one installed as shown in Figure 1. the previous design U-Shaped Support was meant to be welded on the pylon as shown in Figure 2, In the other hand in Figure 1 it shows that it there will be a Mounting Plate connecting the Pylon with the U-Shaped Support, and the reason is because the team have chosen to have the pylon and the U-Shaped Support material as Carbon fiber so it could have more stiffness and as the Carbon is known that it is light weighted. The main change in the pylon is that as Shown in figure 1 that the top tube is larger than the bottom. It have been flipped because it was meant to have the adjustment do not interfere the Springs attached So they could operate normally as needed. **As of this Point Progress of the New CAD Assembly is 20% Completed.** • Tasks: ◦ L-Shaped Support holes dimensions, Resize and Print on A3 to Leah For punching Holes.

			(Completed and provided a Screenshot for Leah) • Springs determined to be used for motion. **(Completed, Needs to be added to the Assembly)** • Rockwest attachment **(Completed, STP format file had to be converted to SLDPRT part)** • Rockwest clamp **(Completed, File was not provided on the Website. I have contacted the company to send the STP file and it have been converted to SLDPT)** • Look for the foot attachment Grabcad. **(Not Completed, had to determine all the dimensions to be designed on Solidworks. The part was not found in Grabcad.)** • If all parts below the U-Shaped are done Start the new assembly. **(In Progress, Since most of the parts are located and designed the assembly have started including the U-Shaped Support, Mounting Plate, Pylon new clamp, top and bottom tubes for the pylon, Screws, Bolts and Nuts to secure all parts in place.)** • **Drawings Updated" L-Shaped, U-Shaped, Mounting Plate, Bearing, shoulder bolt, Thigh cuff, Calf cuff, Small Spring, compression Spring for motion, Screws, Bolts and Nuts."**

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion

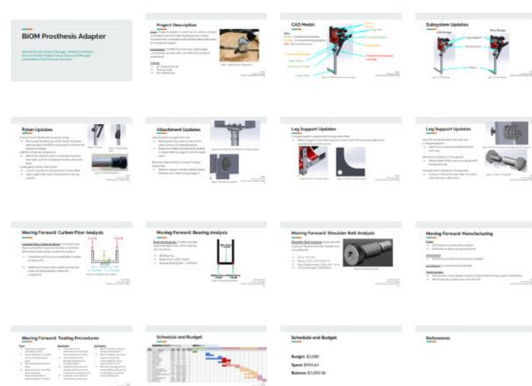
Drill holes in Thermoplastic cuffs	March 9th	March 8th	 Figure 3: Thigh cuff  Figure 4: Calf cuff

			 Figure 5: Knee cuff
Attach the velcro straps to the cuffs	March 11th	March 11th	 Figure 6: Velcro Straps attached to the cuffs

Attach the cuffs to the L shaped carbon fiber	March 10th	March 10th	 Figure 7: Upper part of the device assembly

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Write Abstract for UGRADS submission	March 4th	March 3rd	0.5 hr	BiOM Prosthesis Adapter The BiOM Ankle Prosthesis Device is an advanced robotic ankle which allows people with below-the-knee amputees the ability to walk unassisted. An adjustable adapter was needed to test the BiOM Ankle Prosthesis device for research purposes. The adapter was to span from the BiOM Ankle Prosthesis device to the bent knee of an able-bodied person to allow research to be conducted on the ankle prosthesis without the need of an impaired subject. This adapter was to fit different sized users, be lightweight, comfortable, durable, safe, cost effective, and have a quick attachment for the user. Currently, researchers have no way to accurately and quickly test the BiOM device on able-bodied users. If the BiOM device could be tested on able-bodied users, it would shorten the time the BiOM would be under research, and would provide amputees with a more reliable and realistic BiOM device.

Drill holes in L-shaped carbon fiber component	March 7th	March 6th	3 hr	
Drill holes in U-bar carbon fiber component	March 7th	March 6th	1.5 hr	See U-bar above.
Review Midterm Report & edit as needed	March 8th	Not complete		due-date moved back 1 week. Focused on powerpoint presentation in lou of moved due date.
Complete midterm powerpoint presentation	March 10th	March 10th	6 hr	

The following are the Action Items for next week:

Team Member	Action Items	Date Due

Abdulla Ghayeb	1. CAD Package Update [~5 hr]
	• Complete 80% of the upper Part of the device Assembly
	    • Add L-Shaped Support
	    • Add Cuffs
		1. March 15th

	• Add bearing • Add shoulder bolts • Add chicago bolts • Add Velcro Strap	
Ebrahim Hubail	1. Cut and form the galvanize plate to shape the new U-shaped attachment. 2. Attach the pylon to the attachment and then to the U-shaped attachment.	1. March 13th 2. March 13th
Leah Liebelt	1. Complete midterm report [2 hr] 2. Drill holes in carbon fiber U-bar support for attachment [2 hr] 3. Drill holes in carbon fiber upper pylon	1. March 13th 2. March 12th 3. March 12th

ACTION ITEMS

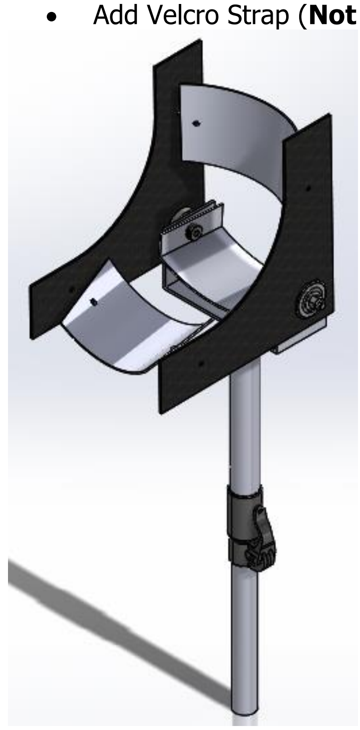
TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, March 25th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion

CAD Package Update	March 25th	March 20th	1. CAD Package Update [~5 hr]
			• Complete 80% of the upper Part of the device Assembly
			  • Add L-Shaped Support (**Completed**)
			  • Add Cuffs (**Completed**)
			  • Add bearing (**Completed**)
			  • Add shoulder bolts (**Completed**)
			  • Add chicago bolts (**Not Completed**)
			  • Add Velcro Strap (**Not Completed**)
			
			Figure 1: Updated CAD Package.
			As Shown in figure 1 70% of the upper portion of our device is completed. over all the CAD package is still in progress where it

			is in 75% of completion. all what is left is the chicago bolts, velcro straps, springs, and attachment to the BiOM.

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion
Cut and form the galvanize plate	25th March	-	Not completed and will be done by the 26th of March.
Attach the pylon to the attachment and then to the U-shaped attachment	25th March	-	Not completed and will be done by the 26th of March.

