Prosthetic Hand- Midpoint

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March 13, 2019

Project Description

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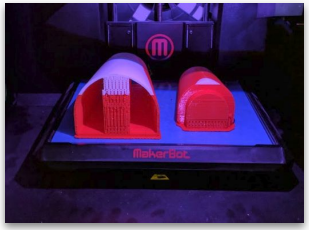
This project aims to provide below-elbow amputees with an affordable prosthetic, that provides them with haptic feedback.

Importance

A prosthetic does more than replace a limb. It has the ability to make the wearer feel whole, have sense of belonging, feel unique, and enable their independence.

Proposed Design Fall 2018

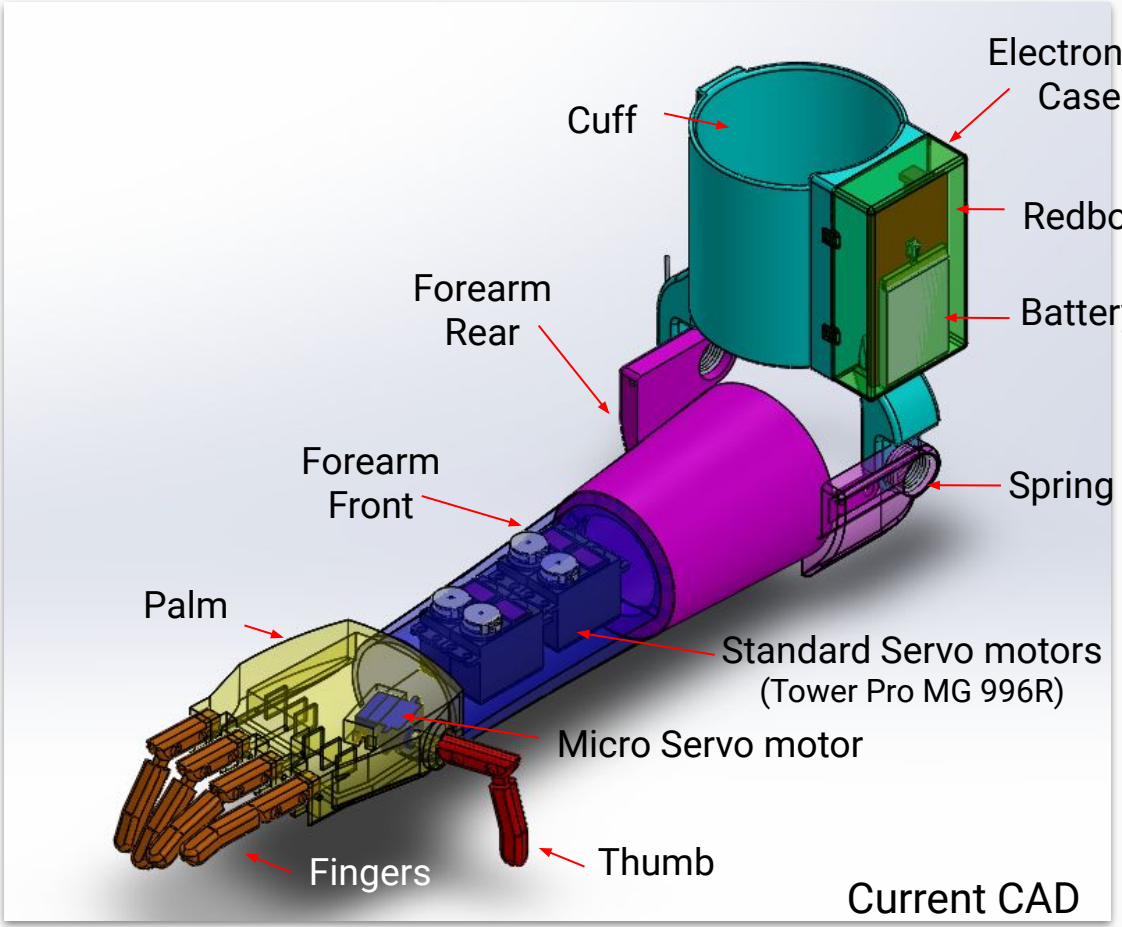
Current Finger



Current Forearm

Current Palm

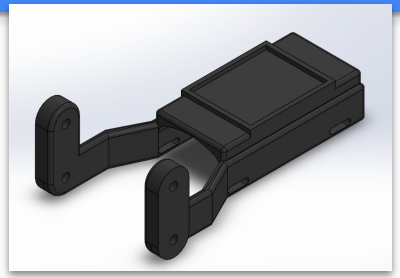
Current Cuff



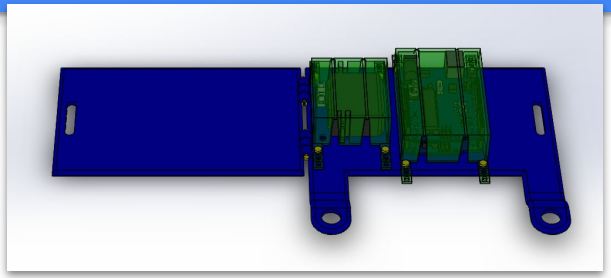
Current CAD

