Team Terminator Arm
Fall 2015
Progress Report

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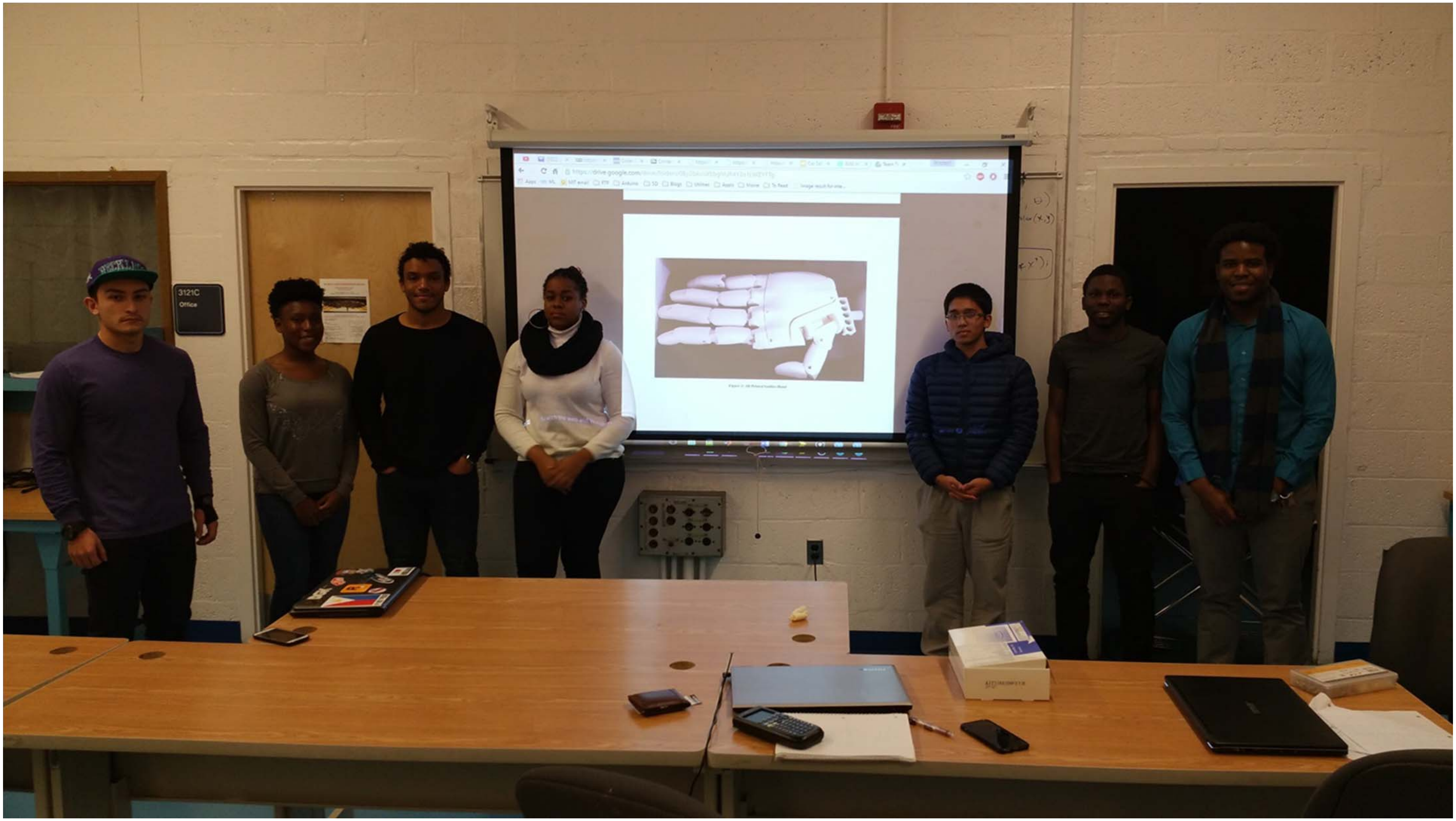
December 7, 2015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Problem Statement

Amputees deserve a normal life like everyone else. They require an inexpensive hand that also provides high functionality comparable to the human hand, which is also light and comfortable enough and reliable to use for everyday activities

We intend to produce a prosthetic using electromyographic methods that is waterproof and resistant to deformation

Current Status of Art

- Traditional myoelectric prosthetics cost upwards of $3000, this would be assembled for less than one-tenth the price
- e-NABLE has open-sourced design for hand-prosthetics that are purely mechanical "Inexpensive & electrically activated prosthetics are rare"

Design Requirements

Customers

Amputees with loss of forearm

Needs

Inexpensive prosthetic hand
Hand with great degree of motion i.e comparable to the human hand
Reliable to use for everyday activities eg writing, picking objects
Resistant to deformation (scratches, corrosion)
Water proof
Should be light and comfortable enough

Design Requirements (Contd.)

