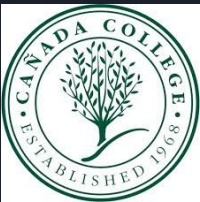


# Advanced 3D-Printed Child's Prosthetic Hand

ASPIRES Summer Internship 2017

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# Overview

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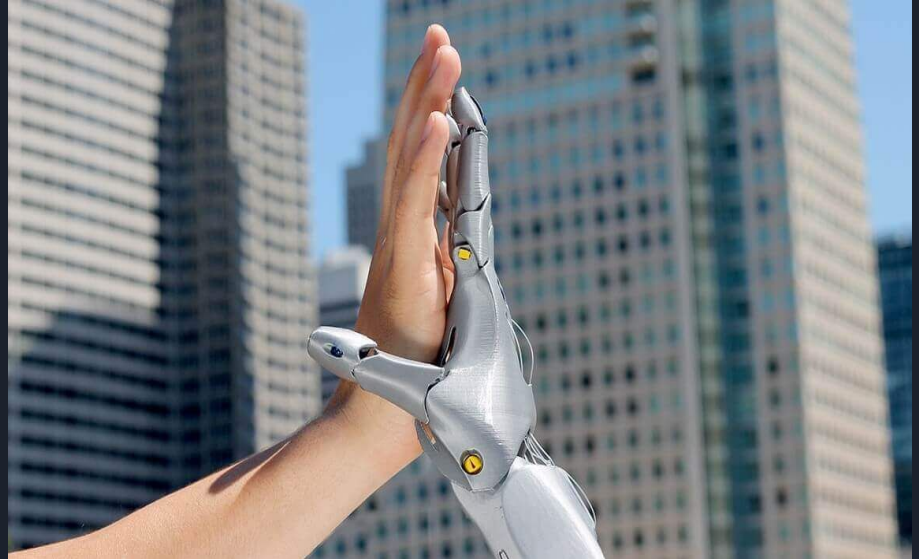
# Background & Motivation

- Most pediatric amputations occur in ages of 0-5 yrs
- 4 out of 10,000 births suffer from upper limb deficiency
- Commercially available prosthetics cost upwards of \$4,000
- Child growth requires new prosthetics
- Limited motion through single wrist actuation



