Prosthetic Hand

Mechanical Engineering Team

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Project Description

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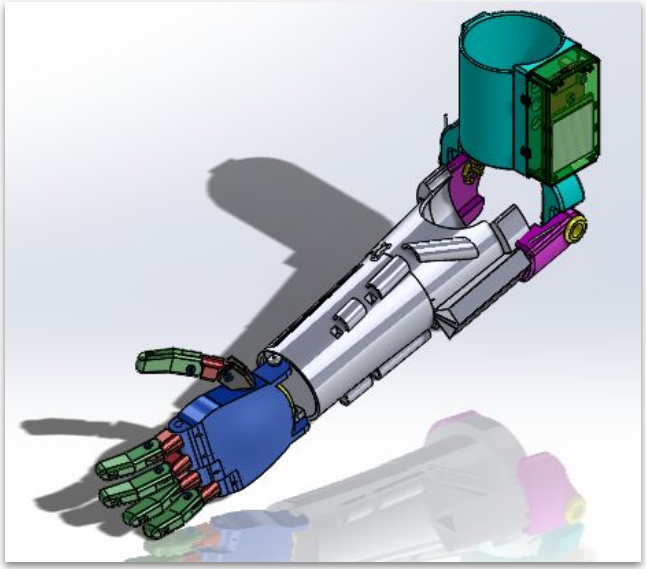
Objective:

- provide below-elbow amputees with an affordable prosthetic with haptic feedback.

Importance:

- It has the ability to make the wearer feel whole, have sense of belonging, feel unique, and enable their independence.



Enable- Enabling the Future

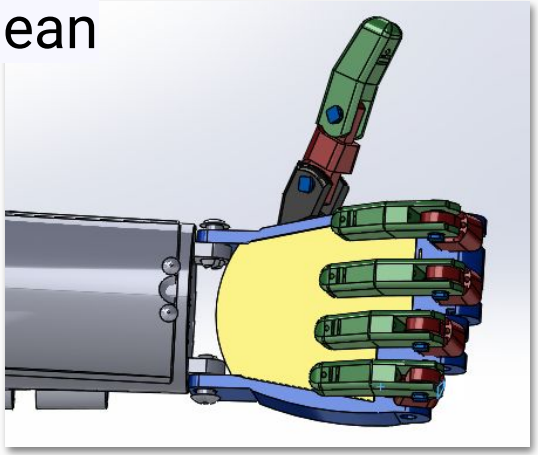
Motivation:

- Groups such as enable provide affordable prosthetics for people in need.
- Kids Grow quickly and constantly need replacement arms to fit
- We wish to improve their design for electronic activation

Enable Arm [1]

Customer Requirements:

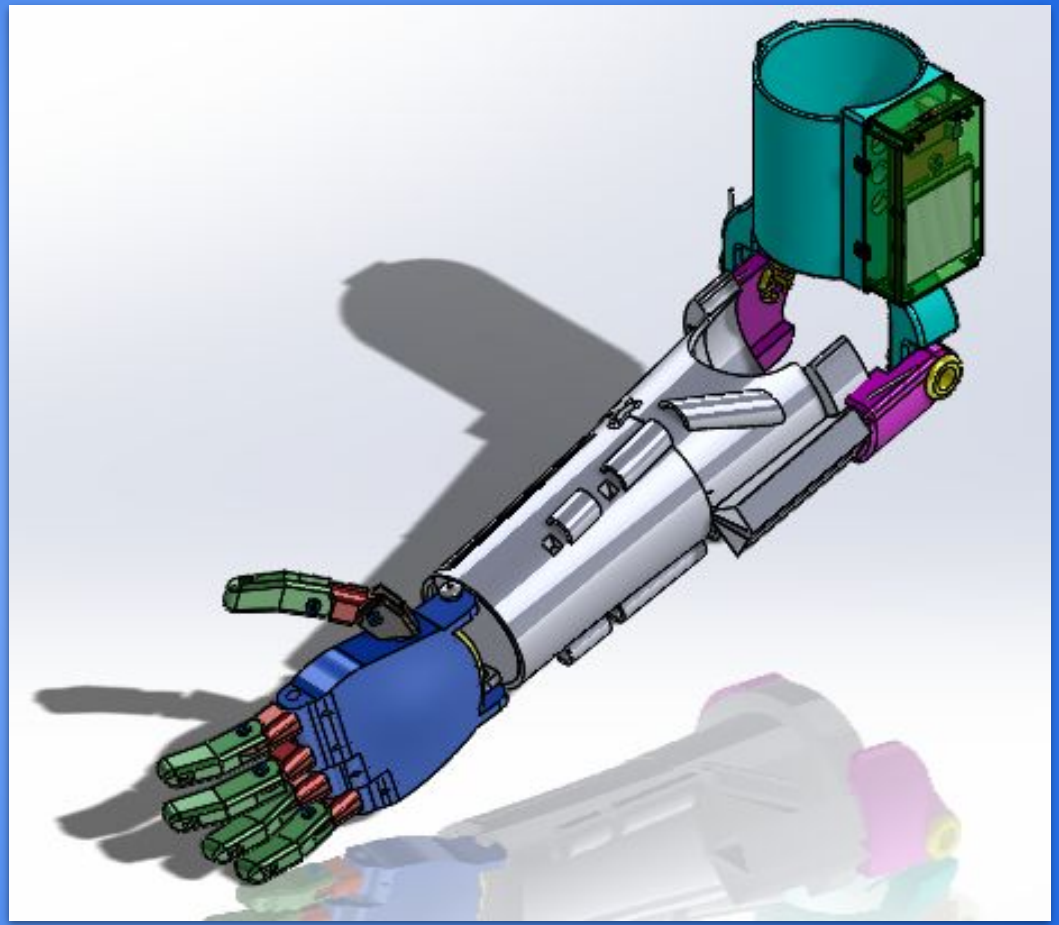
1. Scalable
   a. To fit individuals
2. Lightweight
   a. For comfort and liftability
3. Haptic Sensing System