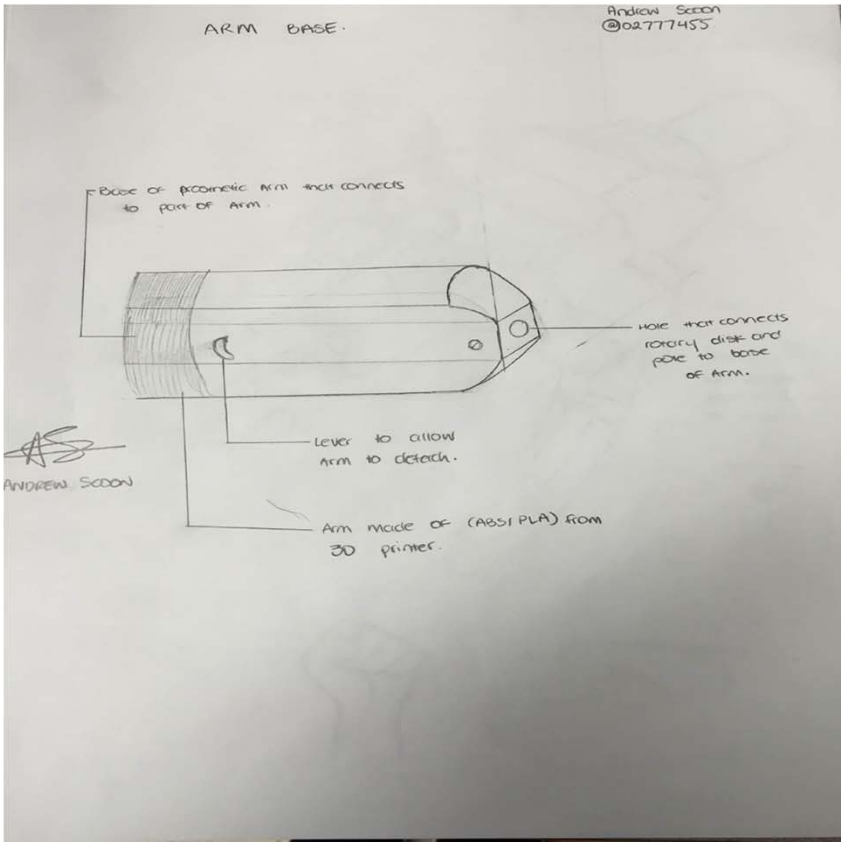
Barriers

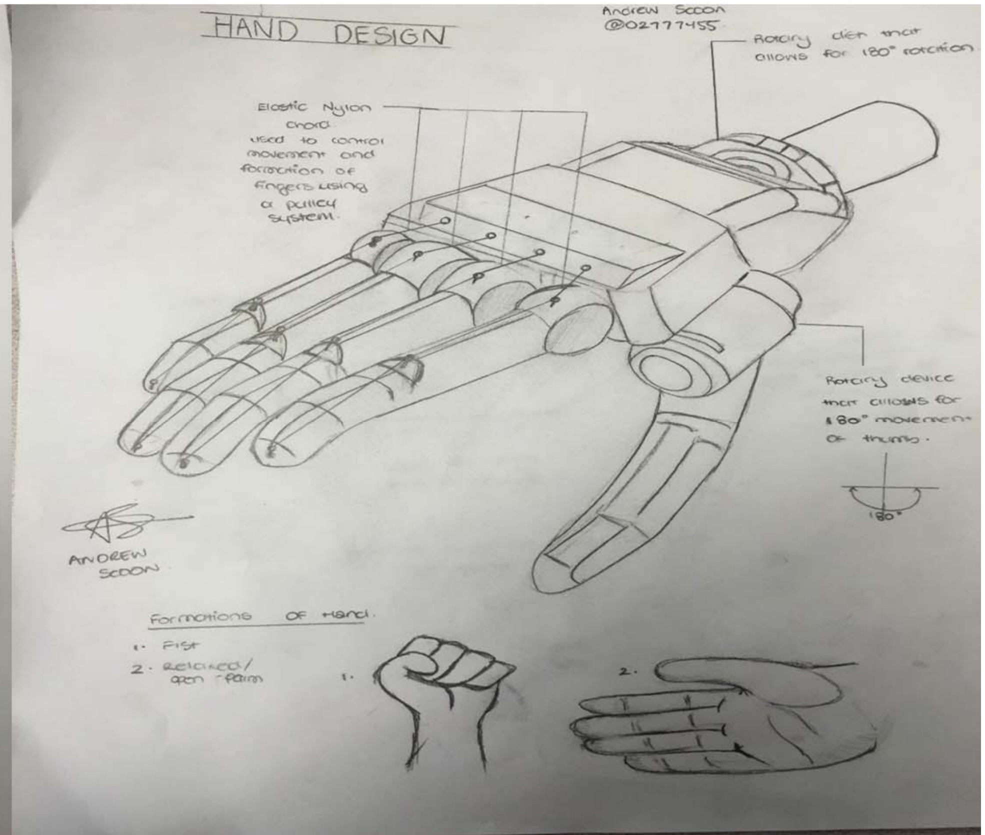
- People have not explored cheaper electromyographic methods
- The strength of the material
- Durability

Advantages

- Cost-effective alternative
- Non-invasive method of prosthesis
- Easily detachable which can be advantageous for cleaning/general maintenance
- Other hands have to be manually adjusted for specific hand gestures, our design eliminates this problem

