

# Design Improvements of Upper Limb Prosthesis to Increase Acceptance Rate

J. Sadler,<sup>1</sup> M. Chapman,<sup>1</sup> S. Srivastava,<sup>2</sup> K. Salisbury<sup>3</sup>

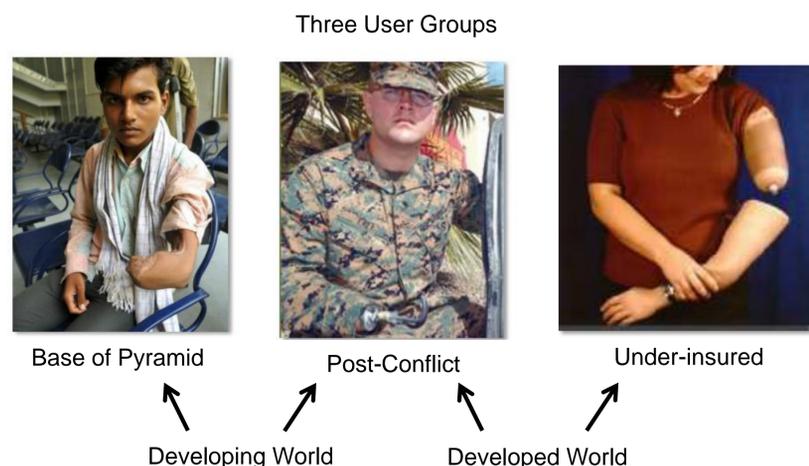
Departments of <sup>1</sup>Mechanical Engineering, <sup>2</sup>Surgery, <sup>3</sup>Computer Science, Stanford University

## Motivation and Objective

Low acceptance rates of the upper limb prosthesis are an on-going challenge for users, medical device designers, and clinicians. Our goal is to better understand this low acceptance rate and explore solutions that may improve user satisfaction. We are prototyping a range of prosthetic devices that vary in anthropomorphic form, functionality, and cost. Our poster presents the current progress in device design and development as well as future testing goals.

## Clinical Need

Amputees of low socio-economic status need access to more affordable prosthesis.



## Current Solution: The Hook

Pro	Con
<ul style="list-style-type: none"> <li>Affordable</li> <li>Grasping functionality</li> <li>High tolerance to harsh conditions</li> </ul>	<ul style="list-style-type: none"> <li>Lacks cosmetic appeal</li> <li>Limited dexterity</li> <li>Self-repair is difficult</li> <li>Fast wear rate</li> <li>Heavy</li> </ul>



Voluntary Open Split Hook

## Design Goals

Based on our need-finding, we have determined the following design goals to improve upon the classic hook:

- Affordable
- Mechanical actuation
- Minimal degrees-of-freedom
- Grasping functionality
- Cosmetic appeal

## Bio-inspired Approach



Hand CT Scan



Joint Actuation

- We created simple pivot joints by modifying CT scans in SolidWorks.
- This approach demonstrates the feasibility of developing user-customized prosthesis based on patient-specific anatomy.
- Complex geometry and single pose are limiting factors.

## Design Progress

### A) One DOF: Coupled linkage achieves Pinch Grip.

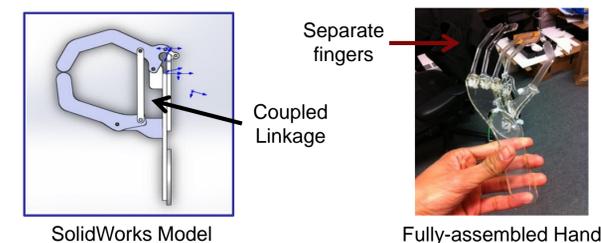


### B) Two DOF: Add elastically-fused ulnar unit

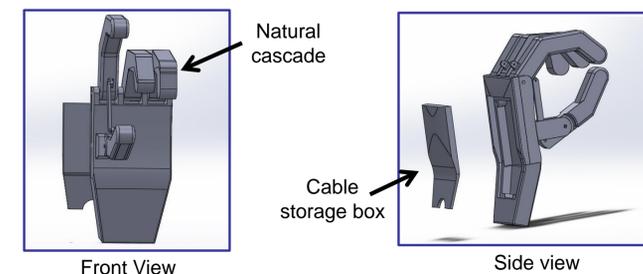


## Design Progress (continued)

### C) Two-dimensional, multi-finger form achieves skeletal frame.



### D) Three-dimensional, cable-driven concept in development



## Key Mechanical Features

- Underactuated
- Two degrees-of-freedom
- Cable-driven
- Natural cascade
- Pinch grip
- Cylindrical grasp

## Conclusions and Future Work

- In this research, we have demonstrated the feasibility of a low-cost prosthetic hand that may improve upon the classic hook design.
- We have explored the challenges associated with balancing anthropomorphism, affordability, function, and cosmetic appeal.
- We have also developed a novel two-stage underactuated grasping mechanism.
- In future work, we will refine our prototypes for user testing and investigate different methodologies for measuring emotional response.