4. Customization
5. Aesthetical
6. Easy to Clean
7. Durable
8. Reliable



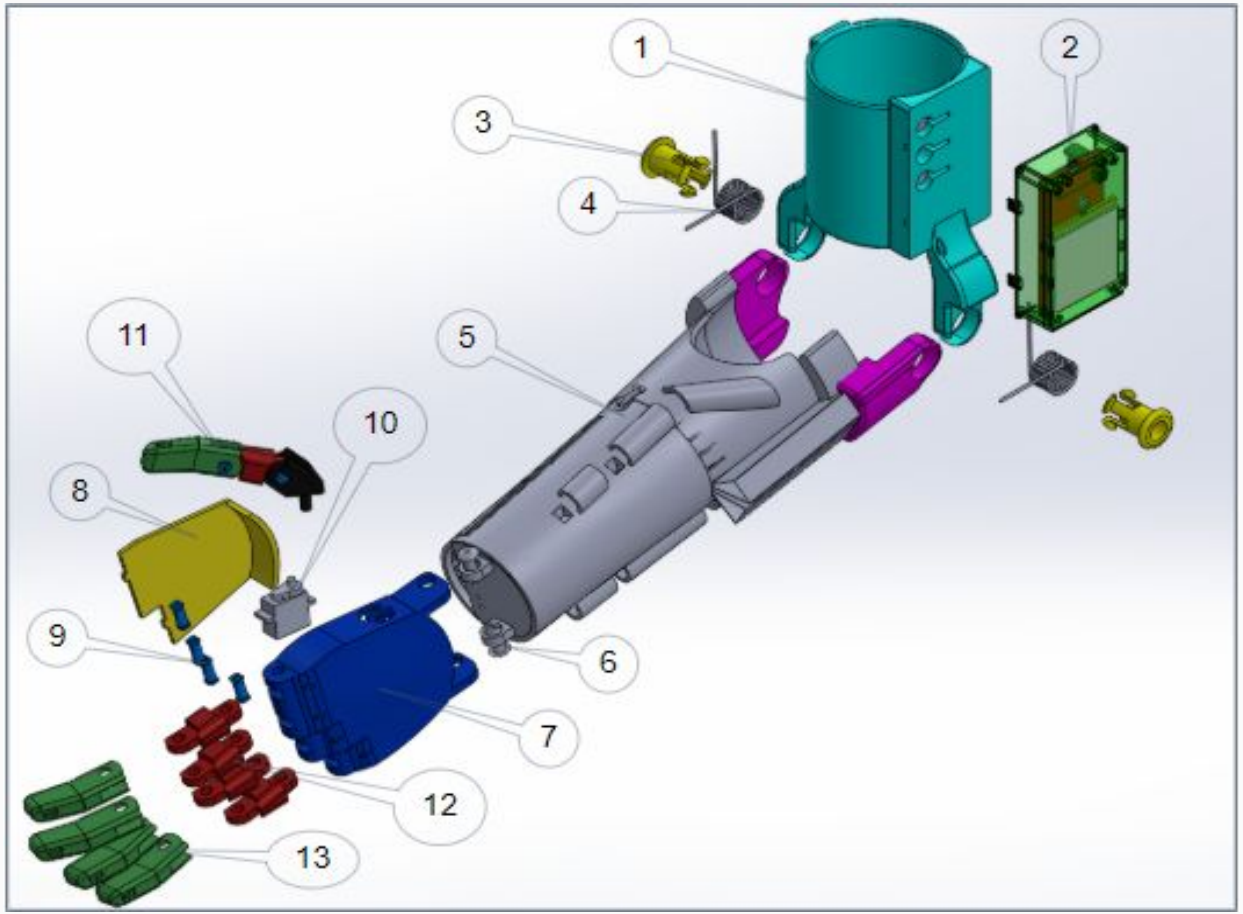
Engineering Requirements:

