# Lara Zlokapa
# Design Portfolio

*MIT (M.S., 2022), UC Berkeley (B.S., 2020)*

*Mechanical Engineering*

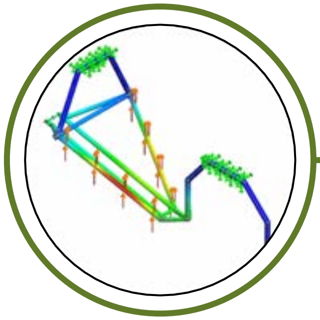
# PROJECT HIGHLIGHTS

### Modular, Sensorized Robotic Hand Design

Four cable-driven robotic hands made to pick up eggs, tighten screws, pour water, and cut paper with scissors.
*RSS 2021, Master's Thesis (MIT).*

### Mechanical Gripper for Tetraplegics

Mechanically actuated device to assist people with reduced hand function in grasping objects.
*Global Product Development (UC Berkeley).*



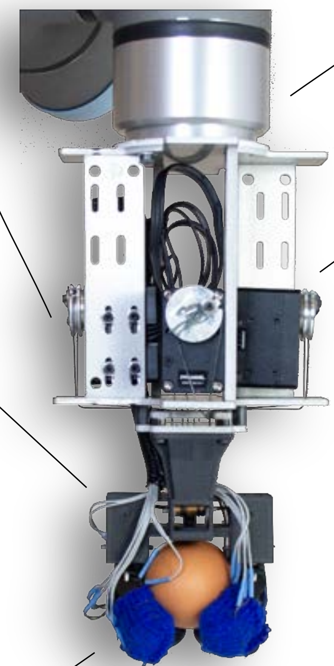
### Human Powered Speed Vehicle

Aerodynamic, recumbent bicycle designed to achieve 70 mph at the World Human-Powered Speed Challenge.
*President, Human Powered Vehicles Club (UC Berkeley).*

# MODULAR, SENSORIZED ROBOTIC HANDS

*Masters Thesis under Profs. Wojciech Matusik and Pulkit Agrawal, MIT* — *Aug. 2020 - Present*

## Egg-Grasping Manipulator



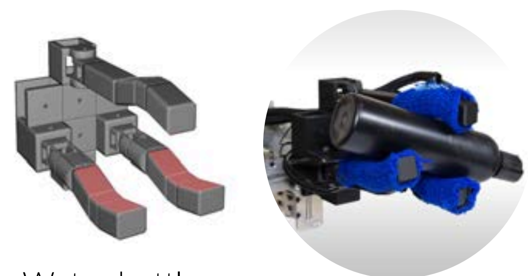

Egg manipulator 3D model.
Sensing surfaces shaded pink.

## My Contribution

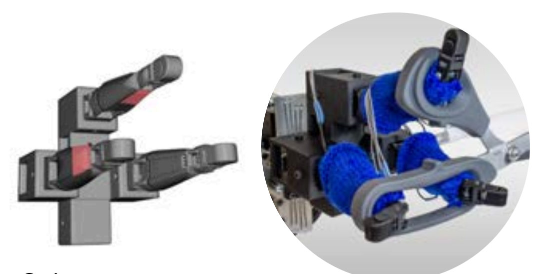
I designed modular, parametrized, sensorized, cable-driven robotic manipulators with automated assembly (via grammar production rules) and manufacturing. I programmed open-loop controls in Python to perform tasks.

## Additional Models

Wing nut tightener



Water bottle pourer



Scissor cutter

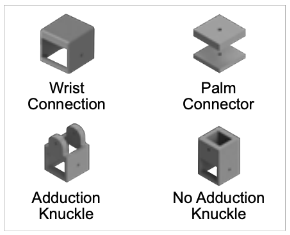
# MODULAR, SENSORIZED ROBOTIC HANDS

*Masters Thesis under Profs. Wojciech Matusik and Pulkit Agrawal, MIT* — *Aug. 2020 - Present*

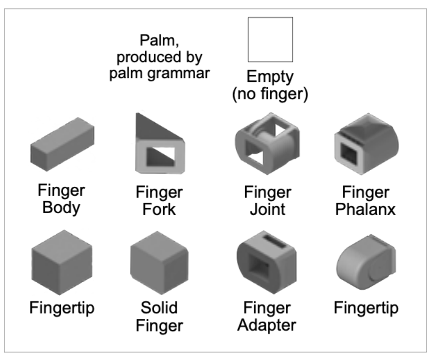
## Modular Approach

To overcome time-consuming and trial-and-error process of designing robotic hands, I created a pipeline to generate modular, parametrized, sensorized robotic manipulators. With this, users can develop new manipulators in minutes.