Conceptual Design 1





Conceptual Design 2

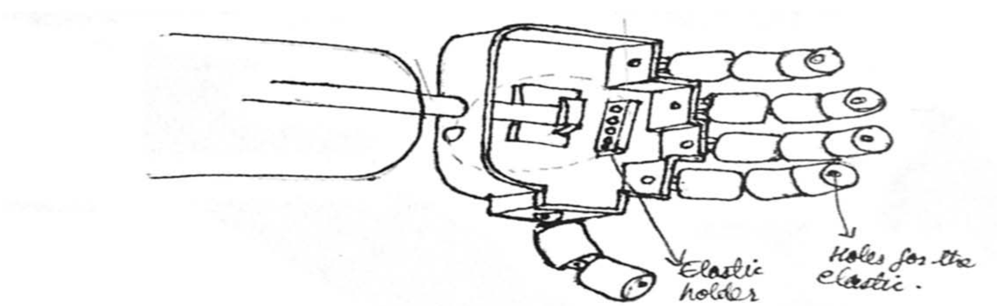


Fig 1: The Hand

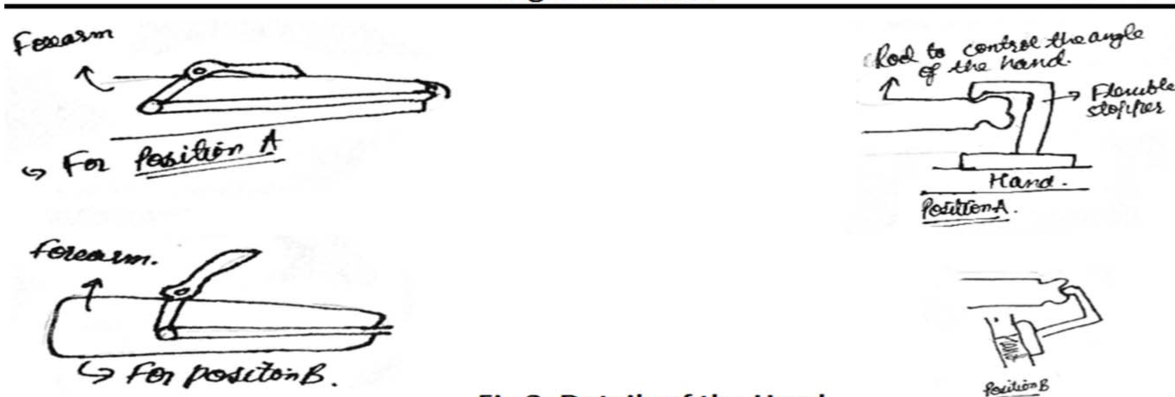
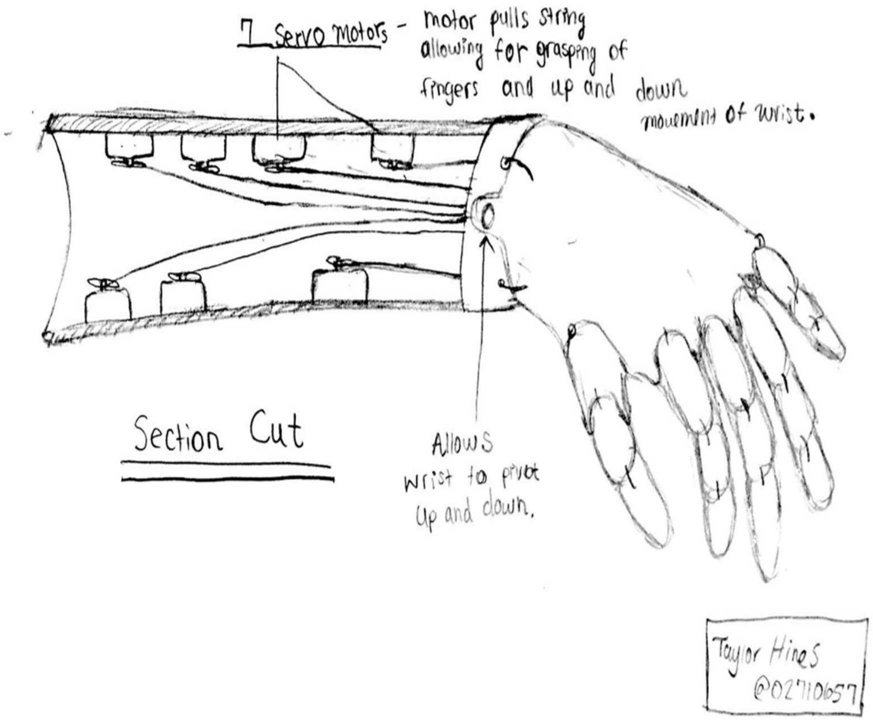
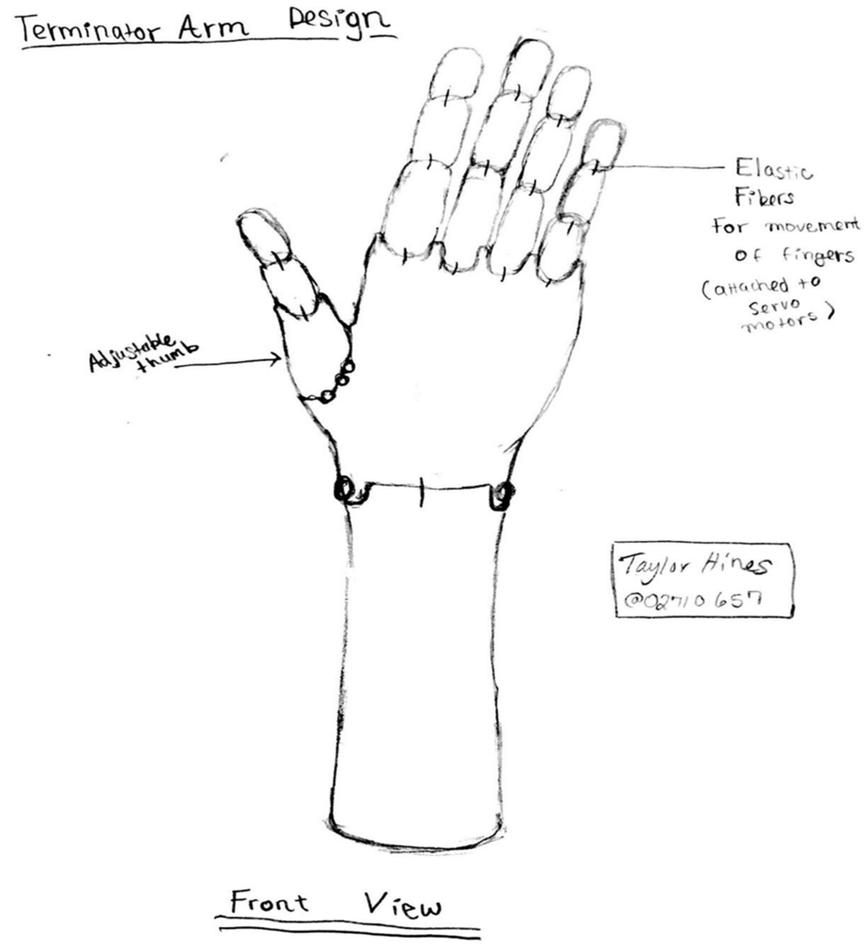