1. Scalable (6-18in)
   a. Adjustable CAD
2. Weight (2 lb)
3. Budget ($500)
   a. Affordable for users
4. Material Properties (10 lbf)
   a. Withstand wear and tare
5. Actuation Force (<5 lbf)
   a. Ease of Use
6. Grip Force (2 lbf)
7. Number of Parts (<100)
   a. Keep it simple

Final Design



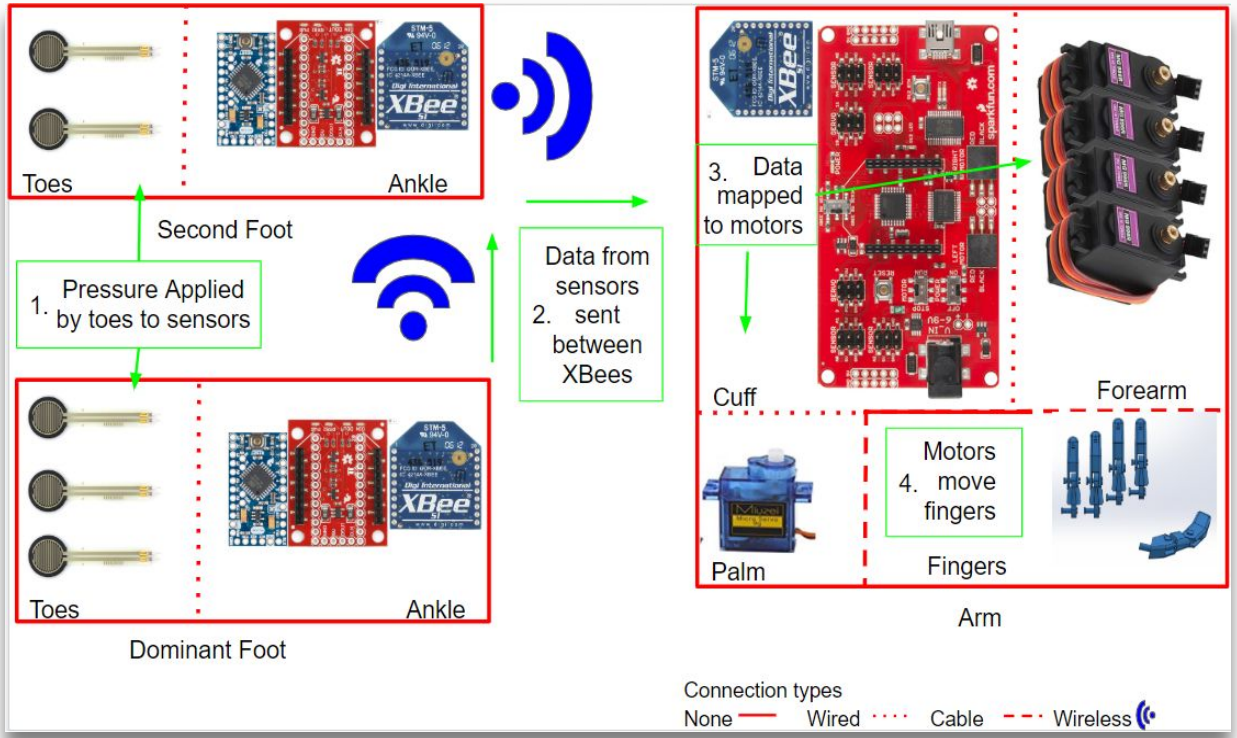
Exploded View of Arm Assembly



Part name	#
Cuff	1
Cuff Motor Assembly	2
Cuff Pin	3
Cuff Spring Attachement	4
Forearm Sub-Assembly with Motor	5
Forearm Pin Attachement	6
Palm	7
Palm Top	8
Palm Pins	9
Thumb Motor	10
Thumb Assembly	11
Proximal Digits	12
Distal Digits	13

Electrical Components

- Pressure input from toes is mapped to motor output to allow position control of fingers and adjustability of grip
- Wireless communication allows for ease of use by client
- Steps 1-4 show actuation process
- Haptic feedback via vibrating motors

