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Title

The Thumb Guys: Prosthetic Thumb

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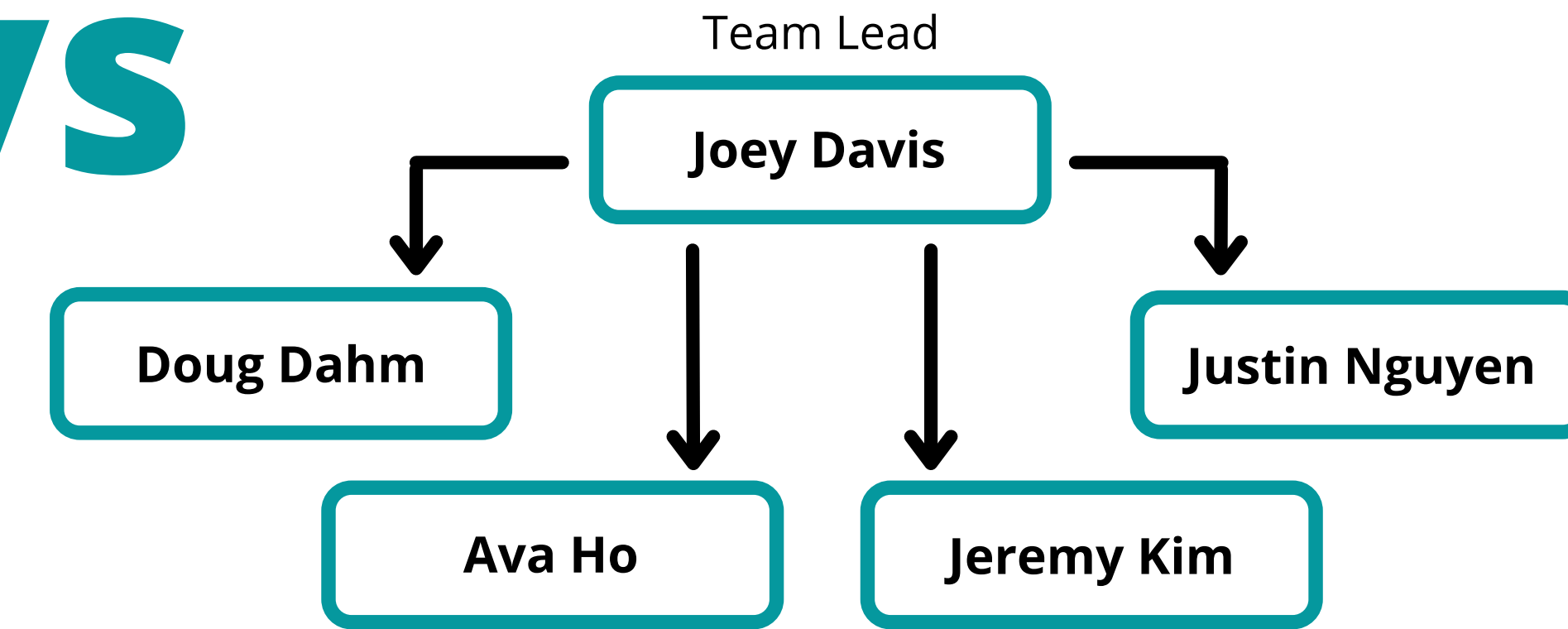
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The Thumb Guys