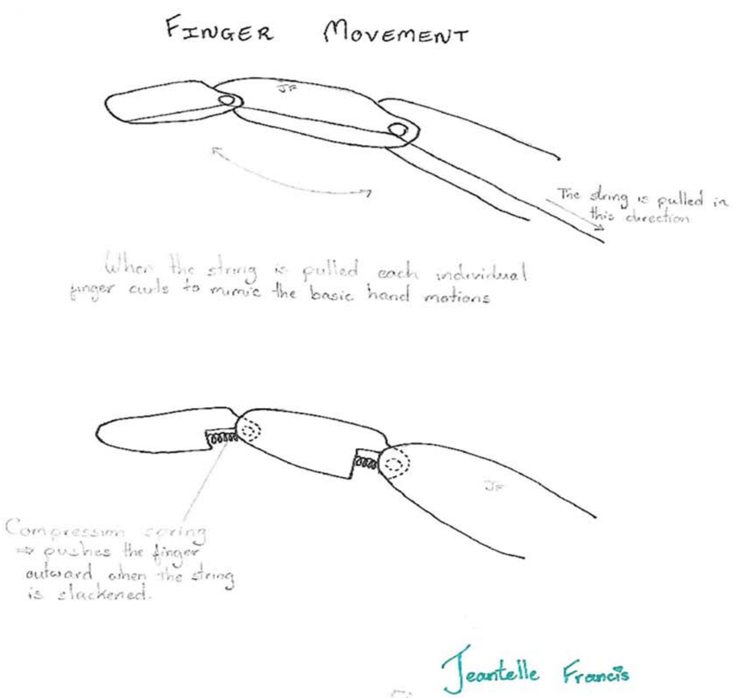
Fig 2: Details of the Hand

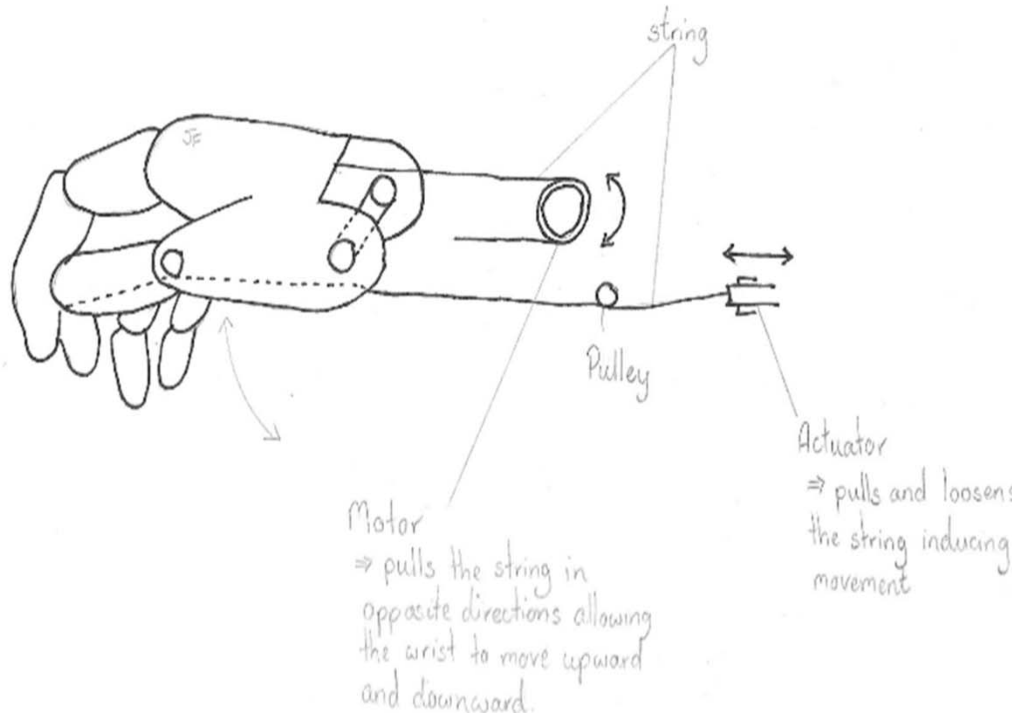
Conceptual Design 3





Conceptual Design 4





Conceptual Design 5

Annotated Dimensioned Mechanical Drawings of Prosthetic Hand

- Veins channel cables from servos to finger joints
- servos housed in 3D printed pocket
- All servos situated below microcontroller
- Hinged wrist allows 60˚ of freedom