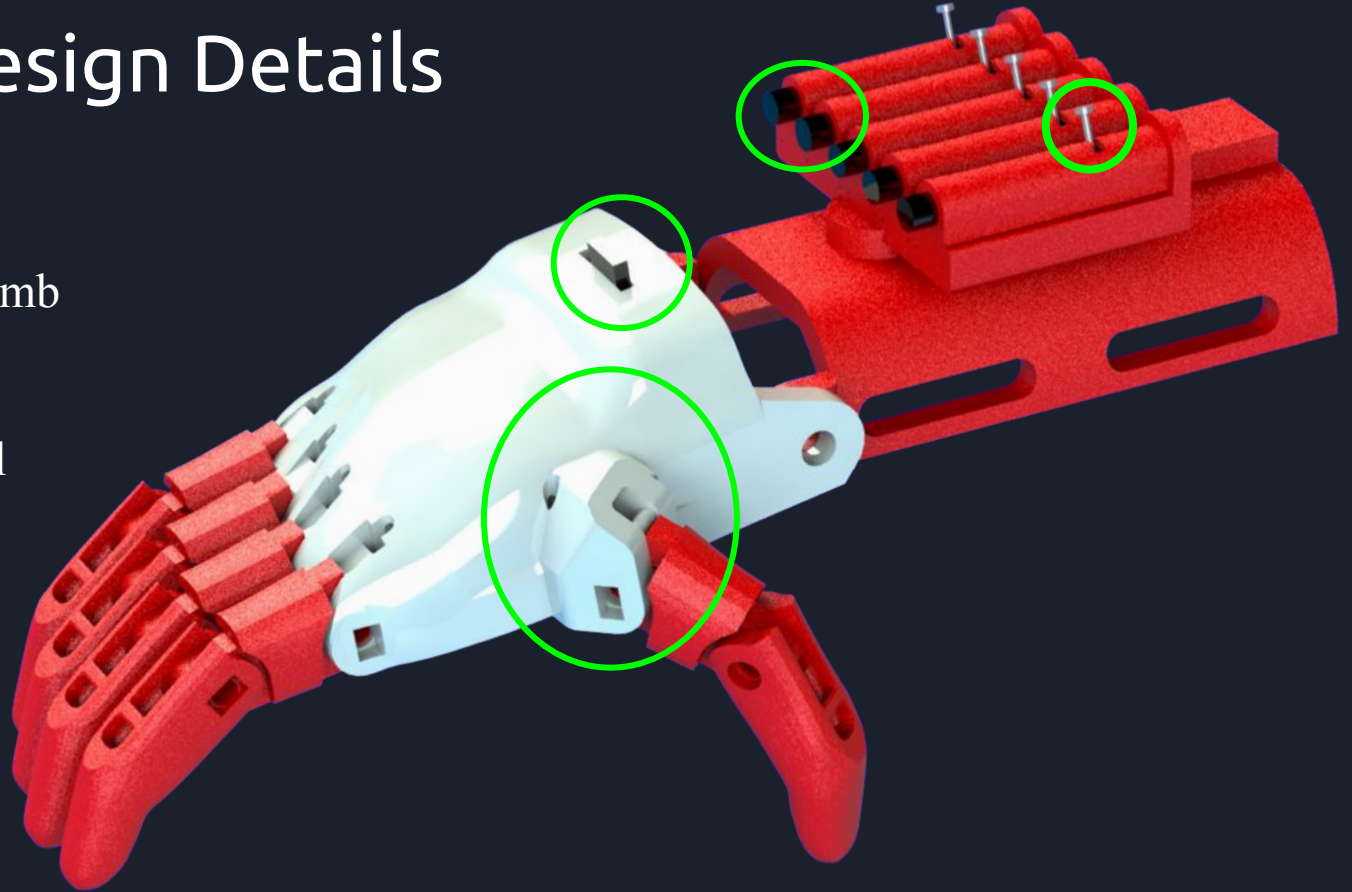
# Solutions

- Low cost PLA
- Mechanisms: IMF & GL
- Abducted Thumb
- Silicon fingertips
- Open Source



# Final Design Details

- Abducted Thumb
- Grip Lock
- Finger Control

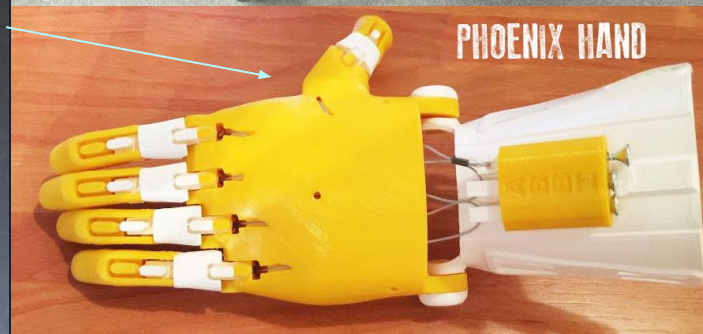
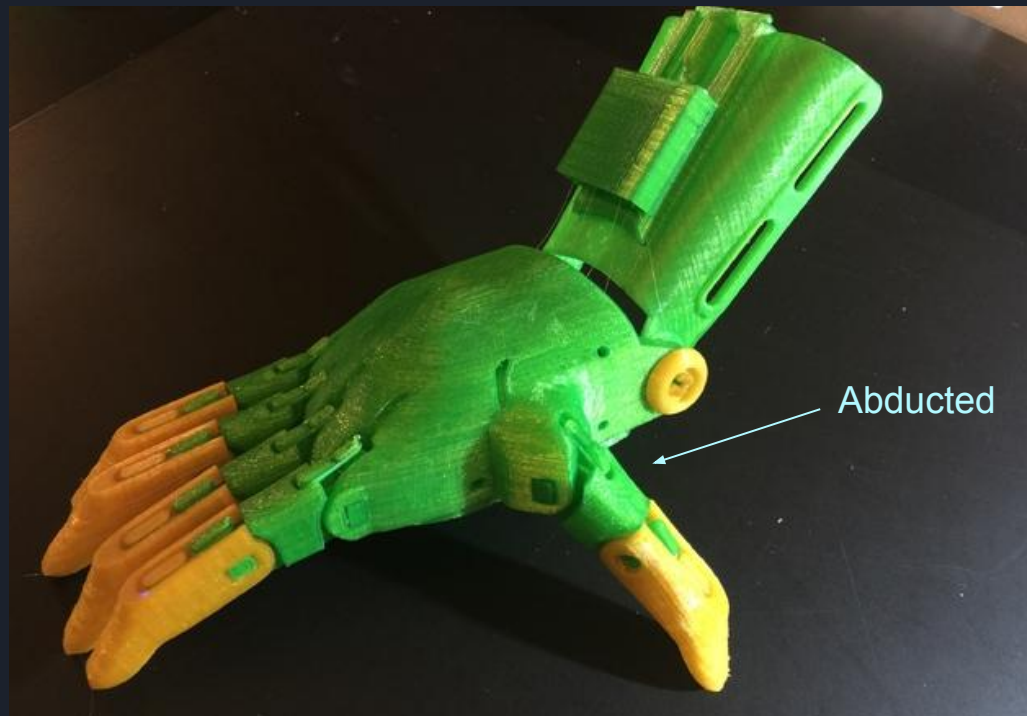