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Complete midterm report	March 13th	March 12th	2 hr	Submitted in BBlearn.
Drill holes in carbon fiber U-bar support for attachment	March 26th			Will be completed by Tuesday 26th of March
Drill holes in carbon fiber upper pylon	March 26th			Will be completed by Tuesday 26th of March

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. CAD Package Update [~2 hr] • Complete 80% of the upper Part of the device Assembly • Add Small springs • Add chicago bolts • Add Velcro Strap 2. Work as a team to assemble as much as we can for hardware review-2. [~3hr]	1. April 1th 2. March 26th
Ebrahim Hubail	1. Cut and form the galvanize plate to shape the new U-shaped attachment. 2. Attach the pylon to the attachment and then to the U-shaped attachment.	1. March 26th 2. March 26th
Leah Liebelt	1. Drill holes in carbon fiber U-bar support for attachment [2 hr] 2. Drill holes in carbon fiber upper pylon	1. March 26th 2. March 26th

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, April 1st, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

<table>
<tr><th>Action Item</th><th>Date Due</th><th>Date Completed</th><th>Result/Proof of Completion</th></tr>
<tr><td>CAD Package Update</td><td></td><td></td><td>

- Complete 80% of the upper Part of the device Assembly
    - Add Small springs (**Not Completed**)
    - Add chicago bolts (**Completed**)
    - Add Velcro Strap (**Completed**)
    - Exploded view (**Completed**)
    - Drawing of exploded view (**Completed**)

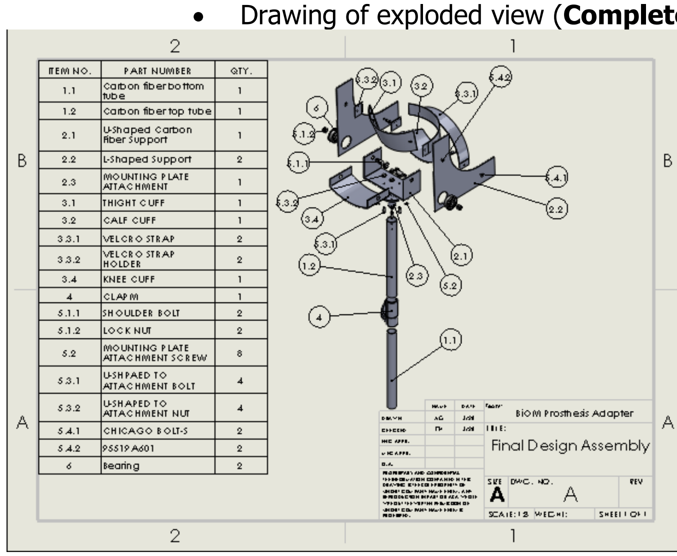


Figure1: Last Updated CAD package

Reaching this point in the CAD package I would say that it is 95% Completed knowing that there are some parts that needs to be designed and added to the assembly. despite the small changes that might happen after the testing procedure. because after the testing the sizes of some of the components in the device will probably change based on the results of the testing. Moreover, after adding all the components and having all the assembly

</td></tr>
</table>

			completed the appearance of the device have to be added to give it the carbon fiber look.
			 Figure 2: Bearing Epoxy Leah have done the mixture of the epoxy because she have done it before a lot, and then she handed it to me and I have applied it to the bearings and the support. after that I have clamped them to the table with Ebrahims help.

Team Member: Ebrahim Hubail

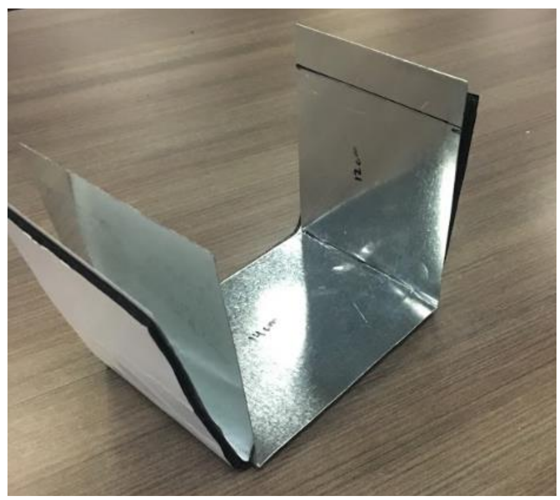
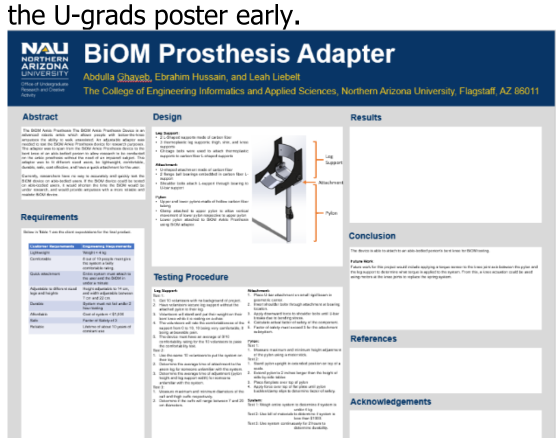
Action Item	Date Due	Date Completed	Result/Proof of Completion

Cut the galvanize plate to shape the new U-shaped attachment	March 26th	March 26th	 

Assembled the upper part of the device for HR2	March 29th	March 29th	
Write down the HR2 summary	March 29th	March 28th	Submitted on BBlearn. Parts that the team ***has*** that have not been listed: • Leg support foam for comfortability • Carbon fiber sticker Tasks that need to be completed: • Layup a new carbon fiber U-shaped • Make a new thermoplastic cuffs • Shorten down the velcro straps after doing the testing procedures • Changing the clamp that is between the pylons • Epoxy and cut down the pylon after doing the testing procedures • After having the new cuffs we will apply the foam to the cuffs for comfortability • Apply the carbon fiber sticker to the carbon fiber leg support Parts needed for completion of design: • Springs to range from pylon to calf cuff • Switch the current carbon fiber U-shaped with the new U-shaped. Team members (Abdulla, Ebrahim, Leah) made a meeting to choose the carbon fiber telescoping system. Which is the two carbon fiber pylons and the pylon attachment. Abdulla has been working on epoxing the bearings to the carbon fiber leg supports, and attaching the shoulder bolt to the system. Ebrahim has been working on drilling holes on the cuffs (Building 98C) and attaching the velcro straps. He also worked on attaching the cuffs to the carbon fiber leg supports by using chicago bolts. Leah has been working on drilling holes on the carbon fiber pylon, U-shaped support, and carbon fiber leg supports. She attached the pylon to the attachment and the attachment to the U-shaped support.

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Drill holes in carbon fiber upper pylon	March 26th	March 26th	45 min	
drill holes in carbon fiber U-bar attachment	March 26th	March 26th	45 min	

Attach carbon fiber pylon to U-bar	March 26th	March 27th	30 min	
Layup new carbon fiber U-bar support	March 30th	April 1st	1.5 hr	
Draft the U-grads poster	April 1st	April 5th	2 hr	I had extra time this week so I started drafting the U-grads poster early. 

The following are the Action Items for next week:

<table>
<tr><th>Team Member</th><th>Action Items</th><th>Date Due</th></tr>
<tr><td>Abdulla Ghayeb</td><td>1. CAD Package Update [~4 hr]
• Take measurements of the BiOM attachment whenever you have access to it.
• Complete 80% of the upper Part of the device Assembly
  • Add Small springs
  • Design the BiOM Attachment
  • Add the BiOM Attachment</td><td>1. April 8th</td></tr>
<tr><td>Ebrahim Hubail</td><td>1. Form new thermoplastic cuffs
2. Apply the Spring as a Team</td><td>1. April 8th
2. April 8th</td></tr>
<tr><td>Leah Liebelt</td><td>1. Cure carbon fiber U-bar support
2. Draft operators manual for system
3. Drill shoulder bolt holes in U-bar support
4. Drill attachment holes in U-bar support</td><td>1. April 5th
2. April 5th
3. April 8th
4. April 8th</td></tr>
</table>

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, April 8th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