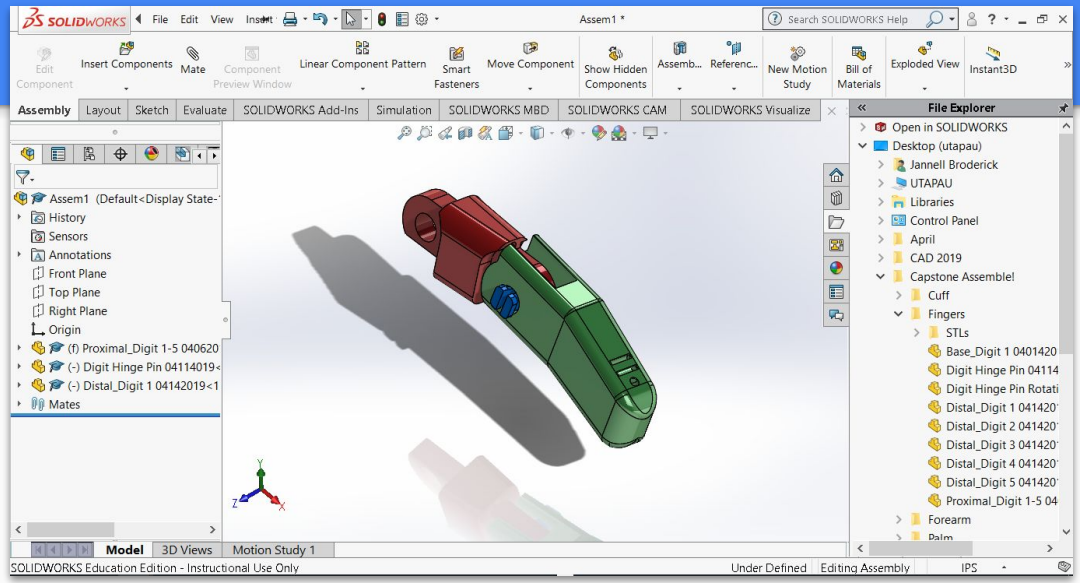


Manufacturing and Testing

Manufacturing

Main Mode of Manufacturing: 3D Printing

1. Model is adjusted in SolidWorks to fit client
    a. Convert to STL files

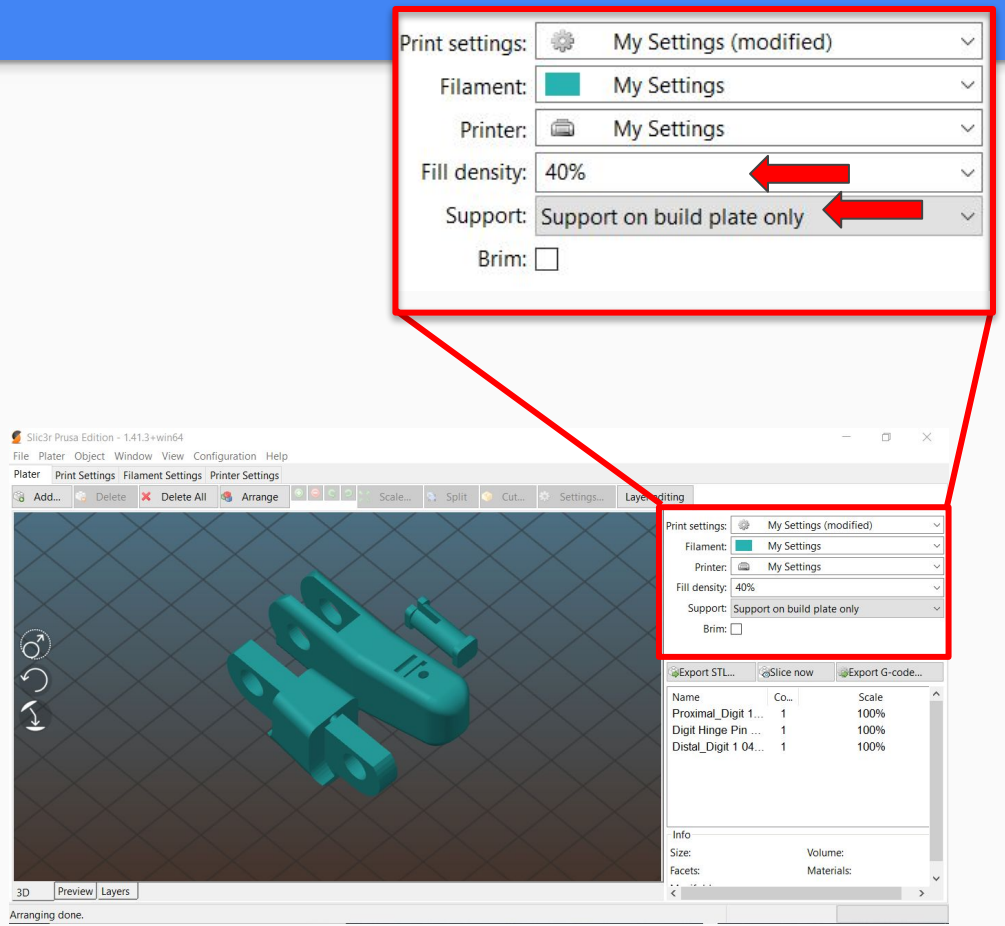


2. Export to G-code

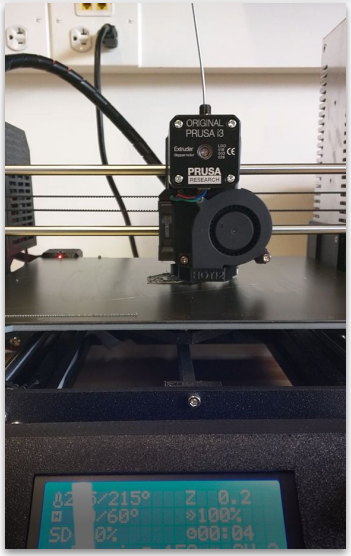
a. Slic3r Prusa Edition converts STLs of solid parts to G-Code

b. Infill density set to 40% for strength, and support is used on build plate only.

c. Orientation is based on printer bed size.