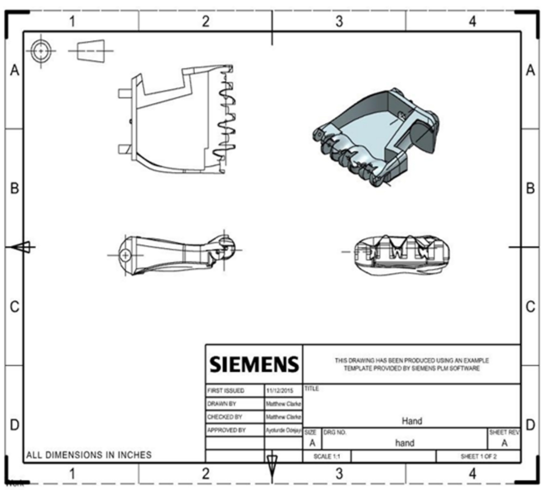


Fig 1. Hand

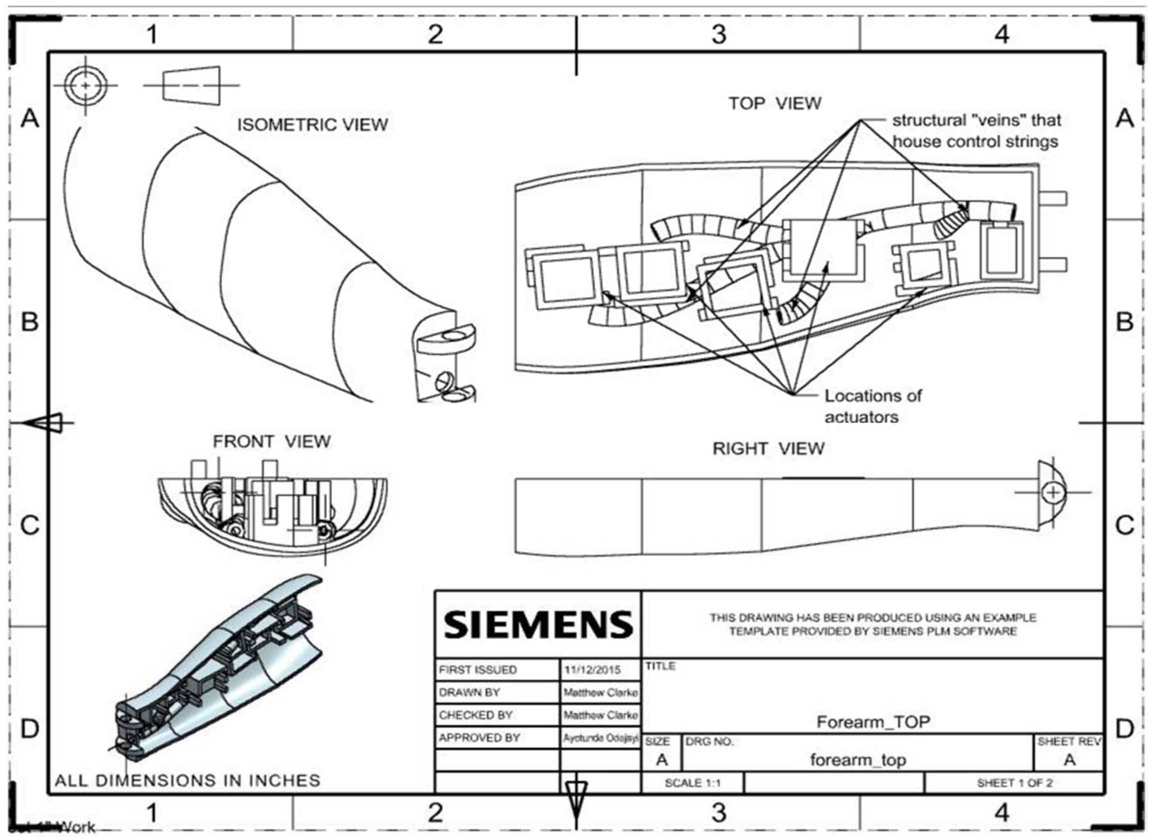