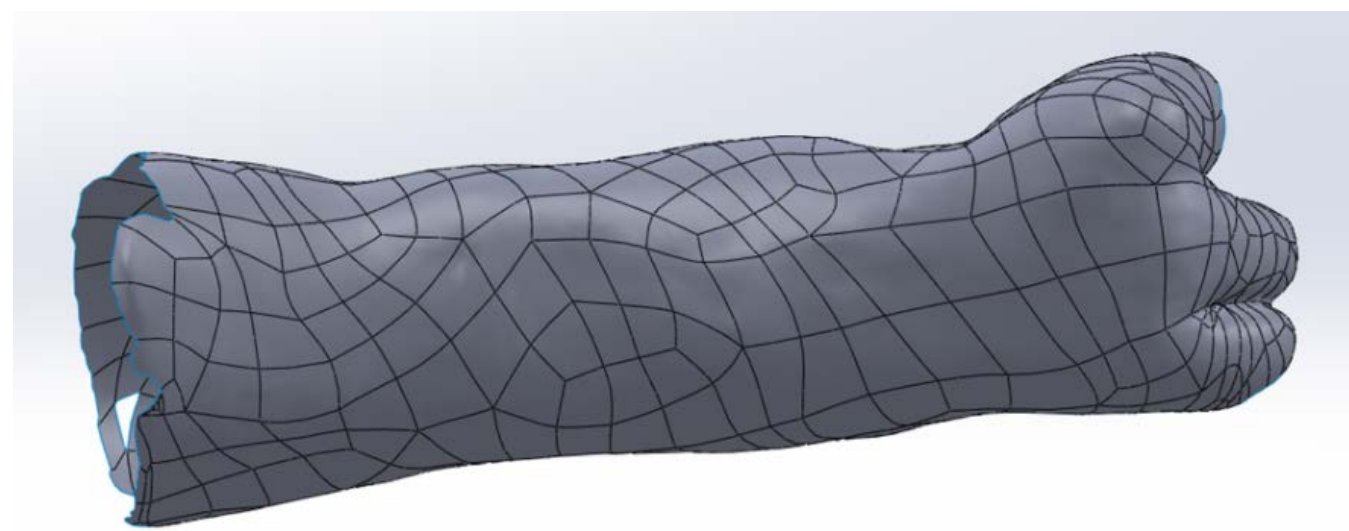
Prosthetic Thumb



3D printed nylon prosthetic thumb with adhered molded silicone, actuated by a ratchet with one way bearing

Custom-fit 3D printed arm cuff (interior: foam padding) with secondary wrist prosthesis secured with boa cable system fitted with 3D printed dial

Background: Client retains portions of fingers on right hand, and his left arm and both feet are amputated



CAD Rendering of 3D Scanned Right Hand



Molded Silicone on Thumb



Ratchet with One-Way Bearing Assembly



Client Testing First Prosthesis Prototype

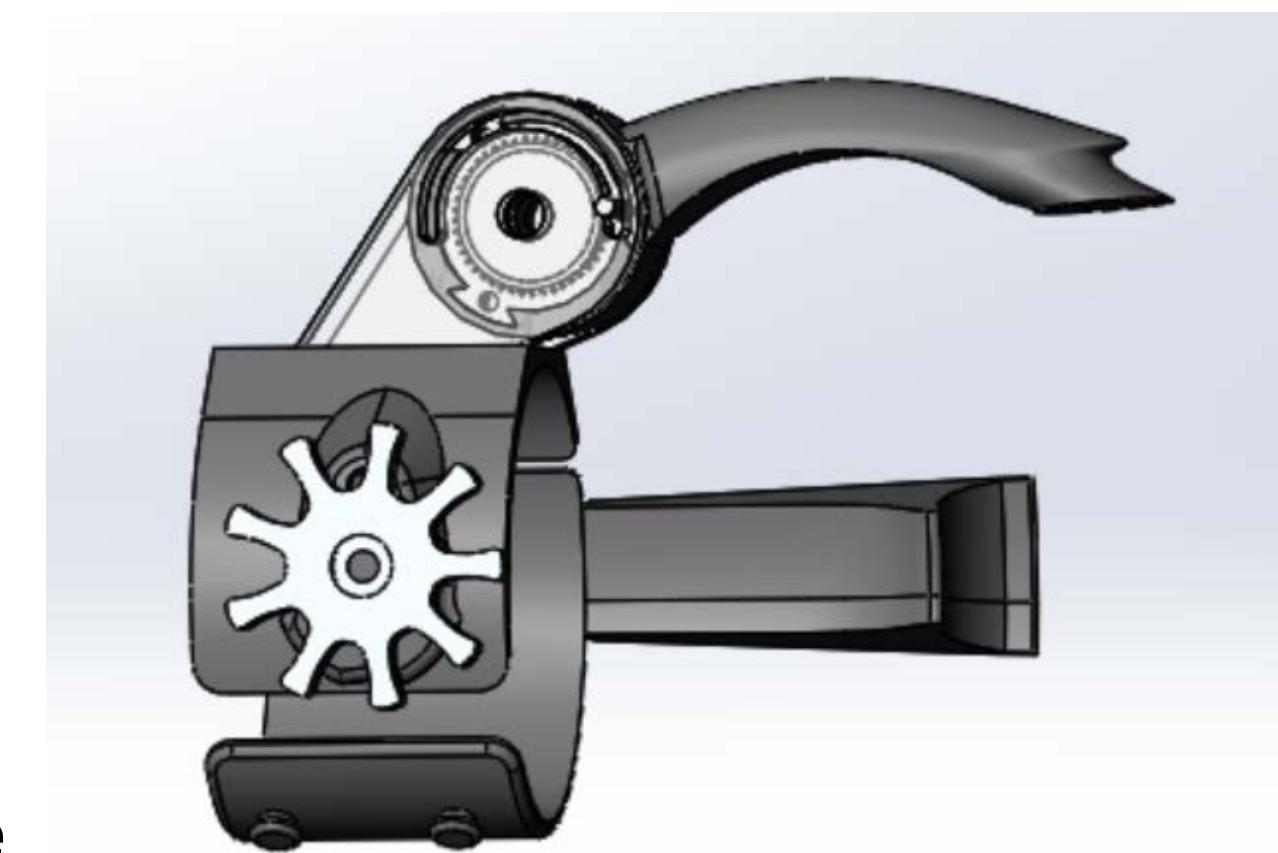
Design, test, and manufacture individualized partial hand prosthesis, that is both user-friendly and comfortable, to accomplish client-requested tasks