# Basic Operation

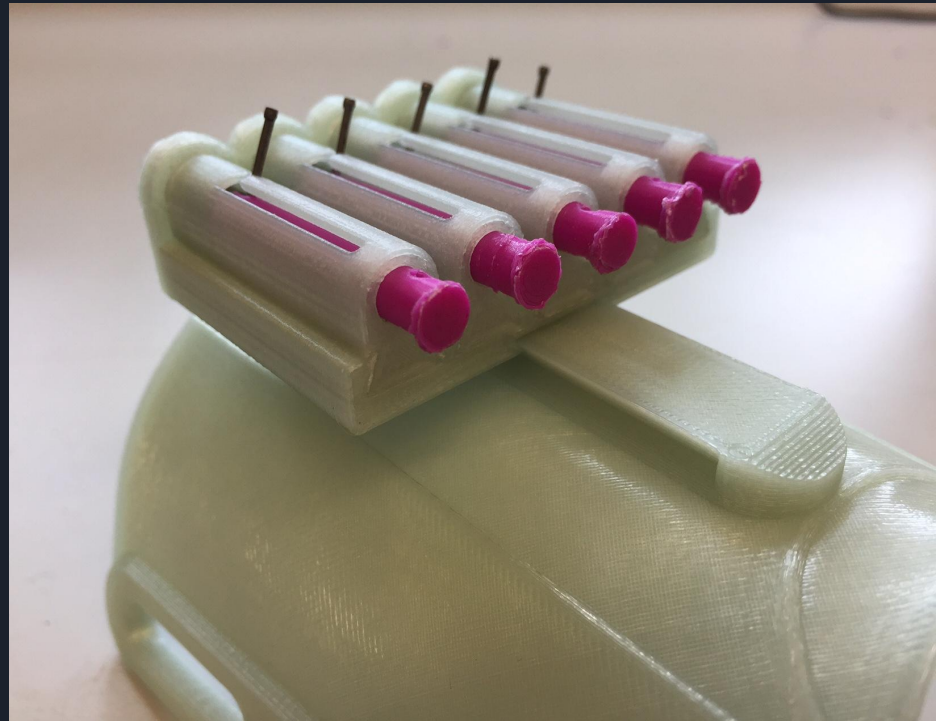
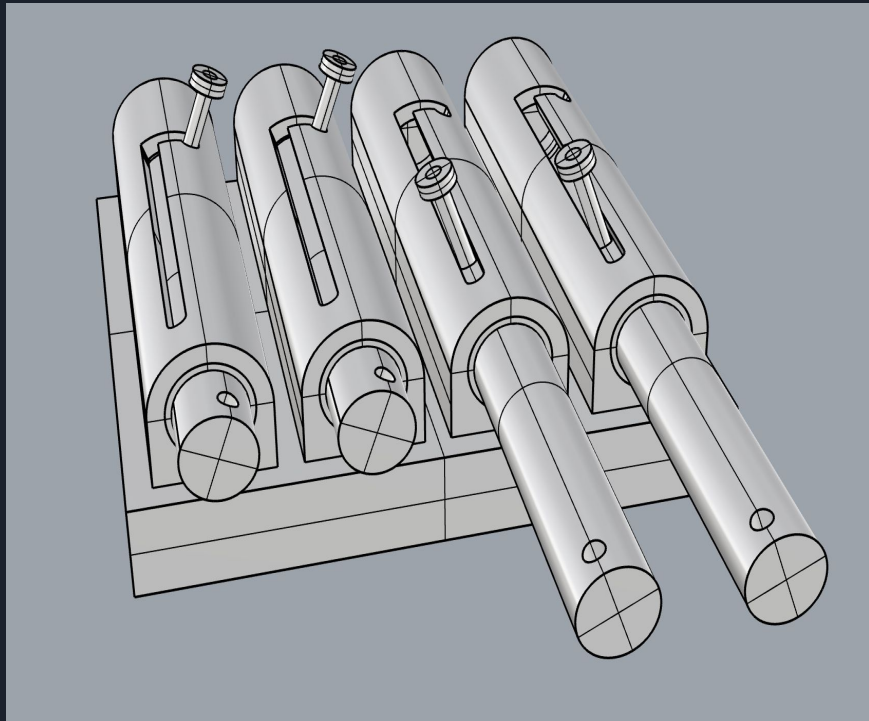