**PALM COMPONENTS**

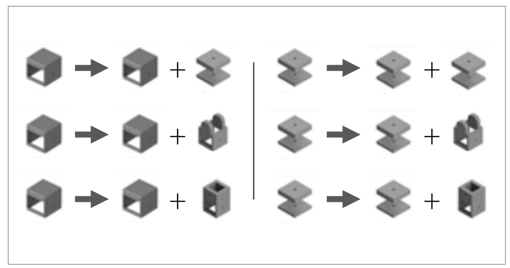



**FINGER COMPONENTS**

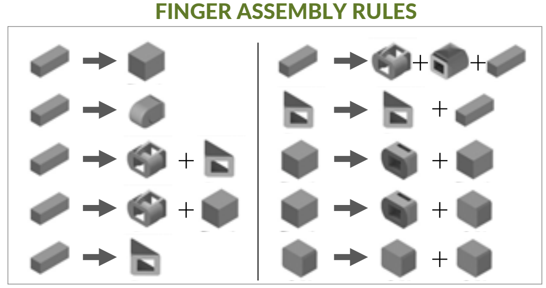



I designed a "Lego kit" of subcomponents that merge virtually to create any cable-driven hand.

**PALM ASSEMBLY RULES**

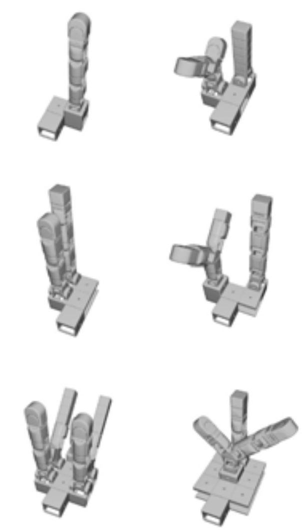


**FINGER ASSEMBLY RULES**



The user applies assembly (grammar production) rules on subcomponents to form the “palm” then “fingers”.

**SAMPLE CONFIGURATIONS**



I designed the components and assembly rules to always ensure manufacturability and valid cable pathways.