Design Process

The circular ratchet with one-way bearing allows manual positioning of thumb without pushback from rigid objects and features a push-to-release tab. Molded silicone provides additional friction between the prosthetic thumb and wrist prosthesis to objects being held. Arm cuff disperses forces over a large surface area, foam padding mitigates possible pain associated with all-day wear. Boa system with custom dial utilizes simple pulling motion to securing prosthetic device to arm.

Right hand prosthesis to complete everyday tasks, including:

- carry a plate or bowl
- eat with a utensil
- hold a soda can
- push a manual wheelchair
- open a water or Gatorade bottle



CAD Rendering of Full Prosthesis Assembly

Engineering Analysis

Client gained the ability to complete several requested tasks, including: carry plate/bowl, eat with utensil, hold soda can, and push manual wheelchair. Client is still unable to open bottles due to the large torque necessary. Action Research Arm Test: 24 to 31 (of 57) and faster time to complete each task Grasp 9 to 11 (of 18), Grip 6 to 9 (of 12), Pinch 0 to 2 (of 18) Box and Blocks Test: 4 to 16 blocks moved in 60 seconds Client gave design a System Usability Score of 90

Final Design Performance

Original actuation method: friction hinge with lever mechanism was unable to hold straight-walled cylindrical objects (e.g. soda cans). Unlike the friction hinge, the circular ratchet with one-way bearing allows the client to securely position thumb without losing applied tension. Completes client-requested tasks quickly and effectively with minimal user force. Does not interfere with client's existing mobility, is comfortable for all day wear, and can be put on & utilized by client without assistance. Operation is intuitive and requires little training.



Completed Prosthesis Assembly

Future Improvements

- Decrease size of axle and surrounding components of ratcheting assembly to reduce overall weight of device and mitigate user fatigue.
- Optimize molded silicone design by changing parameters such as density, pattern, size, shape, and adhesive type to increase grip strength of the prosthetic thumb.
- Increase resolution of push-to-release button/tab to increase ease of use.

Impact on Society

Most functional prosthetic hand devices on the market cost around \$10,000. This prosthesis is low-cost to manufacture (less than \$100) and easily replicated with access to 3D printing.

3D printed prosthetic devices can improve amputees' mobility and allow them to regain independence without being overly expensive.

Acknowledgements

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