# Abducted vs. Adducted Thumb



# Individual Finger Control (IFC)

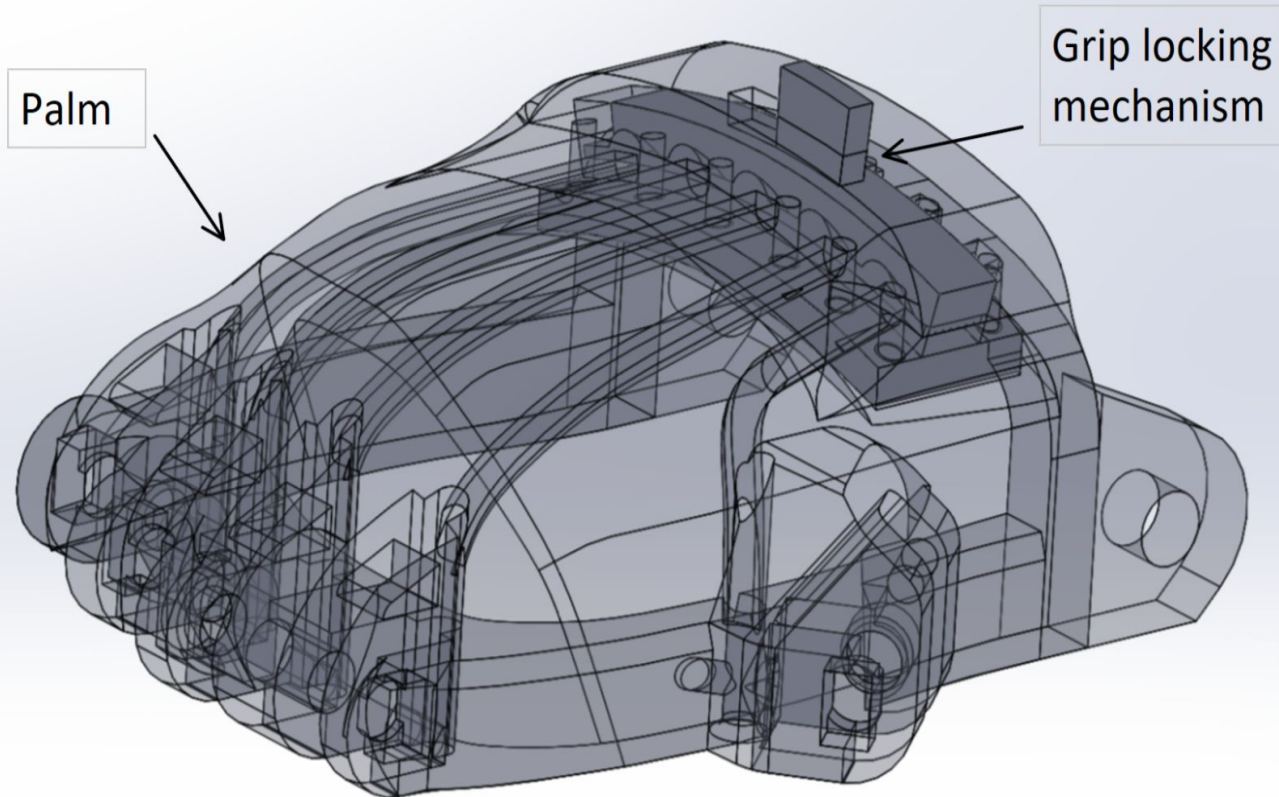




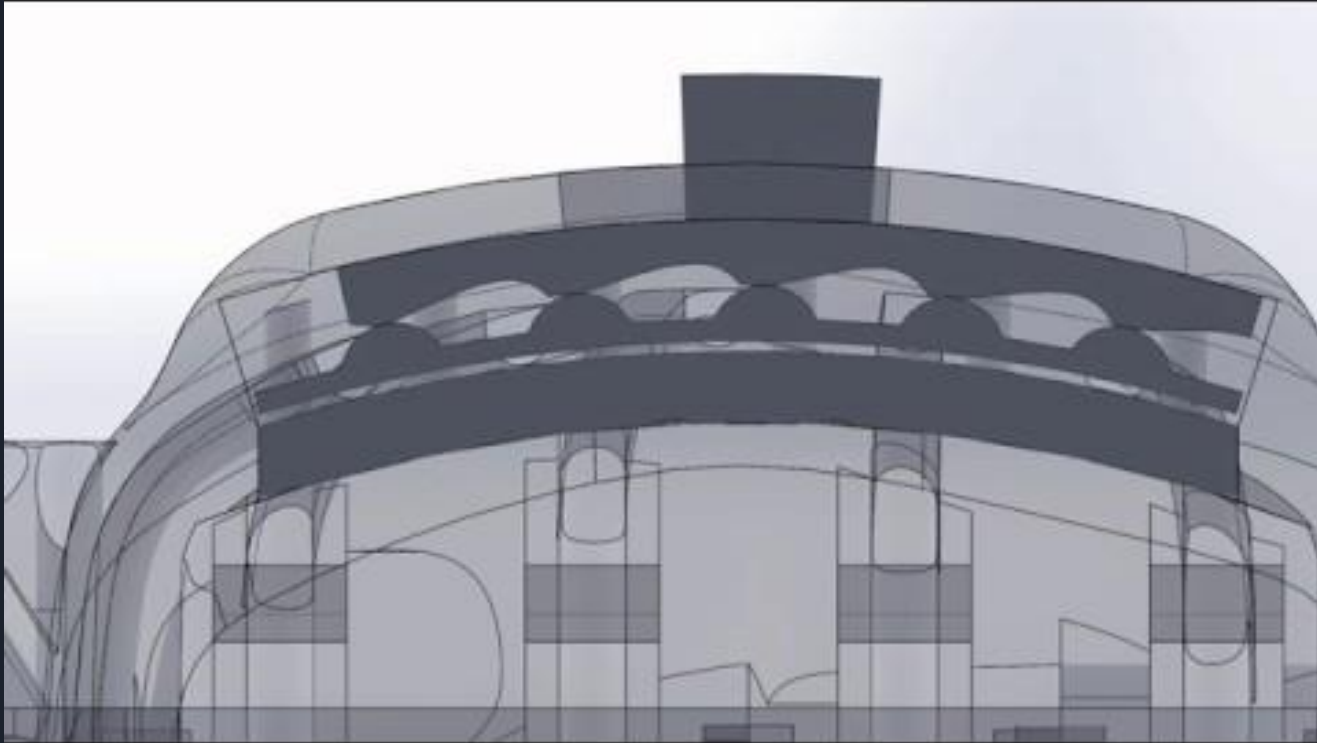