Updates

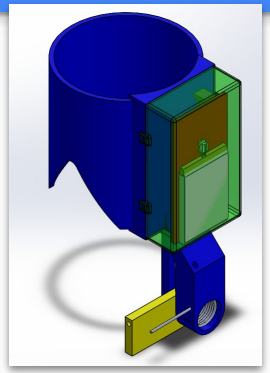
Updates-Cuff



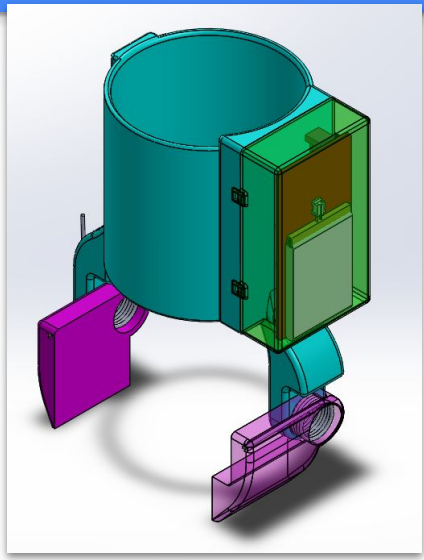
Fall 2018



Early Spring 2019



February 2019



Current

Fall 2018

- Design adapted from e-Nable with Arduino Attachment [1]

Early Spring 2019

- Covers complete arm, adds assistant motor and electronic covers, designed to be thermoformed

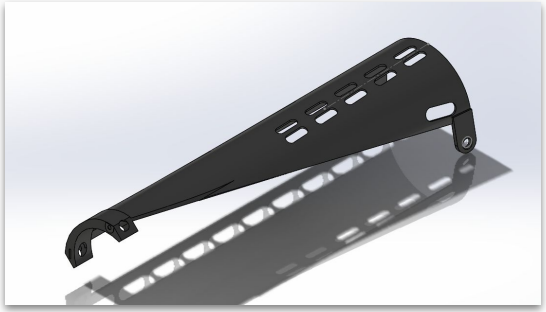
Late February 2019

- Increase thickness and percent infill, cannot open, no longer thermoformed, motor removed, assistance springs added

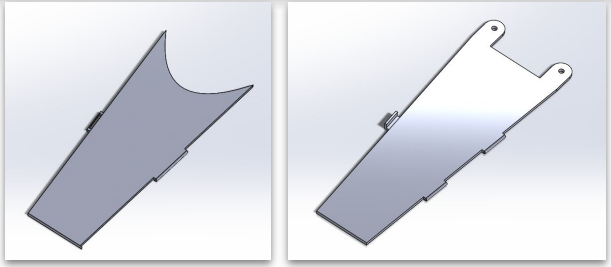
Current

+ Includes attachment to forearm, allows for two assistant springs, included new Arduino (RedBoard) and LiPo battery
- Oversized attachment to forearm