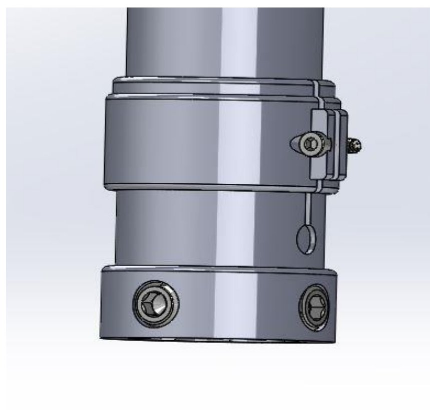
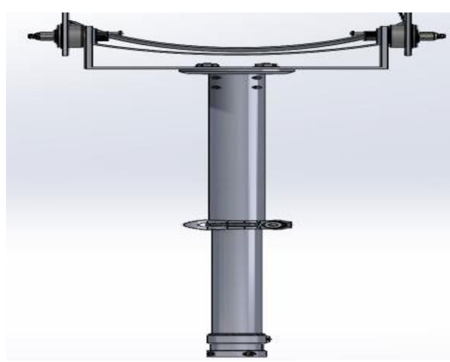
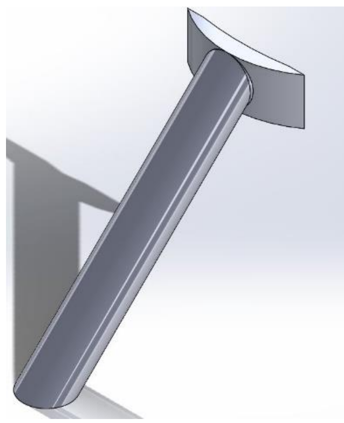
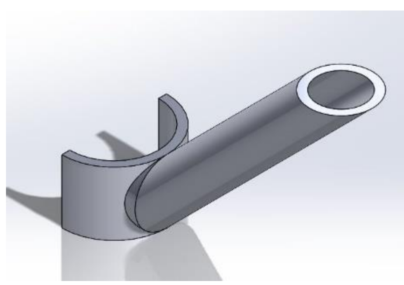
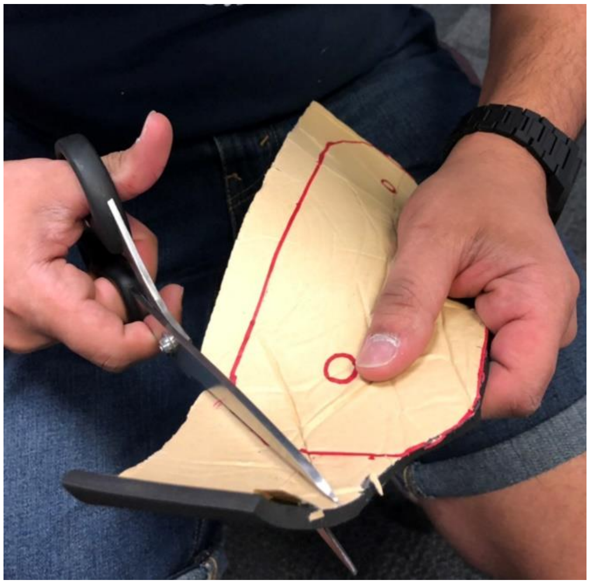
Action Item	Date Due	Date Completed	Result/Proof of Completion
CAD Package Update	April 8th	April 5th	 Figure 1: BiOM Attachment Since there I couldn't find A Grab CAD file from the website, I have considered DR. Sarah’s suggestion to tke measurements off the part and design it by myself to add it in the assembly.  Figure 2: BiOM Attachment added to the Assembly

			 Figure 3: Clamp Update The plastic clamp was replaced with the Bike clamp since its stainless steel. As the team have decided to go with the Bike clamp because it's stiffer and it will hold better.  Figure 4: Top of Mechanical Hydraulic System  Figure 5: Bottom of Mechanical Hydraulic System Figure 4 & 5 shows the idea that the team have decided to go with to attach the spring in the device to operate as wanted. A mechanical hydraulic system was designed to be placed under the calf cuff and the top pylon to hold the spring.

Pickup Print out	April 7th	April 7th	 Figure 6: Mechanical Hydraulic System The red and blue parts were 3D printed after they were designed in Solidworks. after the print out was picked up, the OD of the Blue part was not fitting in the Red Part. I have sanded down the OD of the Blue part about 1mm. The ID of the pylon fit was slightly off so I had to sand it down with Leah's help and it have fitted successfully.
Cutting Foam	April 8th	April 7th	 Figure 7: Cutting Foam I have Cut the foam that is going to be placed in the cuffs with Ebrahim's help. So that it could be easily placed when the full device is assembled and finalized.

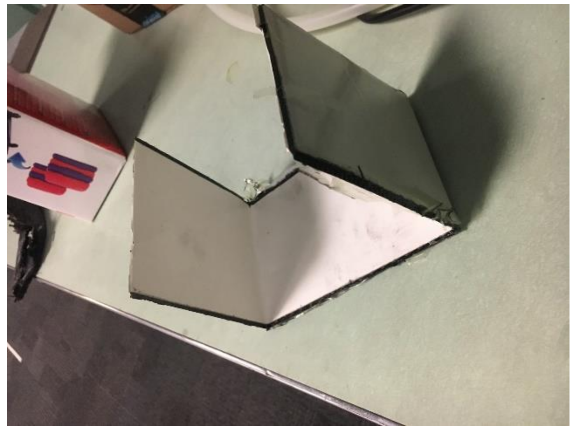
Team Member: Ebrahim Hubail

Action Item	**Date Due**	**Date Completed**	**Result/Proof of Completion**
Form new thermoplastic cuffs	April 8th	April 5th	 • Knee cuff was re-made. • Calf cuff was replaced with a cuff that we had previously. • Thigh cuff was reformed by using the heat gun.

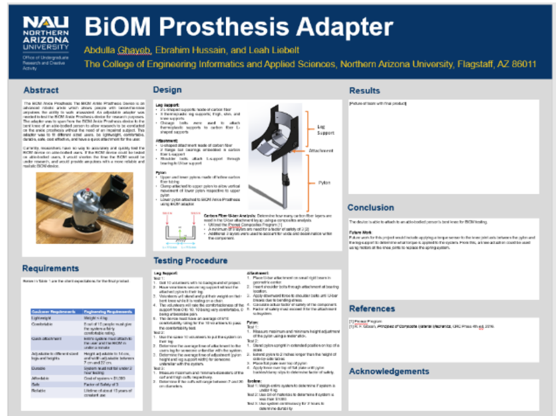
Applying the Spring to the device	April 8th	April 7th	 **Abdulla and Ebrahim worked on fixing the hydraulic system with the spring and epoxied the hydraulic system to the device.**
Sand down the bike clamp	April 8th	April 5th	 **Abdulla and Ebrahim went to the machine shop 98C and sanded down the clamp so it fits our telescoping pylons. The original clamp size is 34.9 mm, so we sanded it down to 33.9 mm.**

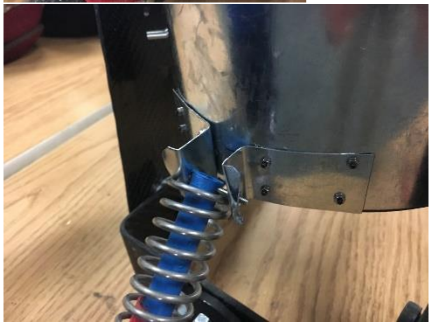
Marking holes	April 8th	April 7th	 • I marked the holes for the carbon fiber leg supports for a second hole, so that the calf cuff do not move and the hydraulic system do not break. • I marked the holes for the galvanize plate support that was attached under the calf cuff.
Shorten Velcro straps and sticking the foam	April 8th	April 8th	 **Abdulla and Ebrahim worked on sticking the foam to the cuffs.** **Ebrahim worked on shortening down the Velcro straps, making holes, and fixing them to the device.**

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Cure carbon fiber U-bar support	April 5th	April 2nd	3 hr	
Draft operators manual for system	April 5th	April 25th	----	**Ebrahim and Abdulla wrote operators manual due to unforeseen circumstances. I had time to edit and put final touches in the draft.** **see bblearn for final submission.**
Cut and Dremel Carbon fiber U-bar	April 8th	April 7th	1 hr	

Drill 2 ½" shoulder bolt holes in U-bar support	April 8th	April 7th	0.5 hr	See above photo
Drill 4 attachment holes in U-bar support	April 8th	April 7th	0.5 hr	See above photo
Find a fix for pylon slipping	April 8th	April 5th	2 hr	 Encountered issue with the pylon holding more than 60 lbs. Drilled required holes in aluminum pylon as a backup plan if no fix was found for carbon fiber pylon. Carbon fiber pylon was slipping caused by plastic clamp. Ebrahim ordered a new metal bike clamp but it cracked the carbon fiber and would still slip due to varying diameters. I found a fix by wrapping duct tape around the bottom pylon to create a larger diameter so the upper pylon doesn't have to contract much to avoid cracking. It held all the group members weights individually. This is a quick fix until a slightly larger diameter pylon is obtained.