# MODULAR, SENSORIZED ROBOTIC HANDS

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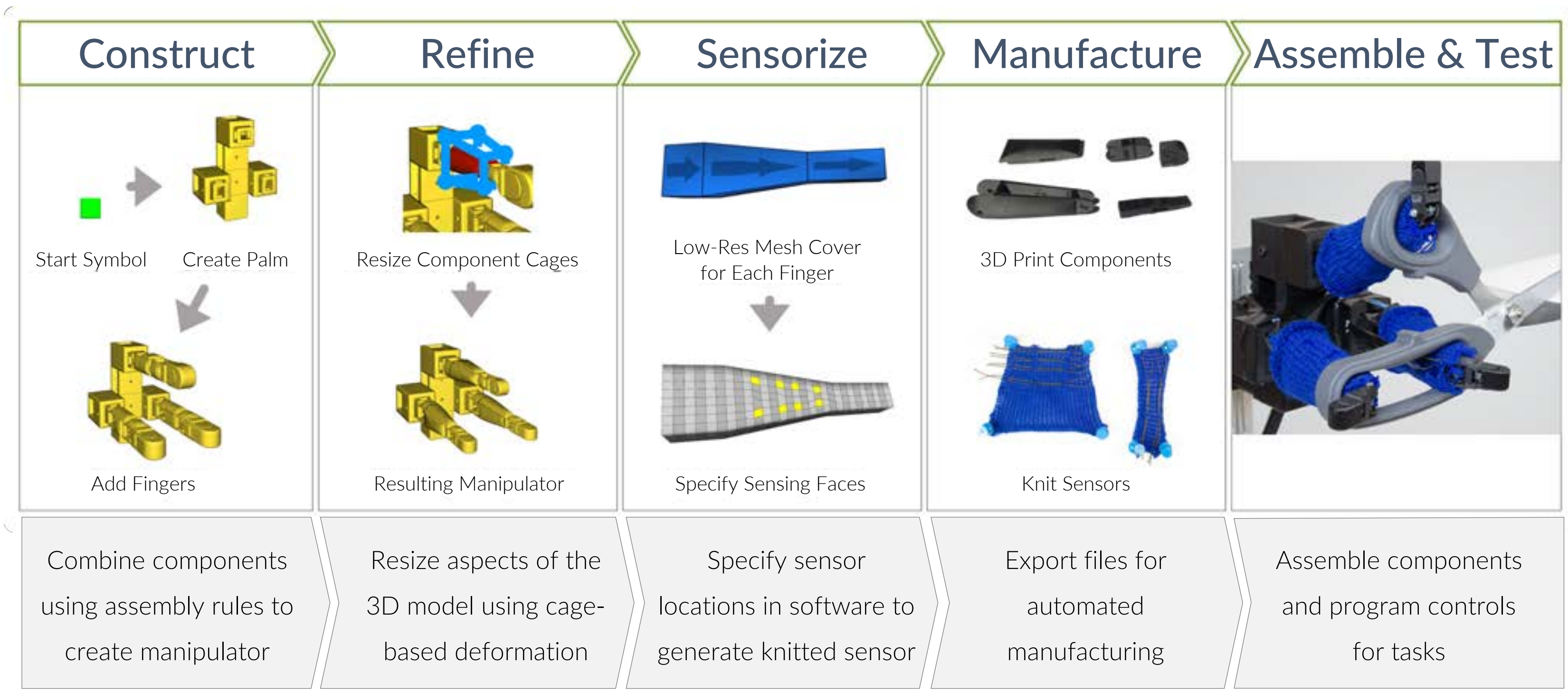
## The Design Pipeline

Below is an overview of the streamlined design process. For videos of the manipulators performing tasks, please see my website: [https://lara-z.github.io/robotic_hand.html](https://lara-z.github.io/robotic_hand.html)




Aspects of research were published in [*An End-to-End Differentiable Framework for Contact-Aware Robot Design*]() (*RSS 2021*).

# MECHANICAL GRIPPER FOR TETRAPLEGICS

*Global Product Development Class and EnableTech Club, UC Berkeley* *Spring 2018, Spring 2019*


## My Contribution

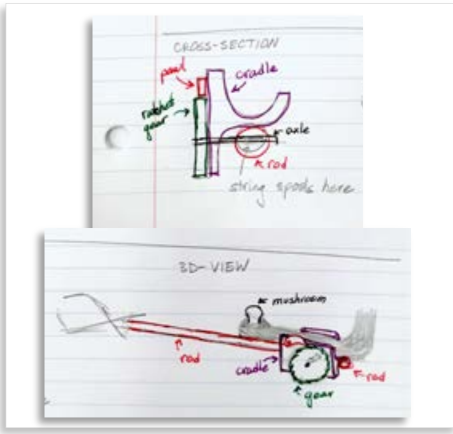
I led a team of three (2019 class) and worked in a team of four (2018 club) to design and build a durable, affordable, easy-to-use, mass manufacturable gripper device for a tetraplegic person with limited hand dexterity in a wheelchair to pick items from floors and shelves. We performed user testing with three tetraplegic individuals.