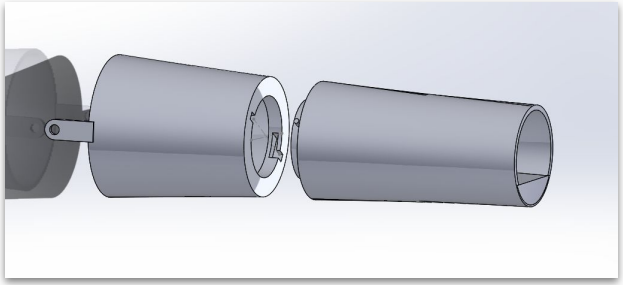
Updates-Forearm



Fall 2018 Model



Early Spring 2019 Model



Current Model

Reason for Changes:

1. Discovered that thermoforming is not necessary if wall thickness is 0.125”
2. Allows for the size of the servo motors
   a. Has flat portion with indents for motors to rest on
3. Easier to manufacture repeatedly

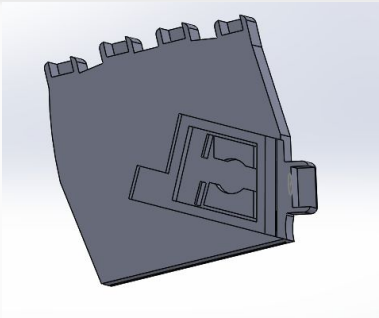
Still Missing from Design:

1. Spring attachment on back
2. Way to connect to palm

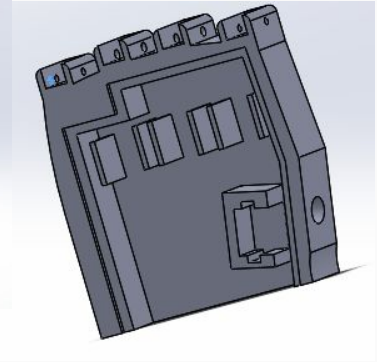
Updates-Palm

- Fall 2018- Palm was more basic with no opening for motor. Thumb had minimal movement
- January 2019- Palm adjusted with opening and for ball and socket attachment
- February 2019- Continual adjustment to palm opening to allow for an easy assembly and for user to be able to adjust the wires and motor attachment. Thumb not was full mobility
- Current Model- Now includes better attachments for the forearm and fingers. More aesthetically appealing