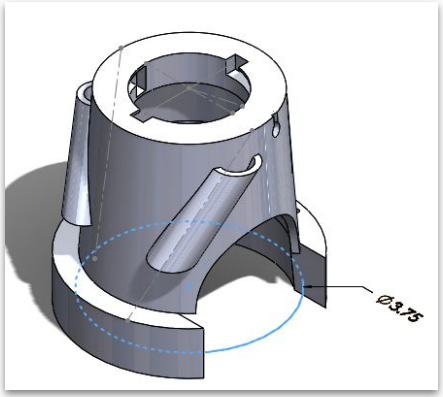


3. Parts can now be printed
    a. Parts were printed on the Prusa I3 MK3S.
4. All other parts are purchased as is
    a. Minor soldering is required for some electronic connections.



Testing Results

- Made 7 tests to determine if arm met requirements



Engineering Requirement	Testing Procedure
Scalable Size (6-18in)	Scale in SolidWorks
Weight (~3 lbs)	Weigh using fishing scale
Cost ($500)	Tally Receipts
Force to Actuate (<5 lbf)	Measure from force sensors (1 lbf)
Force of Grip (2 lbf)	Measure from motors (9.5 in*lbs)
Number of Parts (<100)	Tally Parts
Durability (<10 lbs)	Withstands extreme forces

Testing Results

Engineering Requirement	Testing Results
Scalable Size	10.5-18 (in)
Weight (~3 lbs)	2 (lbs)
Cost ($500)	~$400
Force to Actuate	1 lbf
Force of Grip	+9.5 in*lbs
Number of Parts	98
Durability	Minor attachment fractures

Total Testing Results: Pass!

-minor adjustments to pins, but their durability is also expected to be lower. That is why they are easy to replace

