An Active Prosthetic Device

By: Jannell Broderick, Allison Cutler, Felicity Escarzaga, Toni Goss

Project Description

Felicity E.

Project Description:

This project aims to provide below-elbow amputees with an affordable prosthetic, that can provide them with a sense of touch.

- This prosthetic can be easily replicable by others
- It can be sized for anyone in need
- It can also have temperature or pressure based sensing

Client

Dr. Winfree

Dr. Kyle Winfree is the director of the Wearable Informatics Lab (WIL) and heads the Go Baby Go project at Northern Arizona University (NAU).

He will be the starting Client and will provide the design requirements.

Recipient

Family in the NAZ community

By mid October a recipient family will be determined from the Northern Arizona community.

This family will become the final client and receive the finished arm.

Background & Benchmarking

Toni G.

Background

Cost: The most sophisticated design for below- elbow amputees can cost upward of $20,000

Time: 4-6 weeks to fit a prosthetic arm, with five years of use before replacement.

Materials: Typically made with plastic, titanium, metal gears, and electrical sensing components.

Process: Materials can be melted to take shape or 3D printed. Parts are usually bolted together

Benchmarking

- ## Current E-Nable Hands

1. Lightweight design that utilizes the power of the wrist to open and close the hand.
2. E-Nable- Community that creates prosthetic hands for those in need using 3D printers. The cheaper material provides more affordable options.

- ## Animal 3D printed Prosthetic

1. Animal avengers- Group of volunteers that create prosthetics for animals using 3D printers.
2. Can create anything from beaks to custom fit prosthetic legs and arms.

- ## Prosthetic that feels pain

1. Creates the feeling of “Pain” by stimulating peripheral nerve endings
2. Patience can feel like there is nothing missing, as if they never lost their arm
3. Team from Hopkins university created the design, using funding from Space@Hopkins as well as other fellowship grants

Customer & Engineering Requirements

Jannell B.

Design Requirements

Project Features

- Scalable and customizable size
- Light weight
- Electromechanically controlled
- Sense touch
- Relay touch via haptic interface
- Rechargeable (8 hours of charge)
- Customized hardware
- Customized software
- Identify intention, predicting and acting in user command
- Downloadable design files

Customer Requirements

- Aesthetically pleasing
- No pain or discomfort or strain
- Haptic sensing system
- Scalable
- Customization
- Easy to clean
- Light weight
- Durable

Engineering Requirements

- Scaleable Size (in)
- Weight (lbs)
  - Must be ≤ to the portional weight of what the recipients arm would have been
- Budget ($)
  - < $500
- Material Properties
  - Thermo formal
  - Strength (psi)
- Force to actuate (N)
- Force of Grip (N)
- Number of Parts (#)

House of Quality

System QFD

Project: An Active Prosthetic Device
Date: September 16, 2018
Input areas are in Blue

1	Scaleable Size							
2	Weight							
3	Budget							
4	Material Properties			-3				
5	Force to actuate	3	-3		3			
6	Force of Grip				3	9		
7	Number of Parts	3	3	-3				

Legend
A E-Nable Hands
B Animal 3D printed Prosthe
C Prosthetic that feels pain

	Customer Needs	Customer Weights	Technical Requirements: Scaleable Size	Weight	Budget	Material Properties	Force to actuate	Force of Grip	Number of Parts	Customer Opinion Survey: 1 Poor	2	3 Acceptable	4	5 Excellent
1	Aesthetically pleasing	1	9	0	3	0	0	0	1			ABC		
2	No pain or discomfort or strain	4	3	9	0	3	9	6	3	C		B	A	
3	Scalable	3	9	3	3	3	3	0	6		C	B	A	
4	Customization	3	9	3	3	1	3	6	6			C	AB	
5	Easy to clean	2	0	0	1	3	0	0	3		ABC			
6	Light weight	3	3	9	1	9	1	0	6		C	B	A	
7	Durable	4	1	3	0	9	1	3	3		C	AB		
8	Haptic sensing system	4	0	0	9	0	9	9	0	AB				C
9														
10														
11														
	Technical Requirement Units		in	lbs	$	psi	N	N	#					
	Technical Requirement Targets		6	1.72	500	~1000	10	1000	<100					
	Absolute Technical Importance		5.88	2.93	6.62	2.93	1.97	3.90	4.85					
	Relative Technical Importance		5	2	6	2	1	3	4					