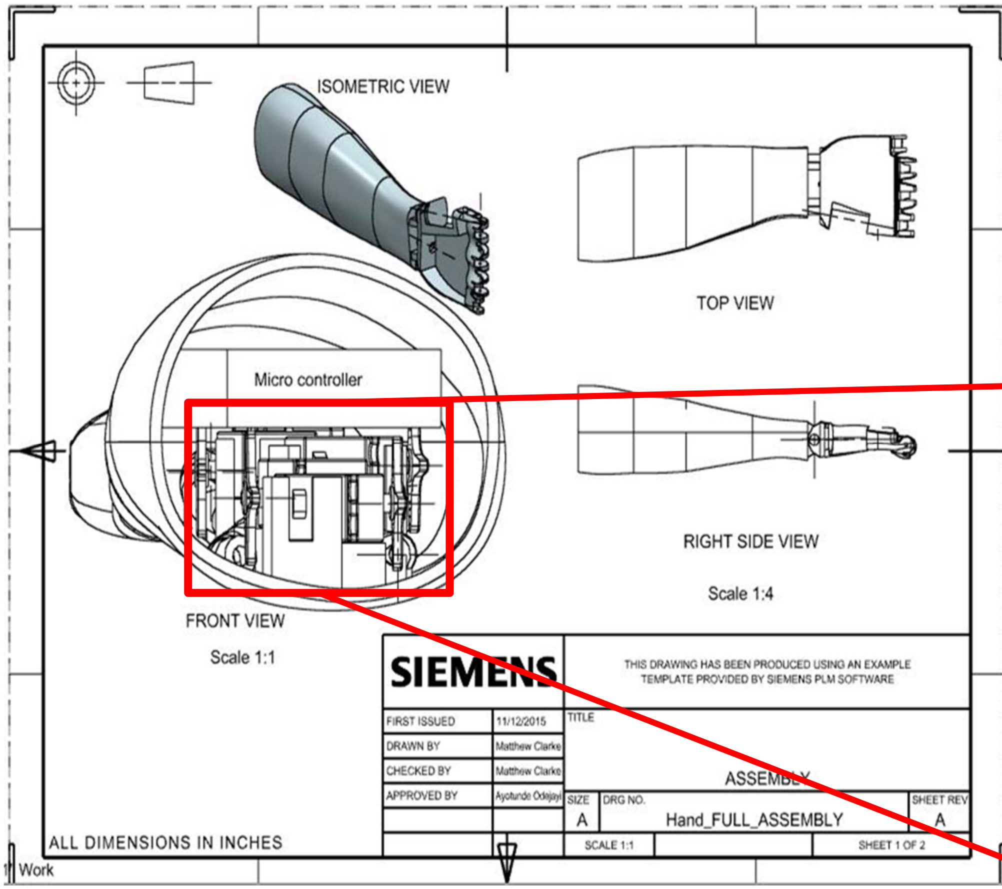
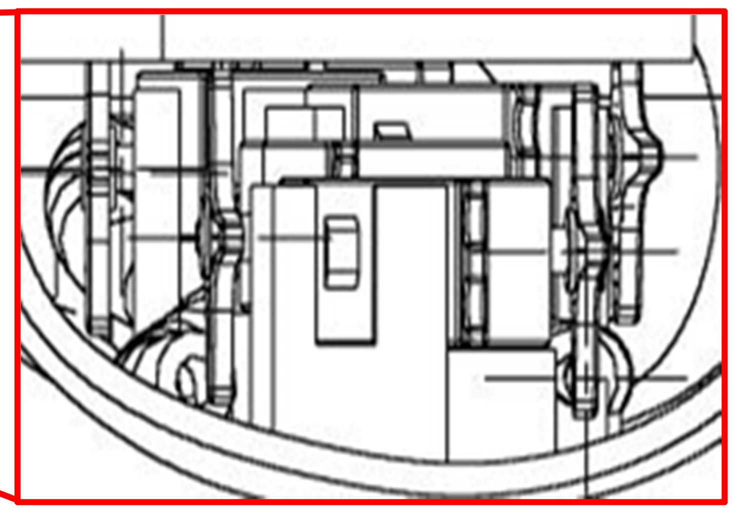