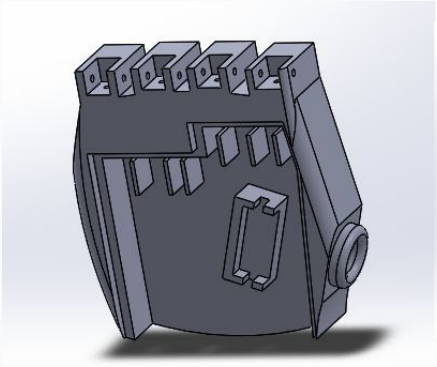
Fall 2018

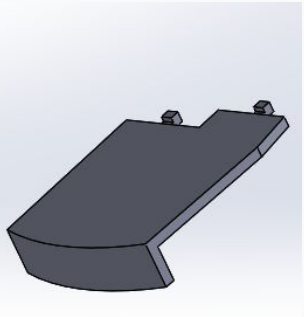


January 2019



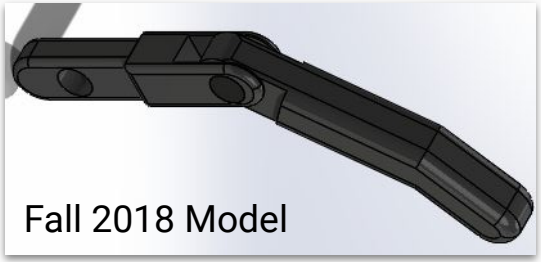
February 2019

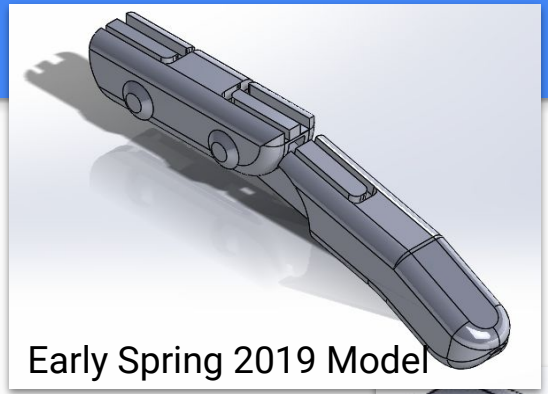


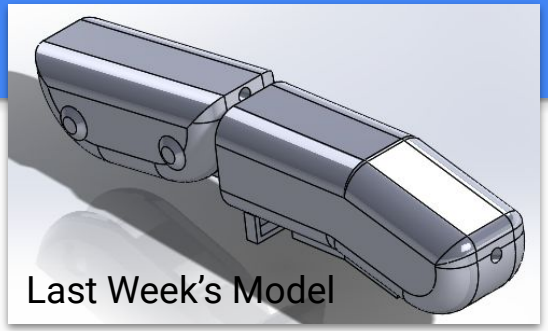


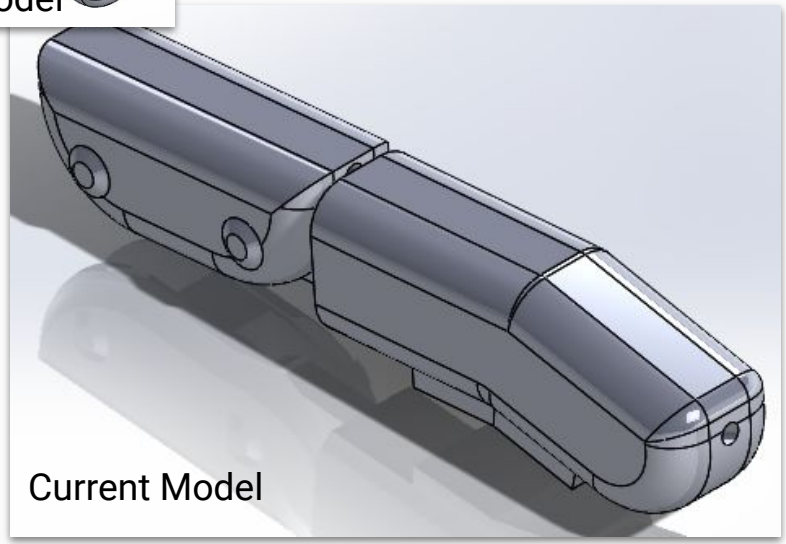
Current

Updates-Fingers


Fall 2018 Model


Early Spring 2019 Model


Last Week's Model


Current Model

Reason for Changes:

1. Fingers were too thin and weak
2. No longer utilizing rubber bands
3. New tendon channels
4. Channel for pressure sensors
5. Decrease thickness to 0.65 inches

Still Missing from Design:

1. Rotating Thumb base
2. Perfect hinge pins
3. Palm Attachments

Moving Forward

Analytical Analyses

- Finger Motion Simulation:
  - Determined the location of finger tips and center of masses
  - Helped to determine the movement of the artificial tendons
- Wireless Communication:
  - Relays information from pressure sensors at the toes to motors in the arm
  - Determined type of wireless communication to be used: XBee
- PID Control:
  - Maps the analog input of pressure sensors to digital output of motors
  - Control of motors is proportional to the pressure applied to the sensor and can hold position
- Pin Tolerance:
  - Allows for clearance, loose, and tight fits for different pins
  - Important for all attachment points

Manufacturing: What is Left?

- Cuff and Forearm:
  - Lift and Motion Assistance
- Palm:
  - Motor enclosure
- Fingers:
  - Thumb Range of Motion
- Connections:
  - Connect subsystems

- Code Communication
- Install Arduino
- Sensors
- Motors
- Tendons

Manufacturing: Plan

- Cuff and Forearm:
  - Spring attachment
  - Dimensions (less Bulky)
- Palm:
  - Adjust cover and motor placement. Improve forearm attachment
- Fingers:
  - Thumb Rotating Base
- Connections:
  - Print subsystems and respective attachments (pins, hinges, etc.)