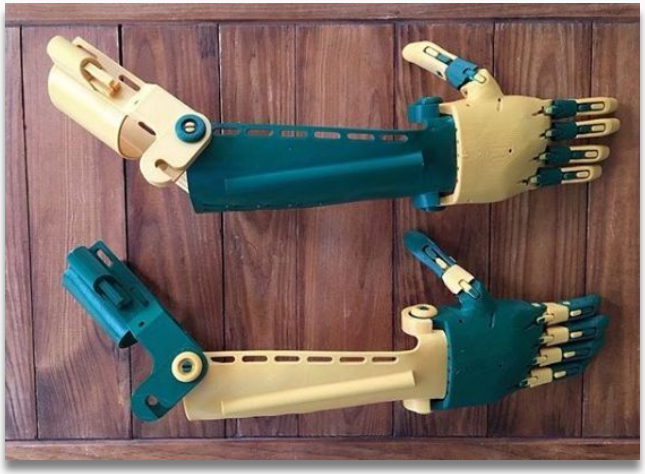
Final Cost

Final Product Cost

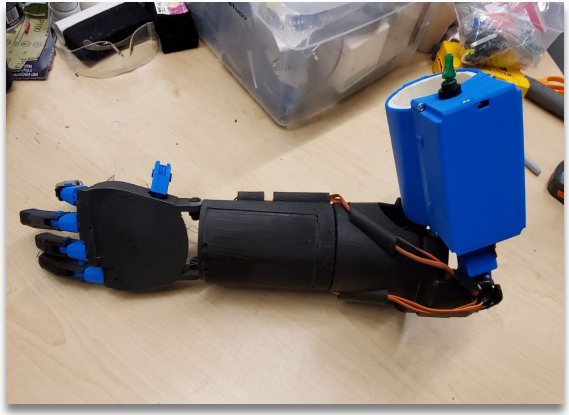
Final product Cost for DIY (Excluding shipping and tax)					
Order	**Price**	**Quantity**	**Price*Quantity**	**Catalog #**	**Vender**
XBee exploror	?	2	?	?	?
Battery 1Ahr	9.95	2	19.9	PRT-13813	Sparkfun
Battery 2Ahr	12.95	1	12.95	PRT-13855	Sparkfun
Charger and Booster	15.95	3	47.85	PRT-14411	Sparkfun
Force Sensitive Resistor 0.5"	6.95	5	34.75	SEN-09375	Sparkfun
Force Sensitive Resistor - Sm	6.95	2	13.9	SEN-09673	Sparkfun
Amphenol FCI Clincher Conne	1.95	7	13.65	COM-14194	Sparkfun
SparkFun RedBot Mainboard	52.95	1	52.95	ROB-12097	Sparkfun
XBee 1mW Trace Antenna - S	24.95	3	74.85		Sparkfun
270 Degree Carbon Steel Mus	12.57	1	12.57	3HPF6	Grainger
Shoe insoles	8.37	1	8.37	B07P3J3CGB	Amazon
Foam Pad	14.24	1	14.24	B000VQFSU0	Amazon
Digital Servo x4	25.99	1	25.99	B01GN0715U	Amazon
Virbrating motor x10 need 3	9.99	1	9.99	B076ZS77T1	Amazon
M3 Screws Assortment Pack	10.99	1	10.99		Amazon
Beaded Wire (x24yr)	2.99	1	2.99		
PLA per kg needed	17.99	1	17.99	Color Dependent	Amazon
Total:	373.93	34	373.93		

Learned how much prototyping increases team cost

Cost Comparison



Enable Arm [1]
~$30-$40

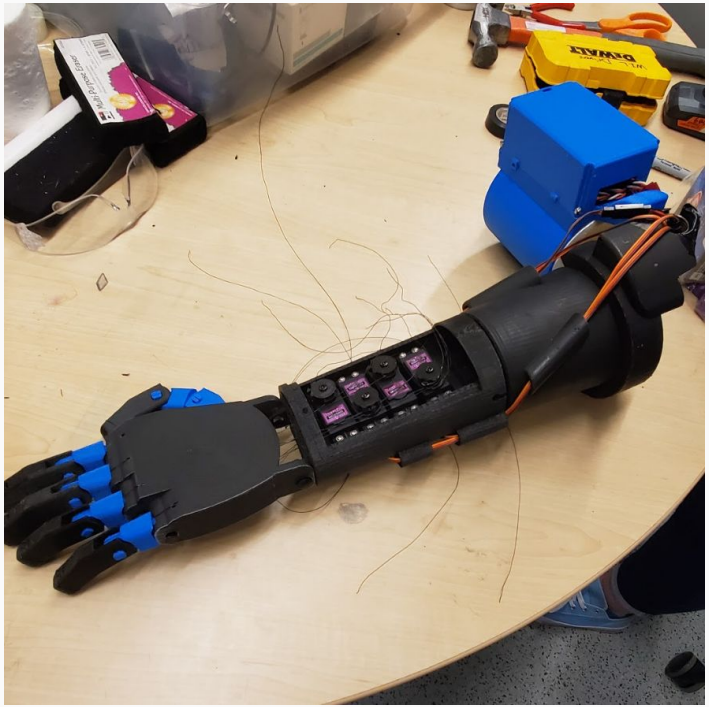


Our Arm
~$400.00

Michelangelo Arm [2]
$120,000

Conclusion

- Successful design- durable, aesthetically pleasing, and scalable
- Fingers actuate when cables are pulled
- Can hold items with fingers
- Has haptic feedback via vibrating motors



References

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

[2] “Michelangelo prosthetic hand,” ottobock. [Online]. Available: https://www.ottobockus.com/prosthetics/upper-limb-prosthetics/solution-overview/michelangelo-prosthetic-hand/. [Accessed: 26-Apr-2019].

[3] D. Murray, “The UnLimbited arm has arrived,” Team UnLimbited, 27-Sep-2015. [Online]. Available: http://www.teamunlimbited.org/e-nableblog/2015/9/27/the-unlimbited-arm-has-arrived. [Accessed: 26-Apr-2019].

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Electrical Engineering Team

Questions?