# Individual Finger Control (IFC)



# Grip Lock



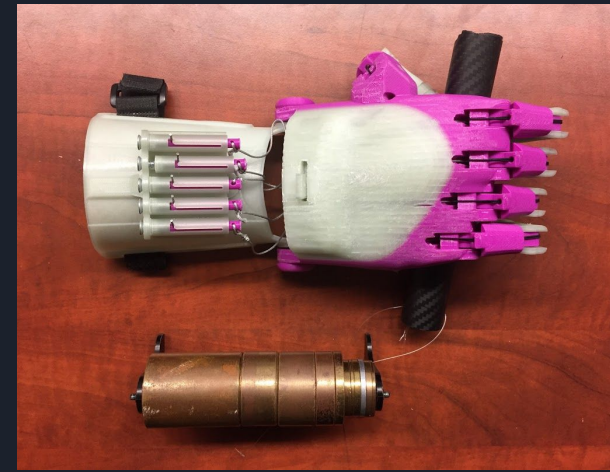
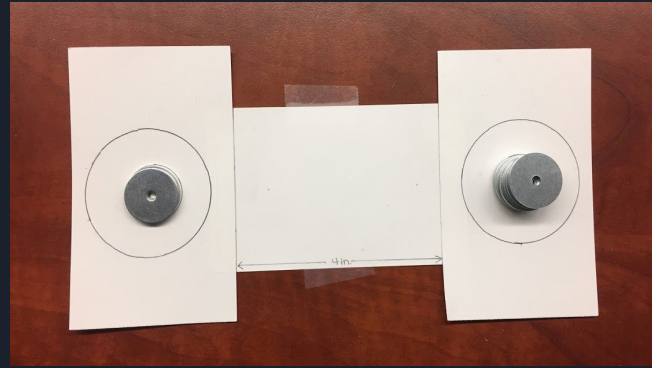
# Grip Lock