# MECHANICAL GRIPPER FOR TETRAPLEGICS

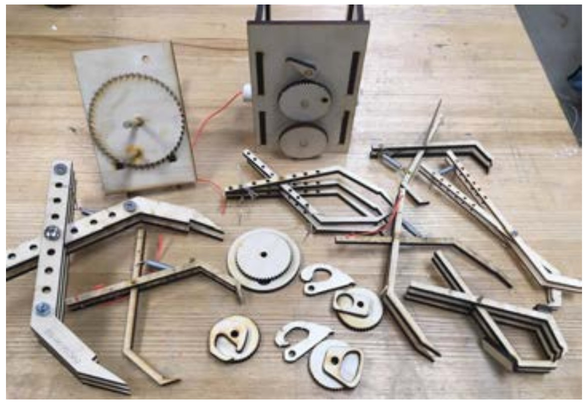
*Global Product Development Class and EnableTech Club, UC Berkeley* *Spring 2018, Spring 2019*

## Prototype Development

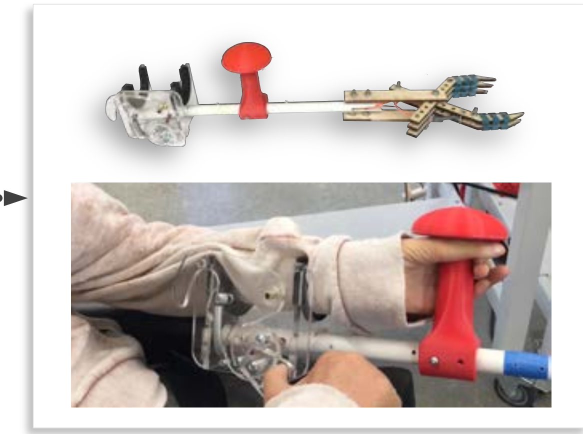
SPRING 2018




Brainstorm sketch



Laser cut test shapes of different claw and rachet-and-pawl actuation



Spring 2018 final prototype developed with user testing

SPRING 2019

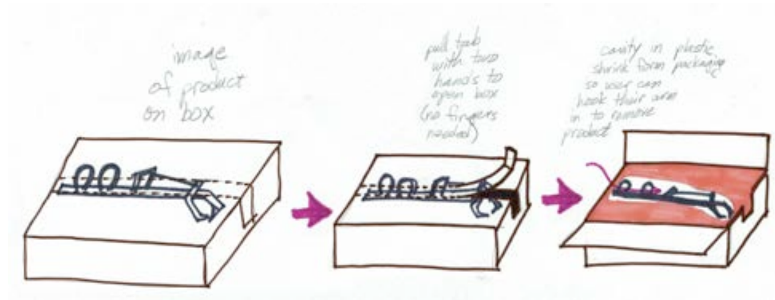
Change to wrist actuation and re-design for mass manufacturability

3D printed wrist and arm support sizes tested with various users

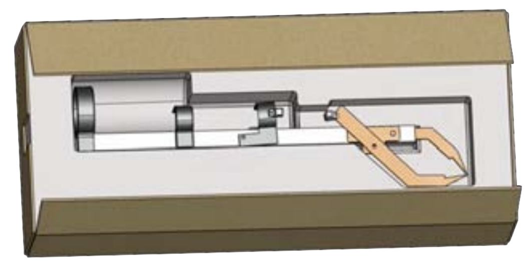
Spring 2019 final prototype

## Product Packaging

I designed the product packaging for tetraplegic users to open independently without additional tools or other aids.



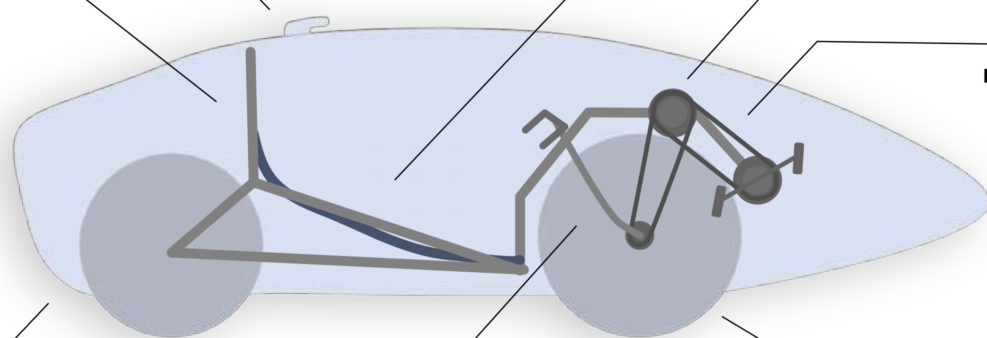

A SolidWorks model reveals the box interior. Padding inside the box holds the product in place for easy removal.