Technical Vs Customer Requirements

		Technical Requirements						
Customer Needs	Customer Weights	Scaleable Size	Weight	Budget	Material Properties	Force to actuate	Force of Grip	Number of Parts
Aesthetically pleasing	1	9	0	3	0	0	0	1
No pain or discomfort or strain	4	3	9	0	3	9	6	3
Scalable	3	9	3	3	3	3	0	6
Customization	3	9	3	3	1	3	6	6
Easy to clean	2	0	0	1	3	0	0	3
Light weight	3	3	9	1	9	1	0	6
Durable	4	1	3	0	9	1	3	3
Haptic sensing system	4	0	0	9	0	9	9	0
Technical Requirement Units		in	lbs	$	psi	N	N	#
Technical Requirement Targets		6	1.72	500	~1000	10	1000	<100
Absolute Technical Importance		88	93	62	93	97	90	85
Relative Technical Importance		5	2	6	2	1	3	4

Technical Requirements Ranking:

- Force to actuate
- Weight
- Material Properties
- Force of grip
- Number of Parts
- Scalable Size
- Budget

Technical vs Technical Requirements

Scaleable Size								
Weight								
Budget				-3				
Material Properties					3			
Force to actuate		3	-3		3			
Force of Grip					3	9		
Number of Parts		3	3	-3				
		Technical Requirements						
Customer Needs	Customer Weights	Scaleable Size	Weight	Budget	Material Properties	Force to actuate	Force of Grip	Number of Parts

Most technical requirements have positive correlation with each other. The budget has a negative correlation because more parts and different material are expensive.