Finalize draft of poster	April 5th	April 4th	1 hr	
Drill extra hole in calf cuff and carbon fiber L-shaped support so the calf cuff leg support doesn't move the spring out of place.	April 8th	April 7th	0.5 hr	
Manufacture stiff coating for calf cuff to allow spring mounting.	April 8th	April 7th	1 hr	Included cutting metal to size, drilling 4 holes to connect to support, and bending to shape required to fit over calf cuff 

Fix spring mounting	April 8th, 5pm	April 8th	2.5 hr	  The printed plastic did not fit over pylon, I sanded down plastic until it fit. The hydraulic-like design did not allow any angular movement about the calf cuff, which is required for the two tubes to move relative to each other. Created hinge for calf cuff by cutting off end of blue tube, drilling small hole through blue tube and connecting two plates of metal to outer metal calf cuff and screwing a bolt through the central hole. Cut slot in red plastic and inserted screw in blue plastic to ensure the pipes would not slip out of each other while in use.

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. As a team Complete Testing Procedure. 2. CAD Package Update [~4 hr] • Device Assembly • Add Small springs • Add Hydraulic System • Add the Compression Spring • Update Exploded View.	1. April 12th 2. April 15th

Ebrahim Hubail	1. Apply the carbon fiber sticker on the L-shaped leg supports. 2. Work as a team on completing the testing procedure.	1. April 15th 2. April 12th
Leah Liebelt	1. Implement poster feedback to finalize poster (future work, conclusions, results) 2. Work with team to complete testing procedure	1. April 15th 2. April 12th

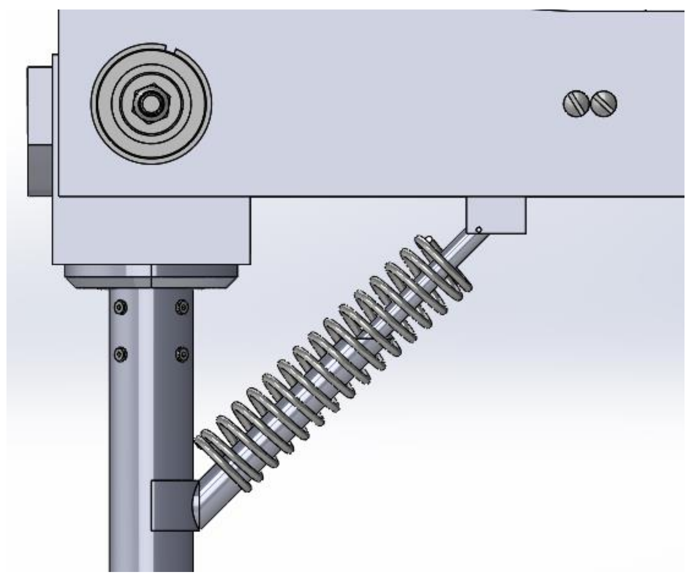
ACTION ITEMS

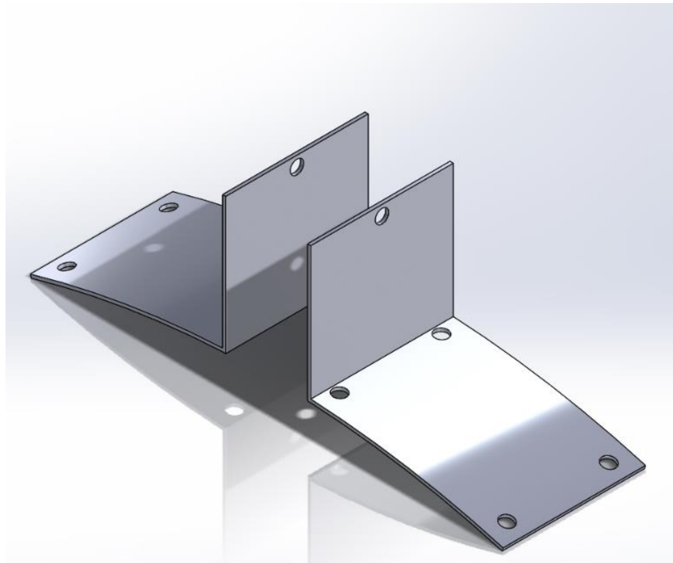
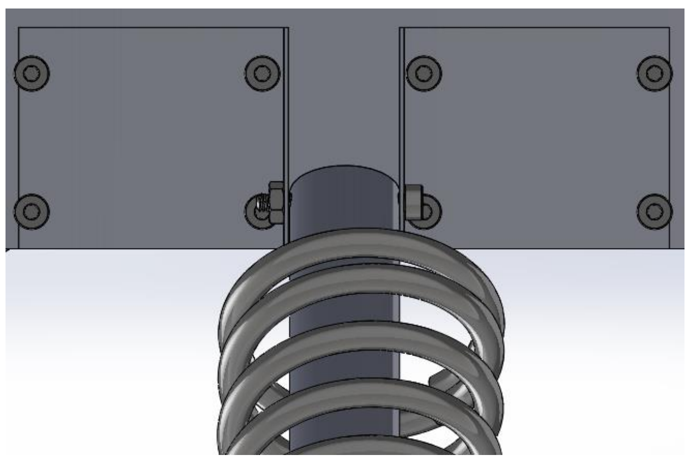
TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, April 15th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
CAD Package Update	April 15th	April 11th	 Figure 1: CAD Package Update As shown in figure 1 the Mechanical Hydraulic System is added to the assembly. In addition to the modification in the Calf cuff of adding two Chicago bolts to stabilize the cuff so the Hydraulic system could operate normally. The modification of adding two holes was required in the L Shaped Support, Velcro Strap, Velcro Strap holder, and the Calf Cuff. To Secure the System in Place bolts required to be added in the assembly.

			 Figure 2: Hydraulic System Mount  Figure 3: Mount Secured Figure 2 shows the Mount designed to be manufactured using galvanize steel, and secured in the Galvanize Cuff that is placed under the Calf Cuff using small bolts as shown in Figure 3. this Mount will allow the spring to have free rotation.