- Code Communication:
  - Code arduino to control movement and sensory response
- Install Arduino:
  - Attach Arduino Hardware to prosthetic
- Sensors:
  - Connect to arduino Hardware
- Motors:
  - Install hardware motors and attach to arduino
- Tendons:
  - Thread through channels
  - Attach to Motors

Plans for Testing

1. Scalable Size (6-18 in)
2. Weight (<2 lbs)
3. Budget (~ $500)
4. Durability (<10 lbs)
5. Force to Actuate (< 5 lbf)
6. Force of Grip (<2 lbs)
7. Number of Parts (<100)

1. Test print a smaller and larger arm to determine if the CADs are scalable

2. Compare prosthetic weight to human arm weight. Within 5%

3. Tally receipts

4. Durability will be tested multiple ways:
   a. Releasing a mallet from a 90 angle into the prototype for a number of cycles
   b. Lift up to 10 lbs using only the prosthetic

5. The pressure sensors in the insole measure up to 1 lbf

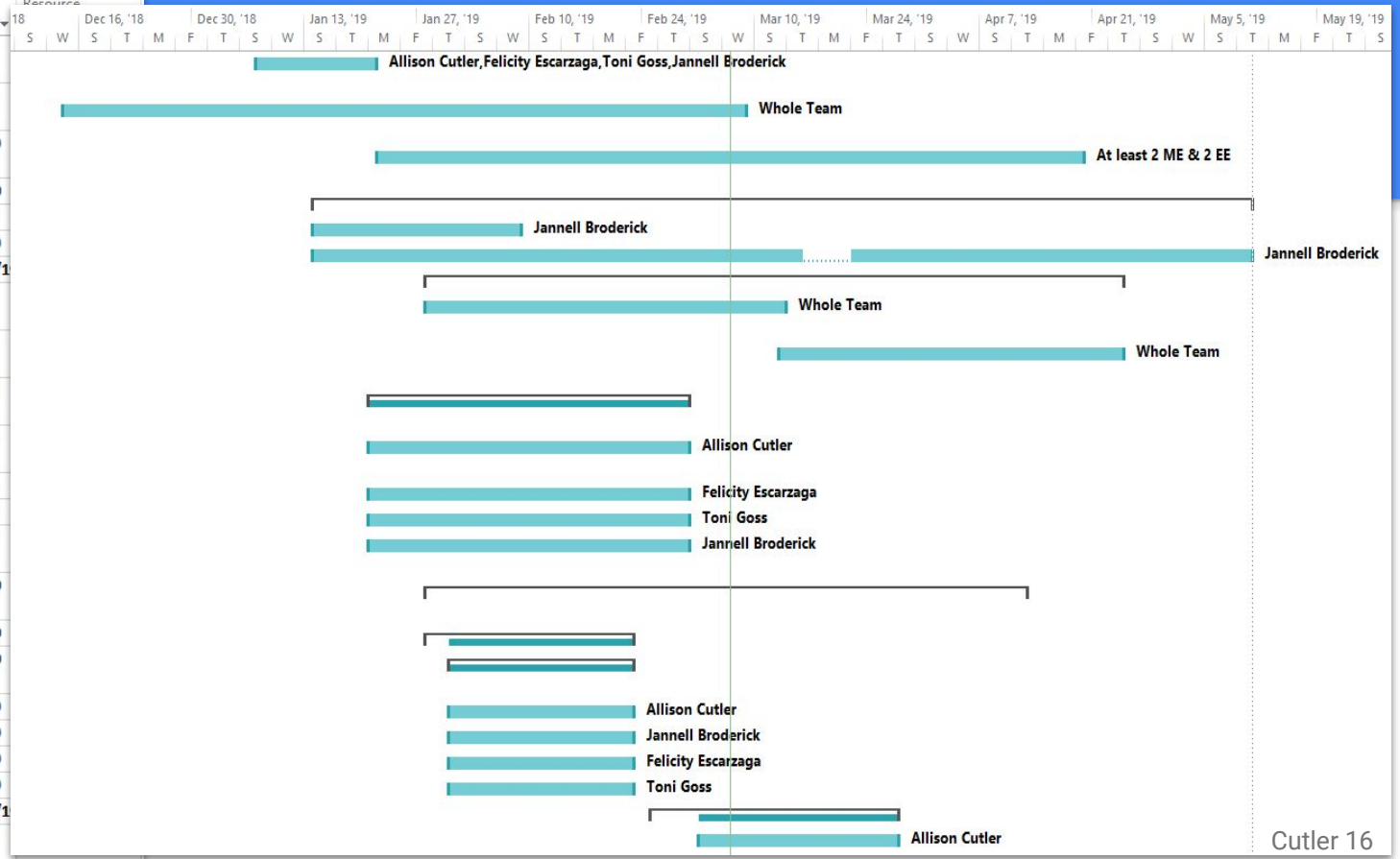
6. Use fishing gage when an object is lifted