Benchmarking Ranking

A. E-Nable Hands

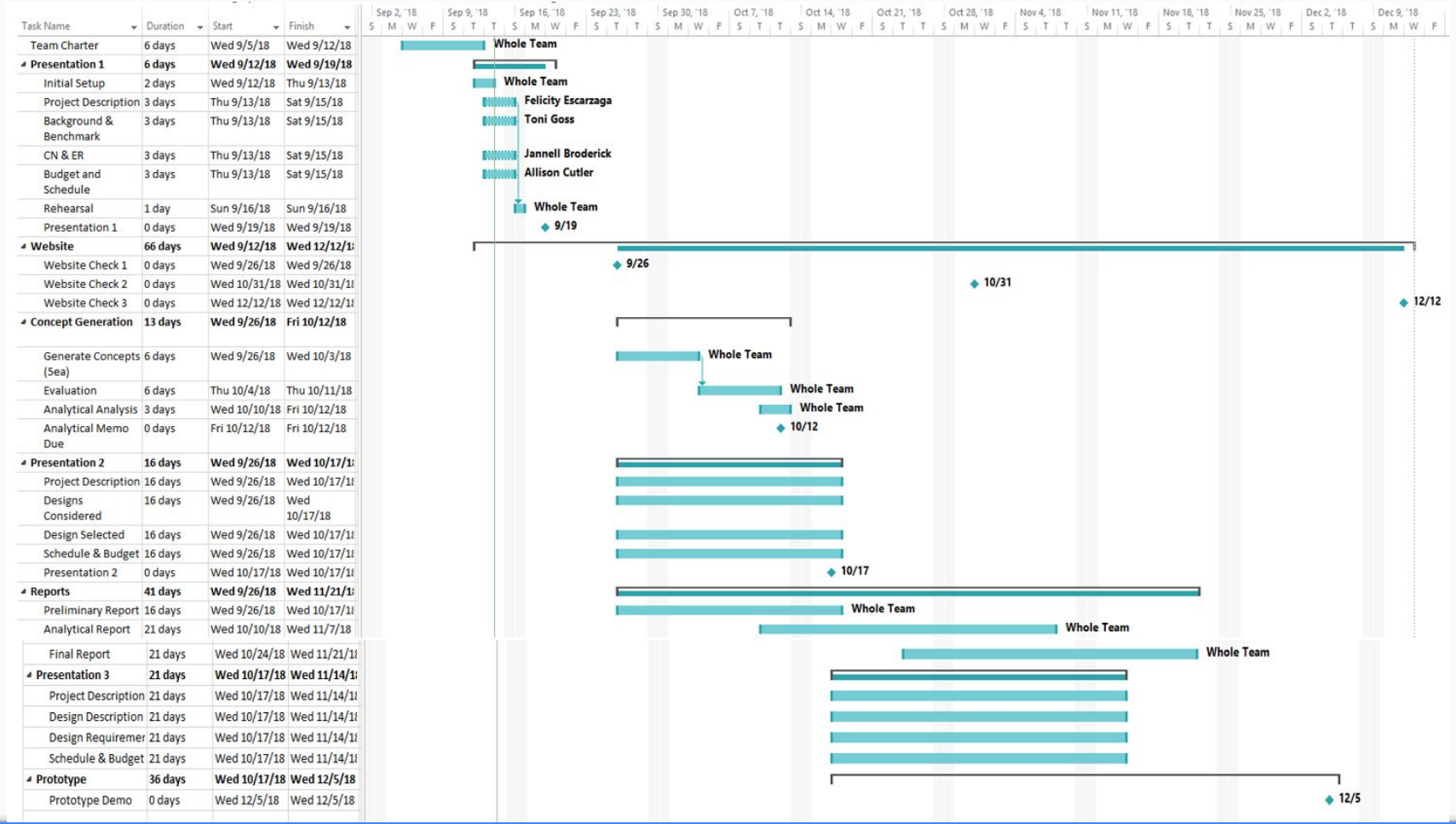
B. Animal 3D printed Prosthetic

C. Prosthetic that feels pain

	Customer Opinion Survey				
Customer Needs	1 Poor	2	3 Acceptable	4	5 Excellent
Aesthetically pleasing			ABC		
No pain or discomfort or strain	C		B	A	
Scalable		C	B	A	
Customization			C	AB	
Easy to clean		ABC			
Light weight		C	B	A	
Durable		C	AB		
Haptic sensing system	AB				C

Schedule & Budget

Allison C.



Task Name	Duration	Start	Finish
Team Charter	6 days	Wed 9/5/18	Wed 9/12/18
Presentation 1	**6 days**	**Wed 9/12/18**	**Wed 9/19/18**
Initial Setup	2 days	Wed 9/12/18	Thu 9/13/18
Project Description	3 days	Thu 9/13/18	Sat 9/15/18
Background & Benchmark	3 days	Thu 9/13/18	Sat 9/15/18
CN & ER	3 days	Thu 9/13/18	Sat 9/15/18
Budget and Schedule	3 days	Thu 9/13/18	Sat 9/15/18
Rehearsal	1 day	Sun 9/16/18	Sun 9/16/18
Presentation 1	0 days	Wed 9/19/18	Wed 9/19/18
Website	**66 days**	**Wed 9/12/18**	**Wed 12/12/1**
Website Check 1	0 days	Wed 9/26/18	Wed 9/26/18
Website Check 2	0 days	Wed 10/31/18	Wed 10/31/1
Website Check 3	0 days	Wed 12/12/18	Wed 12/12/1
Concept Generation	**13 days**	**Wed 9/26/18**	**Fri 10/12/18**
Generate Concepts (5ea)	6 days	Wed 9/26/18	Wed 10/3/18
Evaluation	6 days	Thu 10/4/18	Thu 10/11/18
Analytical Analysis	3 days	Wed 10/10/18	Fri 10/12/18
Analytical Memo Due	0 days	Fri 10/12/18	Fri 10/12/18
Presentation 2	**16 days**	**Wed 9/26/18**	**Wed 10/17/1**
Project Description	16 days	Wed 9/26/18	Wed 10/17/1
Designs Considered	16 days	Wed 9/26/18	Wed 10/17/18
Design Selected	16 days	Wed 9/26/18	Wed 10/17/1
Schedule & Budget	16 days	Wed 9/26/18	Wed 10/17/1
Presentation 2	0 days	Wed 10/17/18	Wed 10/17/1
Reports	**41 days**	**Wed 9/26/18**	**Wed 11/21/1**
Preliminary Report	16 days	Wed 9/26/18	Wed 10/17/1
Analytical Report	21 days	Wed 10/10/18	Wed 11/7/18
Final Report	21 days	Wed 10/24/18	Wed 11/21/1
Presentation 3	**21 days**	**Wed 10/17/18**	**Wed 11/14/1**
Project Description	21 days	Wed 10/17/18	Wed 11/14/1
Design Description	21 days	Wed 10/17/18	Wed 11/14/1
Design Requiremer	21 days	Wed 10/17/18	Wed 11/14/1
Schedule & Budget	21 days	Wed 10/17/18	Wed 11/14/1
Prototype	**36 days**	**Wed 10/17/18**	**Wed 12/5/18**
Prototype Demo	0 days	Wed 12/5/18	Wed 12/5/18