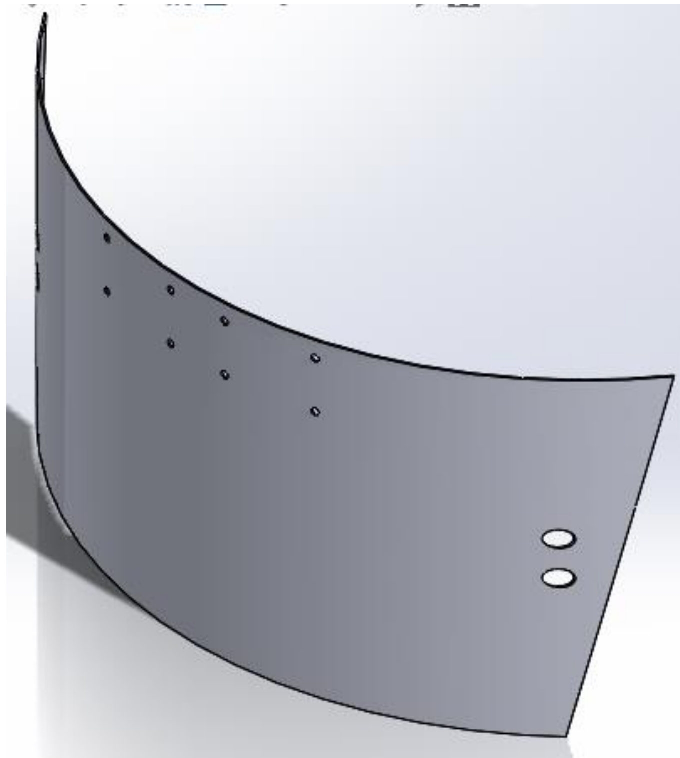


Figure 4: Galvanize Calf Cuff

Figure 3 shows the Galvanize steel that is designed to support the bottom part of the Calf Cuff to attach the mount, so that it reduce the irritation caused by the spring when compressing.

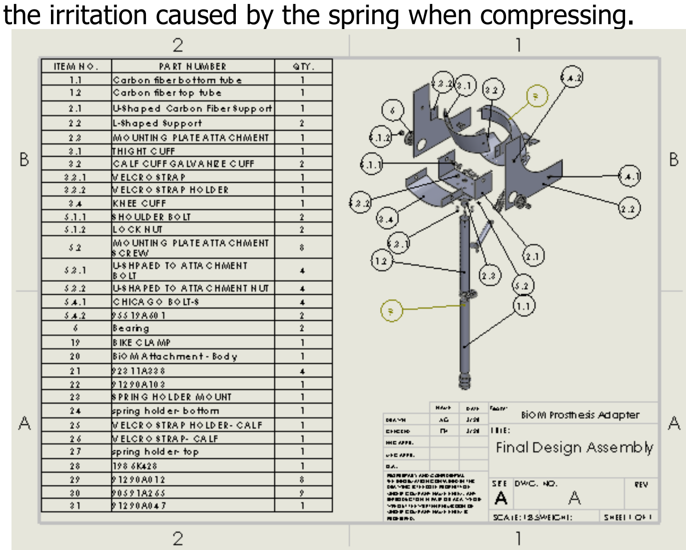


Figure 5: Exploded View Update

Due to added new components to the assembly there was a disorientation in the exploded view of the device. I have reoriented the exploded view. in the other hand renumbering the BOM list have to be edited for upcoming CAD update, as well as

			renaming the new parts added to make it easier to read the components. **Note: I was Trying to figure out how to add the Small Springs in to the System Assembly for one hour. Although, there was a continuous error occurring. There is no mates that could hold them professionally in place other than locking them. This task will be moved to next week Action Items due to complication.**

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion
Apply the carbon fiber sticker on the L-shaped leg supports	April 15th	April 11th	

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion

Implement poster feedback to finalize poster (future work, conclusions, results)	April 15th	April 15th	2 hr	
Work with team to complete testing procedure	April 12th	April 13th	6 hr	**The team worked together to complete testing April 11th and 12th.** **Abdulla and Ebrahim wrote the Final product testing proof document. Leah outlined and edited the document.** **For proof see bblearn for final submission.**

The following are the Action Items for next week:

Team Member	Action Items	Date Due

Abdulla Ghayeb	1. Update Team Website
	• Update Gallery
	• Update Documents Section
	2. CAD Package Update
	• Drawings
	  • Update Exploded View. (Edit drawing BOM)
	  • Hydraulic System Parts
	  • Calf Cuff Galvanize Sheet
	  • Update Modified Parts
	  • BiOM Attachment
	• Device Assembly
	  • Add Small springs (**Try to Fix Error**)
	  • Resize Top and Bottom Pylon Based on Current Measurements
	  • Add Appearance to the device When Assembly is completed
	  • Update Knee Support dimensions
		1. April 22th
		2. April 22th

Ebrahim Hubail	1. Finalize Operations Manual	1. April 22th

Leah Liebelt	1. Brainstorm new solutions for spring system 2. Implement new design for spring system 3. PRINT POSTER	1. April 16th 2. April 22th 3. April 19th

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, April 22th, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

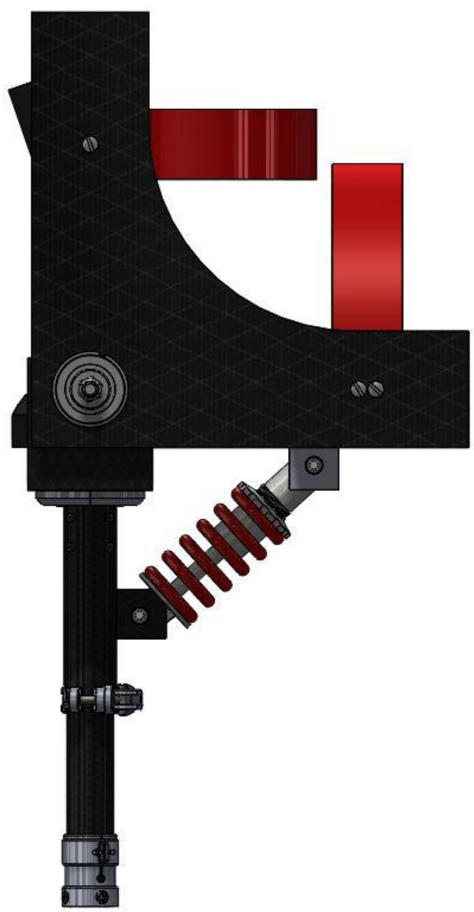
Action Item	Date Due	Date Completed	Result/Proof of Completion
CAD Package Update	April 15th	April 11th	 Figure 1: CAD Package Update

Figure 1 Shows the compleason of the CAD assembly as all parts have been added to the assembly using the right mates. Pylon and knee dimensions have been adjusted to match the actual manufactured device. Small Springs and Spring Mechanism have been added to the assembly. Finally, I have added an appearance to the final assembly.

