BME Design

e-Nable: Improved Grip Strength

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Overview of Presentation

- Background Information
- Problem Statement
- Project Design Specifications
- Preliminary Designs
- Design Matrix
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Figure 1: Phoenix Reborn prosthetic hand received from client

Background Information

- e-NABLE [3]:
  - Global community of volunteers
  - Open Source 3D printable models
  - Low costs to help those in need
- Currently, many professional prosthetics are available but costly
- Competing designs:
  - Cyborg Beast 3D Printed Hand [1]
  - DEKA Hand [2]

Figure 2: The Cyborg Beast 3D printed hand is one of the competitors for accessible 3D printed prosthetics [1]

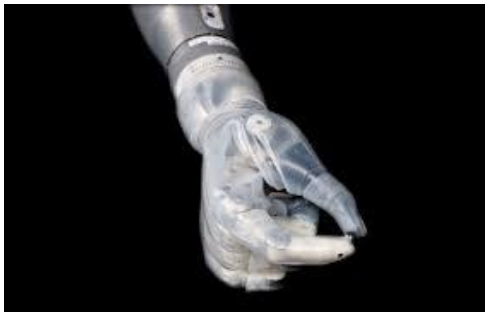

Figure 3: The DEKA hand is a more expensive, professional grade competitor that shows the capabilities of prosthetics. [2]

Problem Statement

- Difficulty picking up cylindrical objects smaller than a soda can

Our task:

- Increase the grip strength of a wrist-actuated prosthetic hand.
- Maintain overall cost of the model
- Take inspiration from existing models, but not be limited by them

Product Design Specifications

- Must hold a cylindrical object 6.6cm in diameter
- Cannot overexert the user's wrist flexion
- Maintain easy 3D printing accessibility
- Continue to be cost efficient
- Will reliably work for everyday use

Design 1: Phalange extension

- This design idea uses the existing two pieces that make up the phalange and extending them with an extra 3D printed phalanx.
- This allows the fingers to be longer to increase surface area of the grip

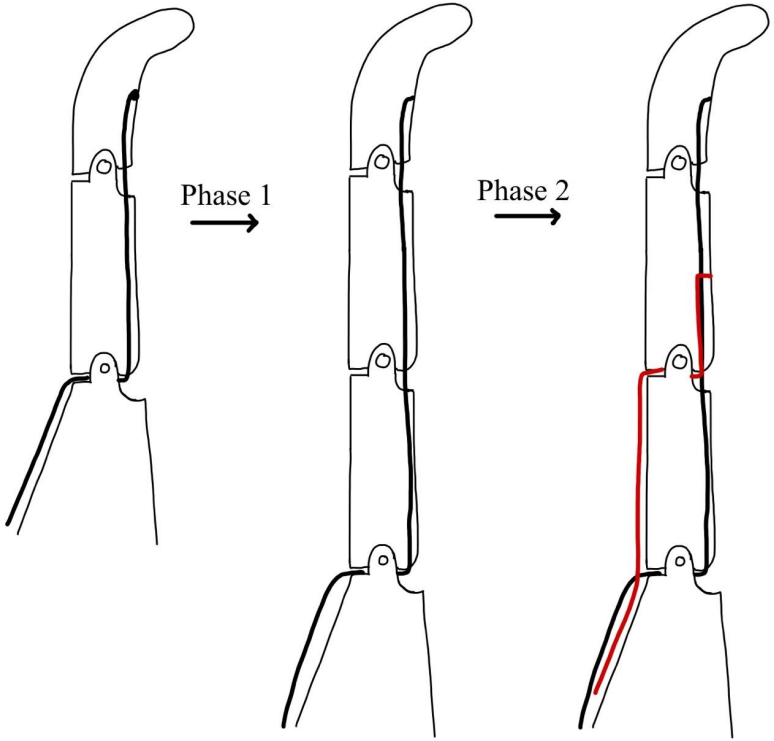

Figure 4: The Phalange extension incorporates an addition phalanx

Design 2: Thumb relocation

- This would relocate the thumb to a position that is in greater opposition to the phalanges.
- Repositioning for a different angle towards the palmar side of the hand
- Could be lengthened for better grasp

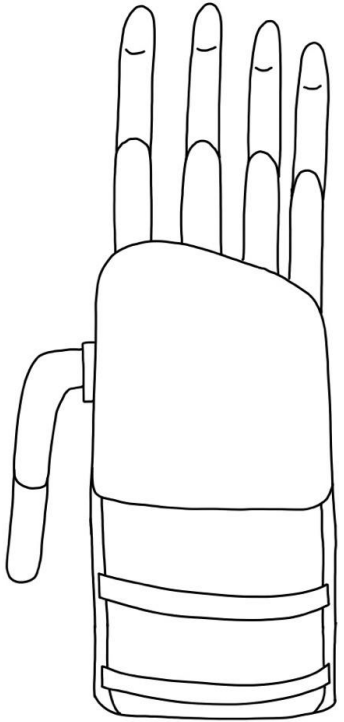

Figure 5: The thumb relocation places the thumb in the same line of action as the fingers

Design 3: Bar thumb

- Switching the thumb to the anterior side of the wrist.
- Using a flat bar piece to attach to a rod piece that follows the path of the thumb
- Flexed bar would rest on top of fingers to improve grip on thinner objects