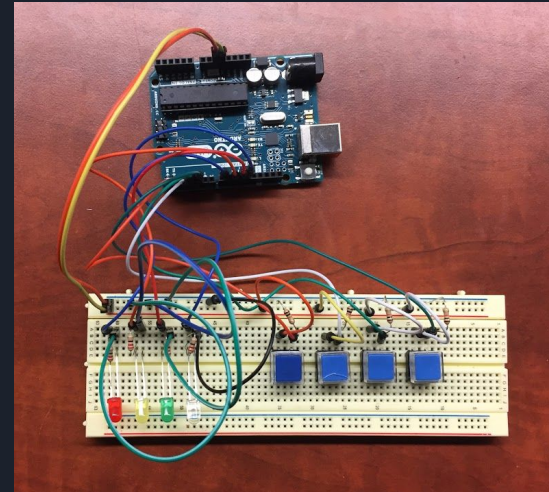
# Grip Lock



# Testing



- Grip precision Test
  - Test: Pick up/move a stack of washers
- Button Selection Precision Test
  - Test: Press buttons in predetermined pattern
- Grip force Test
  - Test: Weight added to rod





# Results and Analysis

- Stacking Washers Test:
  - Modified prosthetic: 9.4 of 15 washers stacked
  - Standard prosthetic: 9.2 of 15 washers stacked
  - Overall advantage: Negligible
  - Observations: Using two fingers reduced likelihood of stacks being knocked over.
- Patterned Button Pressing Test:
  - Modified prosthetic: 97.6% accurate
  - Standard Prosthetic: 30.7% accurate
  - Overall advantage: Significant [66.9% improvement]
  - Observations: Unused, engaged fingers of standard prosthetic caused numerous unintended button presses.
- Weighted Rod Test:
  - Modified prosthetic: 1538.8g (avg. weight held when slippage began)
  - Standard Prosthetic: 568g (avg. weight held when slippage began)
  - Overall advantage: Significant [2.7x]
  - Observations: gel fingertips caused rod to slip slowly, while bare PLA fingers released quickly.



# Bill of Materials

| Item                           | Quantity       | Price   |
|--------------------------------|----------------|---------|
| PLA                            | 1 roll (~111m) | \$20.00 |
| Braided fishing wire           | 1 roll (137m)  | \$10.72 |
| Nylon String                   | 1 roll (~91m)  | \$7.79  |
| Springs                        | 12-pk          | \$ 5.43 |
| Sheet metal screws<br>#6 x 3/8 | 16-pk          | \$ 1.18 |
| <b>Total Cost: \$50.12</b>     |                |         |





# Estimated Cost to Produce our Prosthetic Hand - Breakdown of Materials Used

| Material Used  | Quantity Used | Unit Cost      | Total Price of Material Used |
|--|---------------|----------------|------------------------------|
| PLA  | ~17.2m        | \$0.075/m      | \$3.87                       |
| Braided fishing wire   | ~3.66m        | \$0.078/m      | \$0.29                       |
| Nylon String   | ~1.83m        | \$0.086/m      | \$0.16                       |
| Sheet metal screws   | 5 screws      | \$0.074/screw  | \$0.37                       |
| springs  | 5 springs     | \$0.452/spring | \$2.26                       |
| <b>Estimated Total Cost to Produce our Prosthetic Hand: \$6.95</b> |               |                |                              |



# Future Work

- Switchless individual control
- Streamline grip lock interface
- Silicon to replicate skin
- Implement more aesthetic design
- Improve Comfort

# Summary

- Kids with Partial Hands
- Choice between Limited Functionality or High Costs
- Design mechanisms for higher functioning body powered prosthetics
- Develop tests to determine effectiveness of modifications





# Sources

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Questions ?