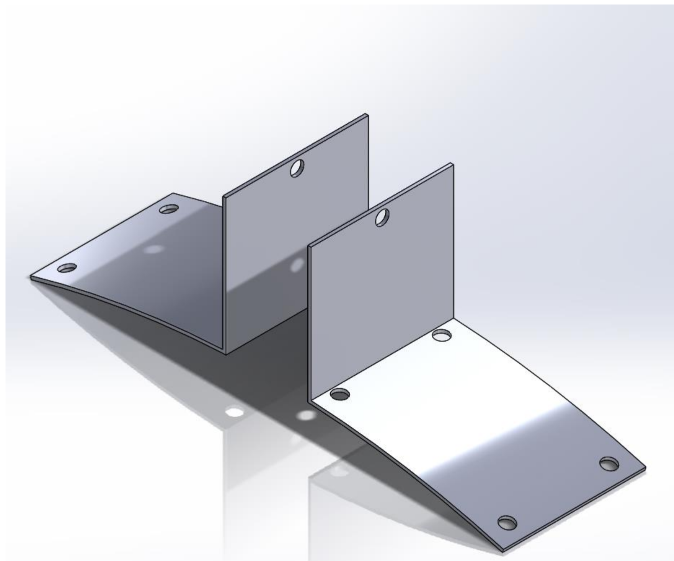


Figure 2: Previous Spring Mechanism Mount to Cuff

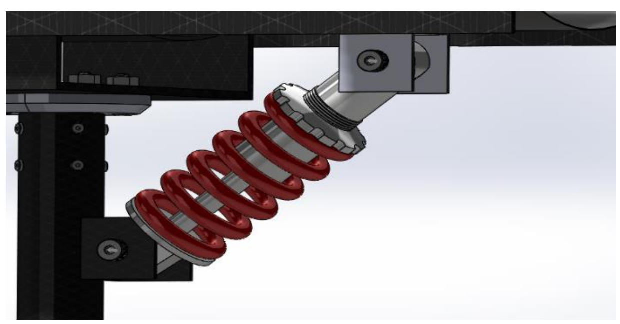


Figure 3: Current Installed Spring Mechanism Mount

Figure 3: Mount Secured

Figure 3 shows the Mount designed to be manufactured using Stainless Steel, and secured in the Galvanized Steel Cuff that is placed under the Calf Cuff using two small bolts to the cuff and one Shoulder bolt to secure the Spring Mechanism in place allowing free rotation.

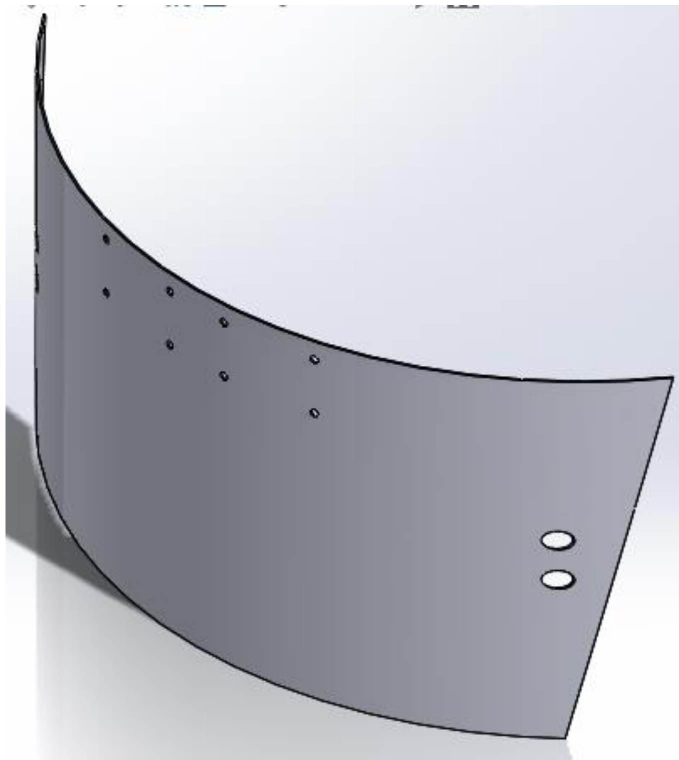
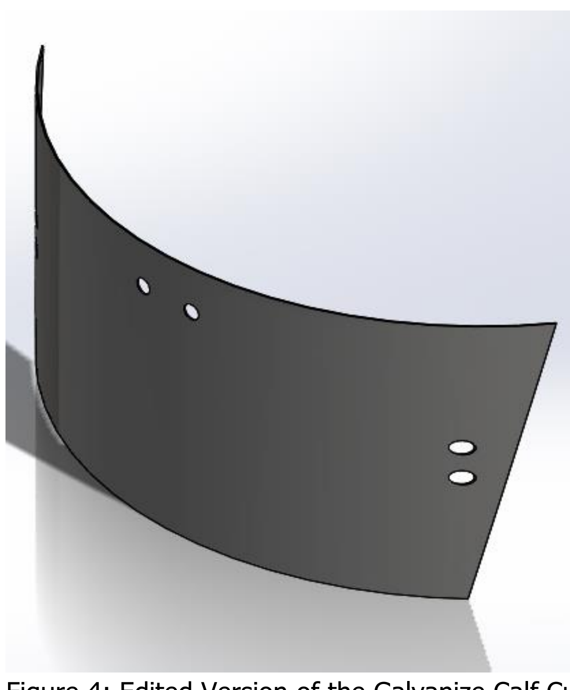
			 Figure 4: Previous Galvanize Calf Cuff  Figure 4: Edited Version of the Galvanize Calf Cuff

Figure 3 shows the Galvanize steel that is designed to support the bottom part of the Calf Cuff to attach the mount, so that it reduce the irritation caused by the spring when compressing.

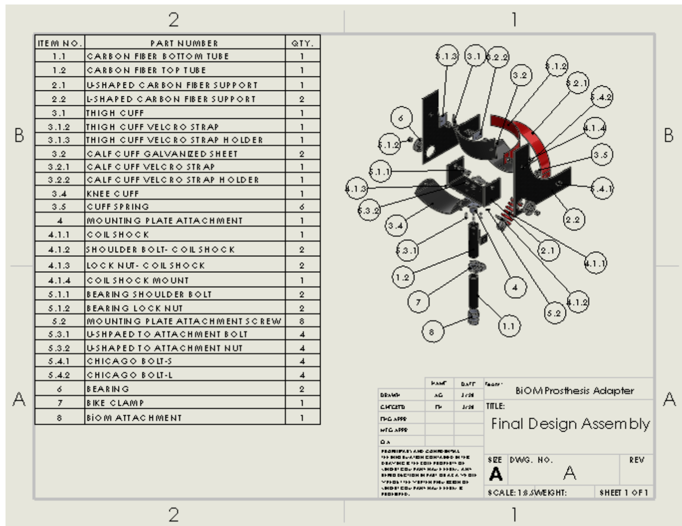


Figure 5: Exploded View Updated

The Exploded View Needed to be Updated do to components added and removed from the assembly. Parts numbering have been edited. Finally, there is no more editing should be further in this drawing.