Fig. 2 Sectioned View of Forearm

Conceptual Design 5 (Contd.)



- Assembly of forearm and hand without finger joints shown right
- CAD Model is a right arm of an adult male
- Ability to house 2 differently sized microcontrollers

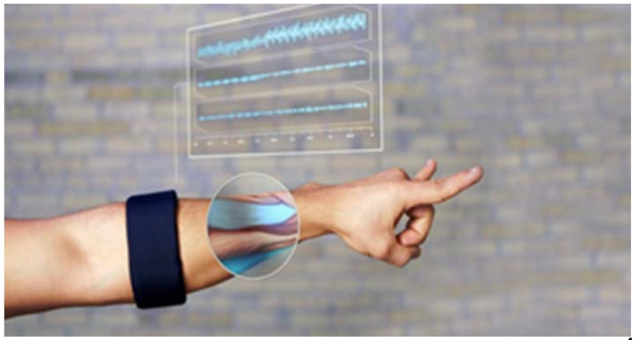


Myo Armband control

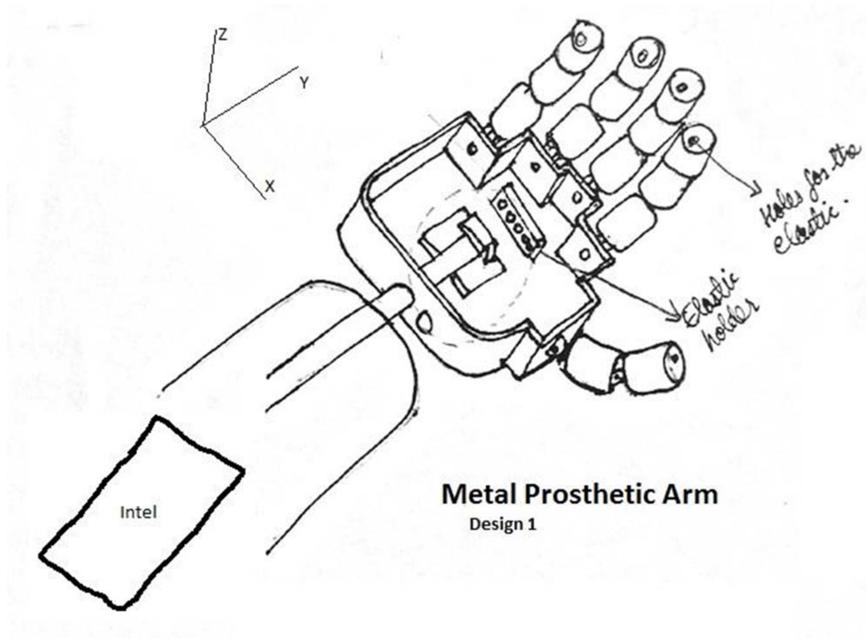
Myo provides remote access to hand motion

C programmable

Communicate with microcontroller



Analysis of Alternative designs



Design 1 (Metal prosthetic arm)

Pros

No thermosensor required

Durable

Cons

Unnatural motion, finger design is also round/cylindrical in shape

Accommodates a single microprocessor (Intel Galileo)

Long time to market (TTM)

** This is a revised version of a previous concept design*

Analysis of Alternative designs (contd.)

Design 2 (Concept Design 5: 3D- printed prosthetic arm)

Pros

Short time to market

Amenable to both hardware and software open-sourcing

Human-like wrist motion

Accommodates 2 or more microprocessors

Cons

Requires thermosensor for protection

Less durable

Top Design Selection

DESIGN MATRIX							
	Weight	**Design 1 (Metal)**	**Unit score**	**Aggregate score**	**Design 2 (3D)**	**Unit Score**	**Aggregate score**
Arm weight (lbs)	2	Approx. 10-15	4	8	Approx. 5-10	**5**	**10**
Functionality	5	Limited degrees of motion	3	15	Human-like arm motion	**4**	**20**
Durability	5	Very durable due to metallic material	5	25	Prone to deformation. Requires extra components to ensure product safety	**3**	**15**
Microcontroller Adaptability	3	Limited to Intel microcontroller	3	9	Flexible with Intel and TI microcontrollers	**5**	**15**
Time to market (TTM)	4	1 month minimum	3	12	Approx. 1 week	**4**	**16**
Open-source amenability	2	Limited to software open-sourcing	2	4	Provides both hardware and software open-sourcing	**5**	**10**
Total				**73**			**86**

Building/Assembling Arm

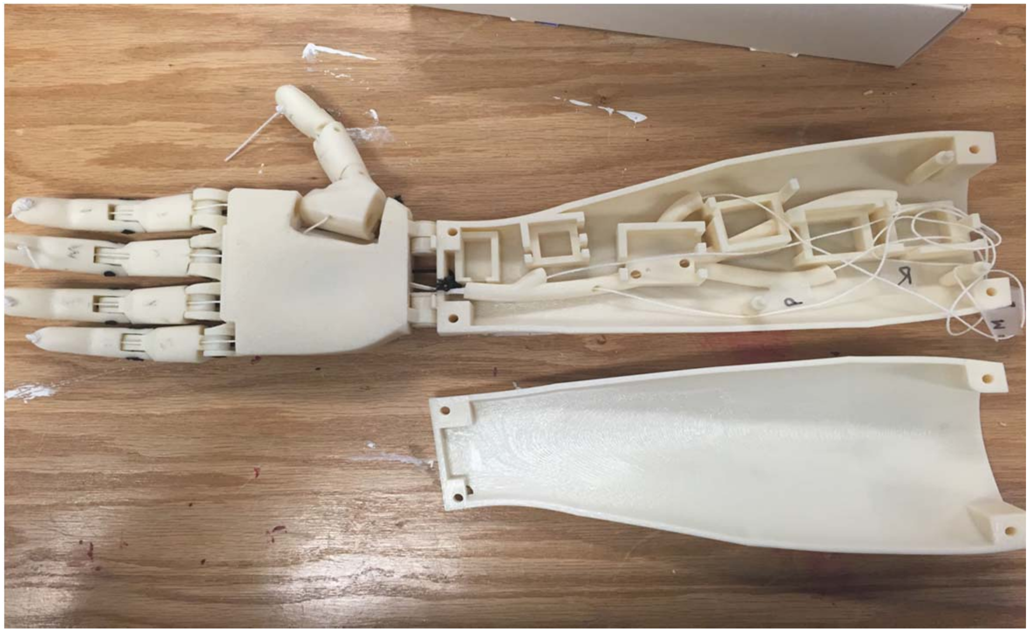
Stage 1 : 3D Printing

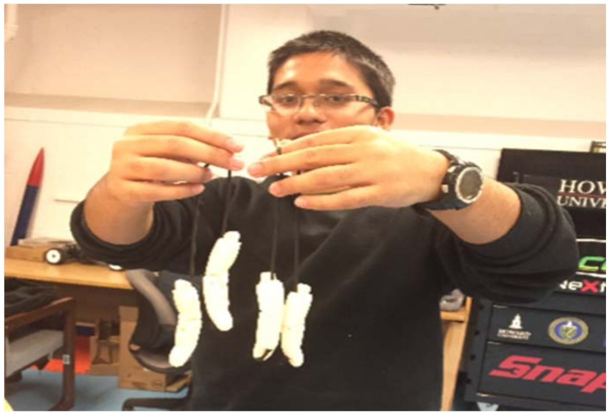
- FDM Process using ABS Plastic
- Process involves the removal of support material using acid bath