7. Tally parts in final prototype

Schedule & Budget

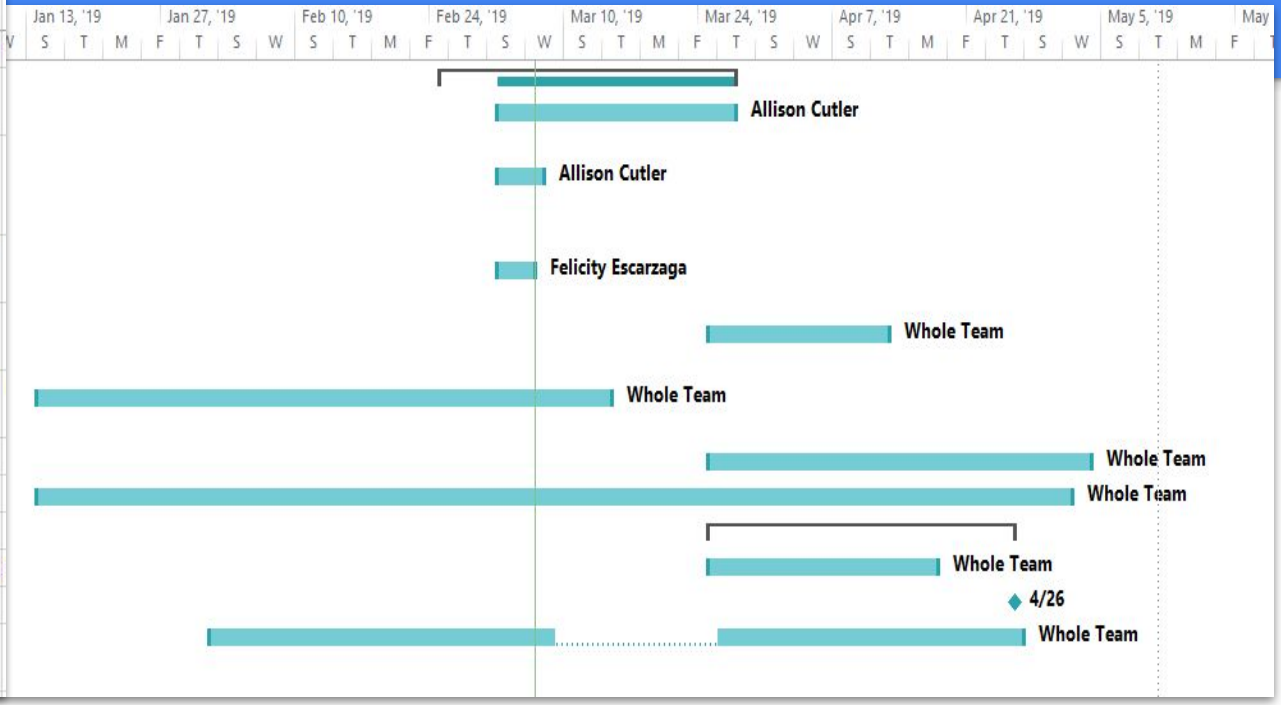
Schedule

Task Name	Duration	Start	Finish
Individual Post Mortem	11 days	Mon 1/7/19	Mon 1/21/19
Implement Proposal Changes	61 days	Fri 12/14/18	Fri 3/8/19
Weekly EE Team Meetings	64 days	Tue 1/22/19	Fri 4/19/19
Website Checks	**85 days**	**Mon 1/14/19**	**Fri 5/10/19**
Check 1	20 days	Mon 1/14/19	Fri 2/8/19
Check 2	81 days	Mon 1/14/19	Fri 5/10/19
Presentations	**63 days**	**Mon 1/28/19**	**Wed 4/24/19**
Midpoint Presentation	33 days	Mon 1/28/19	Wed 3/13/19
Final Presentation	31 days	Wed 3/13/19	Wed 4/24/19
Individual Analysis 2	**30 days**	**Mon 1/21/19**	**Fri 3/1/19**
Wireless Communicati	30 days	Mon 1/21/19	Fri 3/1/19
PID	30 days	Mon 1/21/19	Fri 3/1/19
Tolerances	30 days	Mon 1/21/19	Fri 3/1/19
Sim. in MATLAB	30 days	Mon 1/21/19	Fri 3/1/19
Hardware Reviews	**55 days**	**Mon 1/28/19**	**Fri 4/12/19**
HR1	**20 days**	**Mon 1/28/19**	**Fri 2/22/19**
Prototyping and CAD	**17 days**	**Thu 1/31/19**	**Fri 2/22/19**
Forearm	17 days	Thu 1/31/19	Fri 2/22/19
Fingers	17 days	Thu 1/31/19	Fri 2/22/19
Cuff	17 days	Thu 1/31/19	Fri 2/22/19
Palm	17 days	Thu 1/31/19	Fri 2/22/19
HR2	**23 days**	**Mon 2/25/19**	**Wed 3/27/19**
Redesign Forearm	19 days	Sun 3/3/19	Wed 3/27/19



Schedule

Task Name	Duration	Start	Finish
HR2	**23 days**	**Mon 2/25/19**	**Wed 3/27/19**
Redesign Forearm	19 days	Sun 3/3/19	Wed 3/27/19
Order electrical componen	5 days	Sun 3/3/19	Thu 3/7/19
Update BOM	4 days	Sun 3/3/19	Wed 3/6/19
Final Product Testing	15 days	Mon 3/25/19	Fri 4/12/19
Midpoint Report	44 days	Mon 1/14/19	Thu 3/14/19
Final Report	30 days	Mon 3/25/19	Fri 5/3/19
CAD	78 days	Mon 1/14/19	Wed 5/1/19