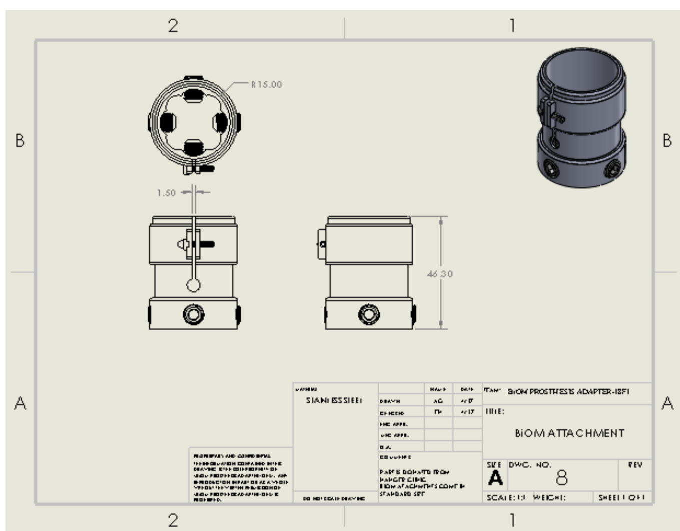


Figure 6: BiOM Attachment Drawing

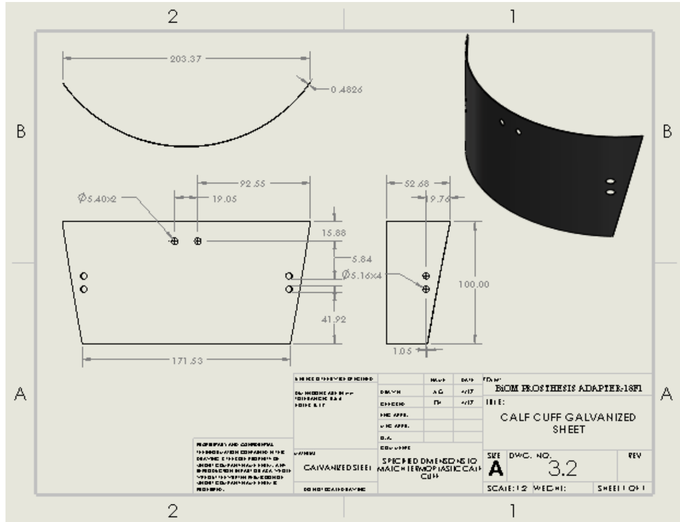
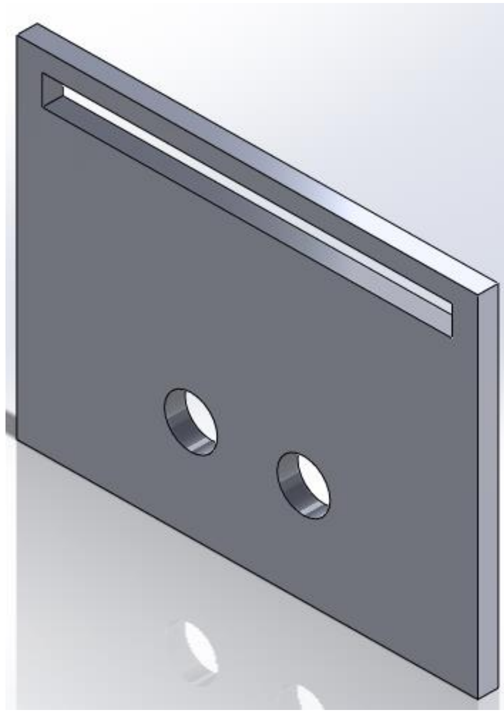
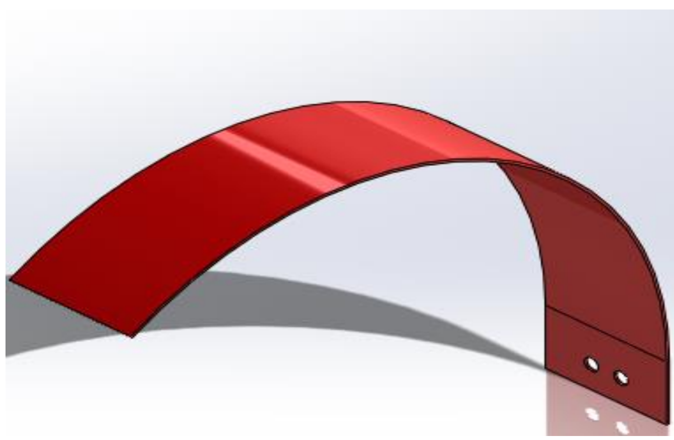


Figure 7: Galvanize Calf Cuff Drawing

Figure 8: Knee Cuff Modified

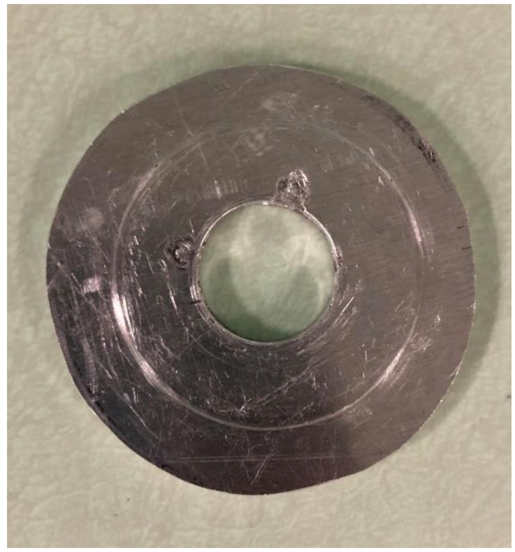
			 Figure 9: Calf Cuff Velcro Strap Holder  Figure 10: Calf Cuff Velcro Strap Figure 6 shows the drawing that have been created for the BiOM Attachment. Figure 7 Shows the most Updated Drawing of the Galvanize Calf Cuff. Figures 8, 9 and 10 are parts updated to the most current manufactured parts. knowing that all the drawings of the parts included in the assembly are updated because of the numbering in the Exploded view drawing "Figure 5."
Update Team Websit e	April 22nd	April 20th	https://www.cefns.nau.edu/capstone/projects/ME/2018/18F1_BIOMAdapter/

			Link above to access the team website, all documentations have been updated. Due to the large amount of pictures have to be added to the Gallery, pictures have been downloaded in my PC and have to be organized to make it easier to upload in the right category in the website.

Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion
Operations Manual	April 22nd	April 19th	Updated the pictures of the Operations Manual draft to a solid background pictures.

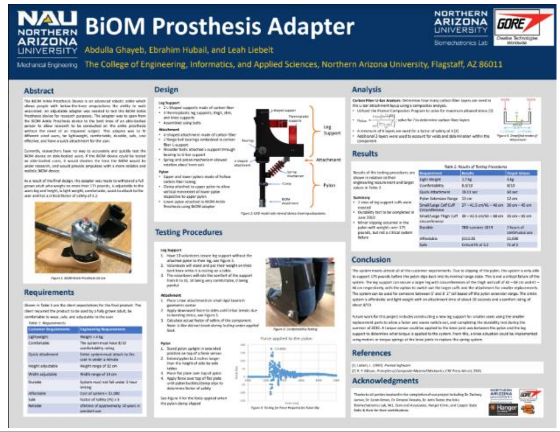
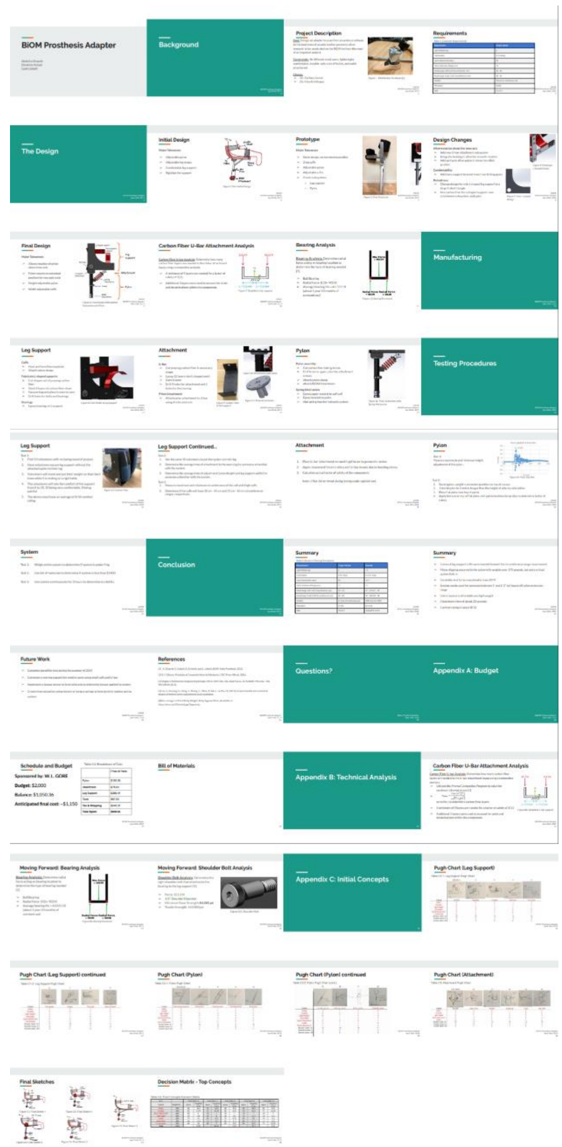
			    