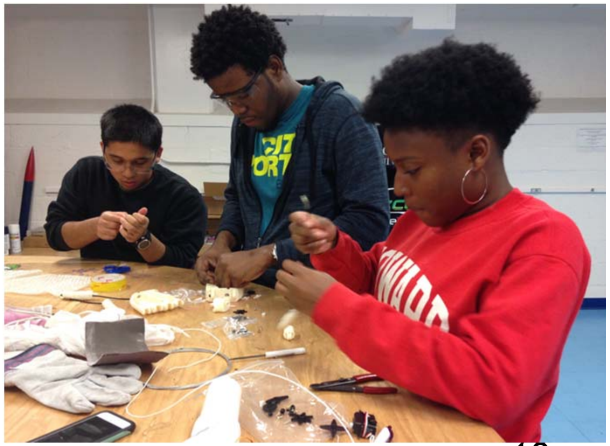
Building/Assembling Arm (contd.)

Stage 2 : Assembly of arm, hand and finger joints

- Assembly took upwards of 2 days and 8 hours
- Utilized additional material purchased







Programming the Hand

Prototyped with Arduino uno development board

Motor Constraints

Servo 1

vs

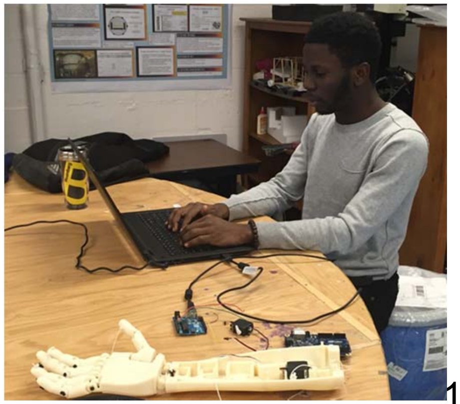
Servo 2

Torque (1.8Kg.cm vs 2.1Kg.cm)

Size (22.2 by 31 cm vs 26.8 by 31.3 cm)

Weight (9g vs 19g)

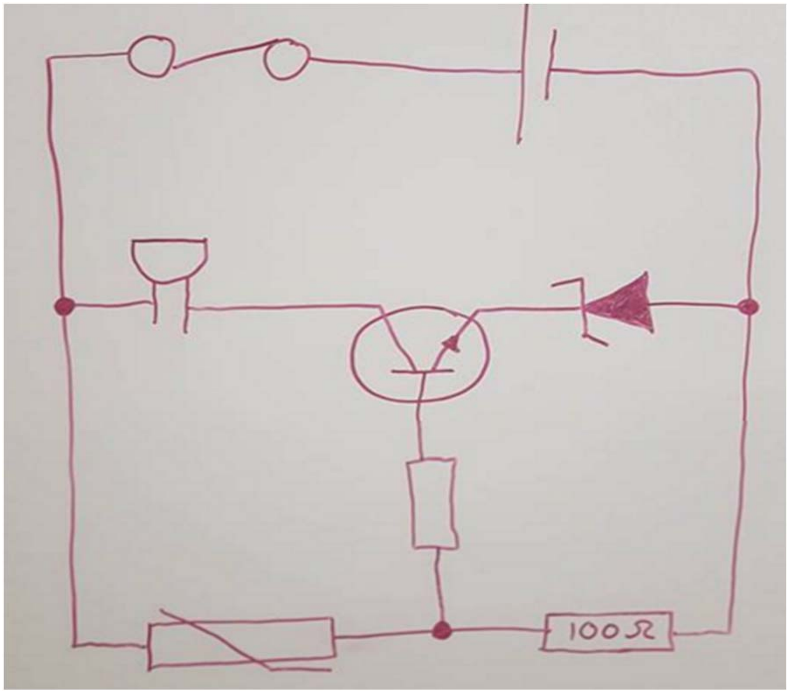
Motion (Continuous rotation vs angle precision)



Heat Detection System

Materials used for the circuit are as follows: switch, batteries, buzzer thermistor, resistors, transistor, diode.

The purpose of this circuit is to alarm when the prosthetic arm is exposed to temperatures which may cause thermal deformation and harm to the amputee.



Landmarks

Designed, printed and assembled 85% of the arm

Prototyped servos with Arduino microcontroller development board

Created a Team website: [Terminator Webpage]

Timeline till date

Proposal of new project	Sept. 2015
Recruited team members	Sept. 2015
Purchased design parts	Oct. 2015
Conceptual designs	Oct/Nov. 2015
Alternative design + Analysis + Top design selection	Nov/Dec 2015
3D printing / Assembly	Nov/Dec 2015
Began Programming servos	Dec 2015

Proposed Plans

Become familiar with Myo

Incorporate new functionality:

- Alert user about low battery, heat etc.
- Reduce lag time
- Provide smoother hand motion
- Improve aesthetics

Complete Arm

Continuously update and improve team website

Participate in Intel Cornell Cup (Registered) and TI innovation Challenge


Start
LIVE DEMO