UGRADS	**24 days**	**Mon 3/25/19**	**Fri 4/26/19**
Poster	18 days	Mon 3/25/19	Wed 4/17/19
Presentation	0 days	Fri 4/26/19	Fri 4/26/19
Operations Manual	50 days	Fri 2/1/19	Fri 4/26/19



Budget

Order	Price	Quantity	Price*Quantity	Catalog #	Link
Wireless Motor Driver Shield	26.95	0	0	DEV-14285	https://www.sparkfun.com/prod
Arduino Pro Mini 328 - 5V/16M	9.95	2	19.9	DEV-11113	https://www.sparkfun.com/prod
SparkFun XBee Explorer Regi	10.95	2	21.9	WRL-11373	https://www.sparkfun.com/prod
Battery 1Ahr	9.95	2	19.9	PRT-13813	https://www.sparkfun.com/prod
Battery 2Ahr	12.95	1	12.95	PRT-13855	https://www.sparkfun.com/prod
Charger and Booster	15.95	3	47.85	PRT-14411	https://www.sparkfun.com/prod
Force Sensitive Resistor 0.5"	6.95	5	34.75	SEN-09375	https://www.sparkfun.com/prod
Force Sensitive Resistor - Sm	6.95	5	34.75	SEN-09673	https://www.sparkfun.com/prod
Amphenol FCI Clincher Conne	1.95	10	19.5	COM-14194	https://www.sparkfun.com/prod
SparkFun RedBot Mainboard	52.95	2	105.9	ROB-12097	https://www.sparkfun.com/prod
XBee 1mW Trace Antenna - S	24.95	0	0		https://www.sparkfun.com/prod
Low torque Spring	12.57	1	12.57	3HPF6	https://www.grainger.com/produ
High torque spring	5.15	1	5.15	3HPL6	https://www.grainger.com/produ
Shoe insoles	15.89	0	0	B07P3J3CGB	https://www.amazon.com/Plant
Foam Pad	14.24	1	14.24	B000VQFSU0	https://www.amazon.com/Jaybi
Digital Servo x4	25.99	1	25.99	B01GN0715U	https://www.amazon.com/MG9
Virbrating motor x10	9.99	1	9.99	B076ZS77T1	https://www.amazon.com/BestT
PLA	15.99	0	0		-
Total:	492.07	37	385.34		

Estimate Budget

Current Spending

References

[1] “Enabling The Future,” *Enabling The Future*. [Online]. Available: http://enablingthefuture.org/. [Accessed: 10-Oct-2018].

Questions?