Schedule

- Expecting 5 full arm prototypes
- 1 to 6 motors depending on design picked [5]
- 2 to 5 sensors depending on design picked [5]
- Shipping costs are to be determined
- Total Budget: $500.00

Part	Qty	Cost ($)	
Printing material (kg)	1 per arm	$15	
	x 5 full arms	$75	
Motor (arduino-uno, arduino-zero)	1 to 6		
	min	$30-60	
	max	$180-360	
Haptic Sensors	2 to 5	$14-$35	
Pressure Sensors	2 to 5	$14-$35	only one
feedback sensor thing	2 to 5	$14-$35	option
Shipping		TBD	
	TOTAL	$269-$470	

References

[1]Arnold, a. (2018). Injured Animals Get Second Chance With 3-D Printed Limbs. [online] News.nationalgeographic.com. Available at: https://news.nationalgeographic.com/2016/08/prosthetics-animals-rescued-3d-dogs-cats/ [Accessed 17 Sep. 2018].

[2]Canner, L. (2018). *New 'e-dermis' brings sense of touch, pain to prosthetic hands: Electronic 'skin' will enable amputees to perceive through prosthetic fingertips*. [online] ScienceDaily. Available at: https://www.sciencedaily.com/releases/2018/06/180620171004.htm [Accessed 17 Sep. 2018].

[3]Clements, "How Prosthetic Limbs Work" 25 June 2008.HowStuffWorks.com. <https://science.howstuffworks.com/prosthetic-limb.htm> 16 September 2018

[4]Heilman,Rattner. "Medical Miracles," Redbook. May, 1991, p. 124+.

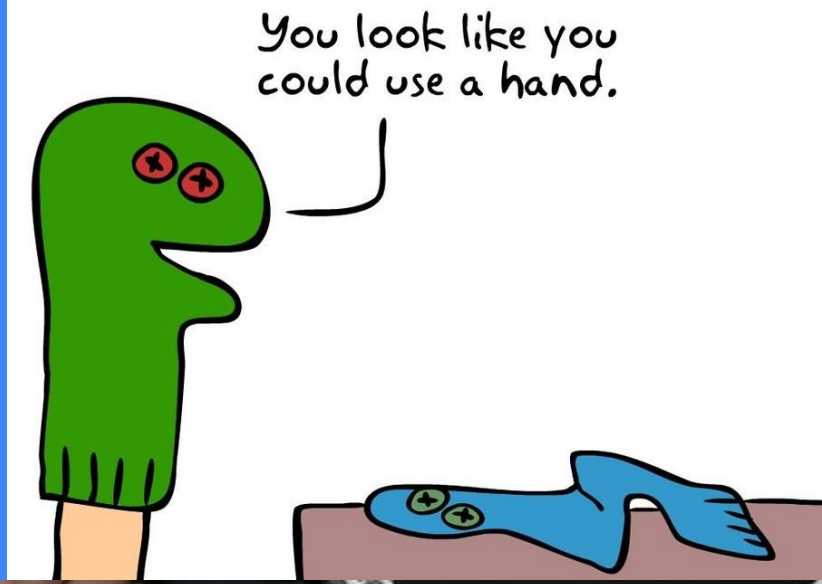
[5]LLC,“How Much Does A Prosthetic Arm Cost - Is It Really Expensive?,” *Discover Devices*, https://discoverdevices.com/reviews/how-much-does-a-prosthetic-arm-cost-below-knee-prosthesis-types/.

[6]Owen, J. (2018). *Enabling The Future*. [online] Enabling The Future. Available at: http://enablingthefuture.org/ [Accessed 17 Sep. 2018].

[7] Sparkfun Electronics, Gella-Arduino, Megan Arnold-Blade, Pete, https://www.sparkfun.com/


I'VE GOT TOO MUCH
Thyme
LEAVES


BRACE YOURSELVES
HAND PUNS ARE COMING


You look like you could use a hand.

Questions?


CYRIAK


THINGS
Things are getting out of hand!