Machined Parts in 98C	April 22nd	April 19th	 **Abdulla and Ebrahim Machined this part in the Machine shop 98C. This part is to hold the spring.**  **Abdulla and Ebrahim Machined this part in the Machine shop 98C. Leah sanded down the corners. Ebrahim attached it to the device.**
Cut down the Spring and fix it to the device	April 22nd	April 22nd	

			Cutted down the spring to the right size and attached it to the device.
Outlined and added the pictures to the U-grads powerpoint	April 22nd	April 21nd	**Abdulla and Ebrahim outlined the powerpoint and added all the pictures.**

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Implement new design for spring system (carbon fiber brackets)	April 22nd	April 20th	1.5 hr	

Get poster reviewed and submitted	April 19th	April 19th	4 hrs	
Make U-grads powerpoint	April 22nd	April 22nd	6 hr	

The following are the Action Items for next week:

Team Member	**Action Items**	**Date Due**
Abdulla Ghayeb	1. Update Team Website • Update Gallery 2. CAD Package Update • Final check on CAD	1. April 29th 2. April 29th
Ebrahim Hubail	1. Finalize Operations Manual	1. April 26th
Leah Liebelt	1. Update Final Report	1. May 3rd

ACTION ITEMS

TEAM: F18 BiOM Prosthesis Adapter

Due Date:
Monday, April 29th, 2019 5:30pm

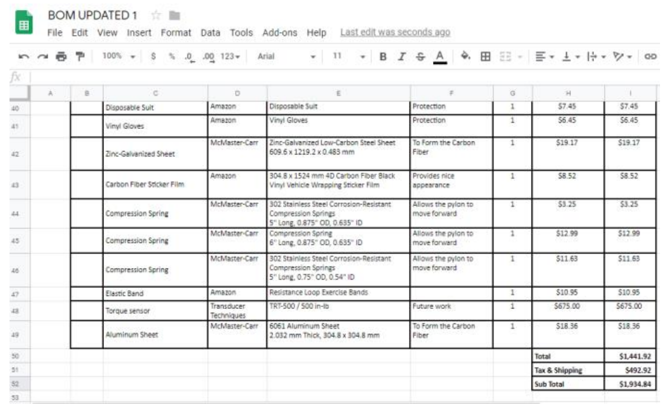
The following are the Action Items from last week:

Team Member: Abdulla Ghayeb

Action Item	Date Due	Date Completed	Result/Proof of Completion
Presentation	April 26th	April 25th	I have practiced my part in the presentation over and over until I have known that I will do my best in the presentation.
Website Update	April 29th	April 28th	https://www.cefns.nau.edu/capstone/projects/ME/2018/18F1_BIOMAdapter/ Pictures Update: I have updated the pictures of the final product and uploaded pictures of the team working on the device. Document Update: I have uploaded the final Presentation in the website.
CAD Package Update	April 29th	April 23rd	Checked on all parts that matches the BOM in the exploded View drawing. made sure that all the drawings are there. there was 3 drawings missing the location of the parts so I have fixed the reference to the part of each drawing. the CAD package up to this point is completed.

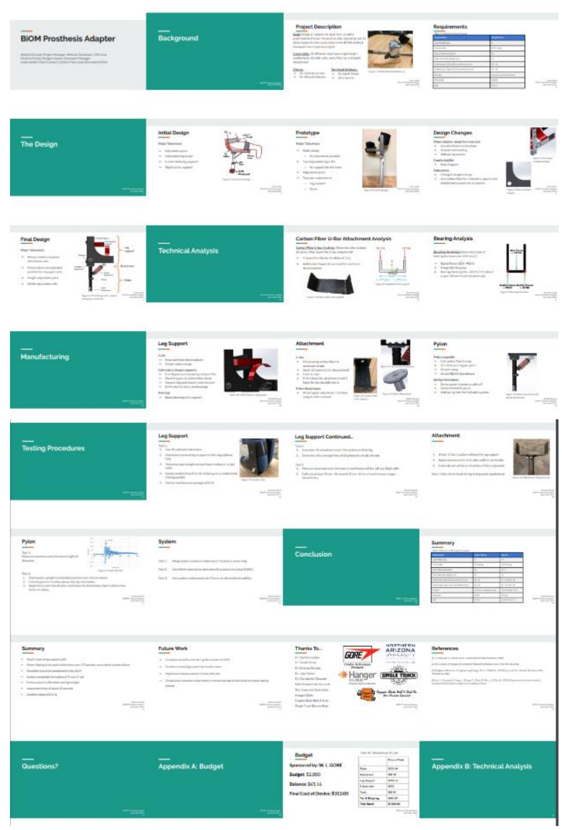
Team Member: Ebrahim Hubail

Action Item	Date Due	Date Completed	Result/Proof of Completion

Finalize Operations Manual	April 26th	April 25th	• Updated the Table of Content. • Added Maintenance section. • Updated all of the figures with the final design. **See BBlearn for Final submission.**
Updated the Final Bill of Materials	April 29th	April 25th	

	A	B	C	D	E	F	G	H	I
40			Disposable Suit	Amazon	Disposable Suit	Protection	1	$7.45	$7.45
41			Vinyl Gloves	Amazon	Vinyl Gloves	Protection	1	$6.45	$6.45
42			Zinc-Galvanized Sheet	McMaster-Carr	Zinc-Galvanized Low-Carbon Steel Sheet 609.6 x 1219.2 x 0.483 mm	To Form the Carbon Fiber	1	$19.17	$19.17
43			Carbon Fiber Sticker Film	Amazon	304.8 x 1524 mm 4D Carbon Fiber Black Vinyl Vehicle Wrapping Sticker Film	Provides nice appearance	1	$8.52	$8.52
44			Compression Spring	McMaster-Carr	302 Stainless Steel Corrosion-Resistant Compression Springs 5" Long, 0.875" OD, 0.635" ID	Allows the pylon to move forward	1	$3.25	$3.25
45			Compression Spring	McMaster-Carr	Compression Spring 6" Long, 0.875" OD, 0.635" ID	Allows the pylon to move forward	1	$12.99	$12.99
46			Compression Spring	McMaster-Carr	302 Stainless Steel Corrosion-Resistant Compression Springs 5" Long, 0.75" OD, 0.54" ID	Allows the pylon to move forward	1	$11.63	$11.63
47			Elastic Band	Amazon	Resistance Loop Exercise Bands		1	$10.95	$10.95
48			Torque sensor	Transducer Techniques	TRT-500 / 500 in-lb	Future work	1	$675.00	$675.00
49			Aluminum Sheet	McMaster-Carr	6061 Aluminum Sheet 2.032 mm Thick, 304.8 x 304.8 mm	To Form the Carbon Fiber	1	$18.36	$18.36
50								Total	$1,441.92
51								Tax & Shipping	$492.92
52								Sub Total	$1,934.84
53									

Team Member: Leah Liebelt

Action Item	Date Due	Date Completed	Time Spent on Item	Result/Proof of Completion
Implement presentation comments from amy	April 26th	April 24th	3 hr	

trim bracket and attach to cuff	April 26th	April 22nd	1 hr	 with Ebrahim and Abdulla
Update Final Report	in progress	may 3rd	-	in progress

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Abdulla Ghayeb	1. Update Team Website • Update Documents • Upload all the documents that have been submitted. • Update the Action Items and Reports. • Update Gallery • Remove the old CAD Package and update the website with the most current ones.	1. May 3rd
Ebrahim Hubail	1. Create the Final CAD pdf file for submission	1. May 3rd
Leah Liebelt	1. Finalize Final Report	1. May 3rd