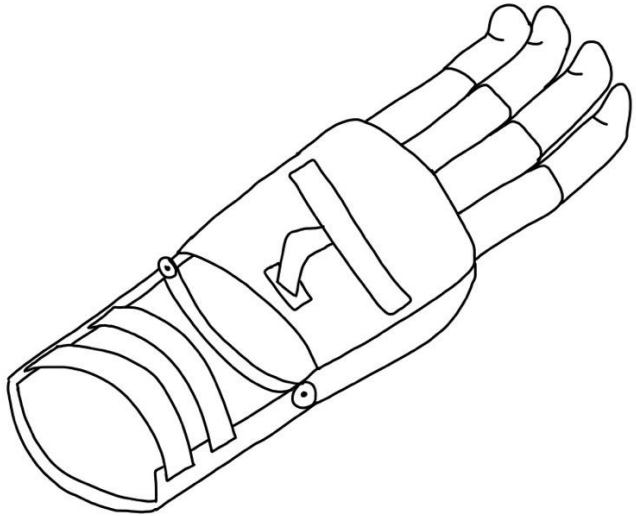

Figure 6: The bar thumb extends the grip surface and acts in a direction parallel to the fingers

Design Matrix

Proposed Final Design: Phalange Extensions

Designs Criteria (*weight)	Design One Phalange Extension		Design Two Thumb Relocation		Design Three Bar Thumb	
Grip Versatility (30)	5/5	30	4/5	24	3/5	18
Safety (15)	4/5	12	5/5	15	3/5	9
Cost (15)	4/5	12	3/5	9	3/5	9
Ease of Fabrication (15)	4/5	12	3/5	9	3/5	9
Product Weight (15)	4/5	12	5/5	15	4/5	12
Aesthetics (10)	4/5	8	3/5	6	3/5	6
Total (100)	**86**		**78**		**63**	

Preliminary Modeling

- Redesigned the knuckle in the current Phoenix Reborn model
- Design based on the existing critical dimensions
- Will be used as an extension to fingers
- Designed to attach to already existing knuckle
- 3D Printed

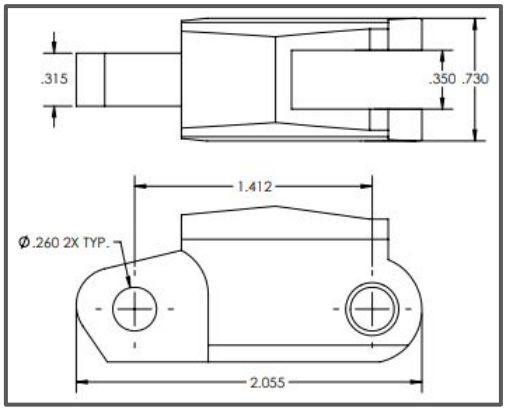

Figure 7: Drawing shown of critical dimensions of the new part

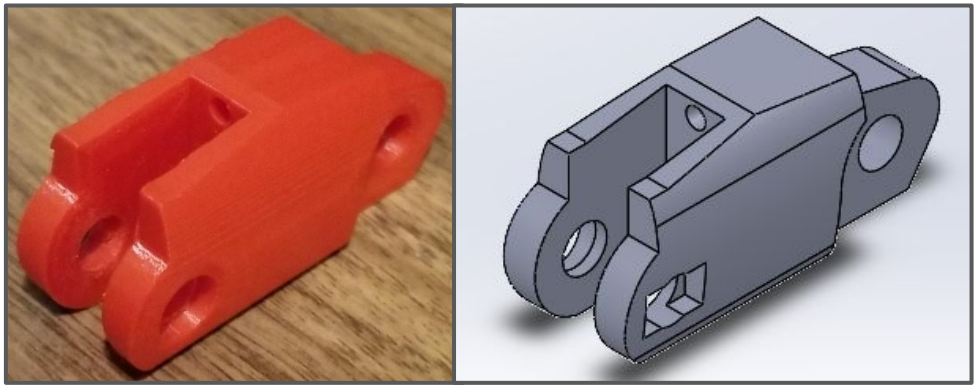

Figure 8: Solidworks phalanx model and the first 3D print

Future Work

- Make sure phalange fits with existing model first before making drastic changes
- Determine favorable length of phalange for optimal performance.
- Consider integrating slightly more complex pulley system to increase strength and user comfort
- Consider adding aspects of other designs to our final design

References

[1] Zuniga, J., Katsavelis, D., Peck, J., Stollberg, J., Petrykowski, M., Carson, A., & Fernandez, C. (2015). Cyborg beast: a low-cost 3d-printed prosthetic hand for children with upper-limb differences. BMC research notes, 8, 10. https://doi.org/10.1186/s13104-015-0971-9

[2] Resnik, L; Frantzy, A; Borgia, M, “The DEKA hand: A multifunction prosthetic terminal device - patterns of grip usage at home” in Prosthetics and Orthotics International, 42(4), 446-454, 2018 [Online] doi: https://doi-org.ezproxy.library.wisc.edu/10.1177/0309364617728117

[3] e-NABLE (2021). [online] Available: https://enablingthefuture.org/

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