A scaled down laser cut box demonstrates the frustration free opening method.

# HUMAN-POWERED SPEED VEHICLE

*President, Human Powered Vehicles Club, UC Berkeley* *May 2018 - Aug. 2019*




## My Contribution

As president of the club, I led a team of thirty engineers in the design, testing, and manufacturing of a human-powered vehicle with a goal speed of 70 mph (no motor!).

Due to Covid-19, the vehicle was never completed or raced after I left the club.

# HUMAN-POWERED SPEED VEHICLE

*President, Human Powered Vehicles Club, UC Berkeley* *May 2018 - Aug. 2019*

## Initial Design

We created an adjustable wooden model to determine the optimal bike geometry (seat angle, pedal location, wheel size, chassis width, etc.) for our rider.

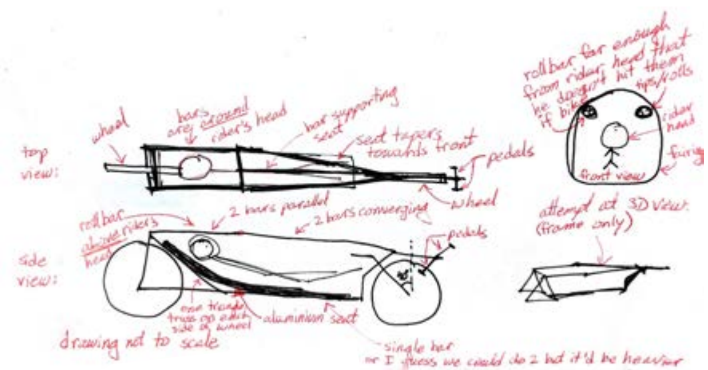
Once we finalized our model, we quickly converted it to a plywood prototype for the rider to ride to double check our dimensions and test our drivetrain design.

# HUMAN-POWERED SPEED VEHICLE

*President, Human Powered Vehicles Club, UC Berkeley* *May 2018 - Aug. 2019*

## Frame Design

I led a sub-team of five in the design, testing, and manufacturing of the vehicle's aluminum frame. The frame shape was inspired by previous bike designs and stress simulated in SolidWorks with guidance from Ford and GM.




A sketch of an intermediate frame design

We created a PVC pipe mock-up to ensure that the dimensions were correct.

### Frame Stress Test Calculations

Impulse equation:

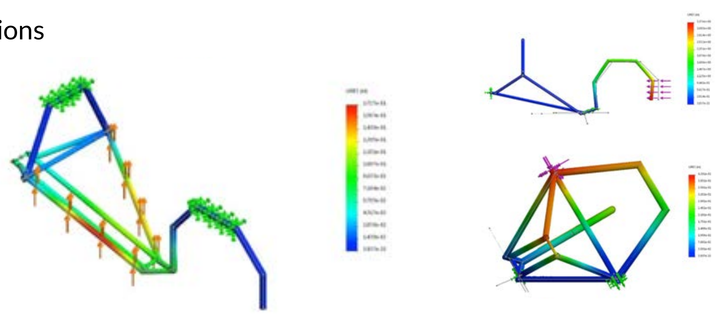
$$F\Delta t = m\,\Delta v$$

Let...

$$m = 6.8\ lb$$
$$t = 1\ second$$
$$\Delta v = 70\ mph$$

Therefore,

$$F = 698\ lbf$$



With guidance from Ford and GM, I simulated stress and deformation in SolidWorks for diverse collision scenarios based on impulse momentum calculations.

# ABOUT ME

I love making things with my hands

I enjoy connecting with people outside the U.S. and speak some French, German, and Serbo-Croatian (the language of the Balkans)

When I'm not working on my latest design project, you can find me swing dancing, hiking, biking, baking, drawing, painting, or swimming

*A few of my personal projects at top: drawing of a polo player, laser-cut clock., laser-cut trick box with hidden locking mechanism (3 photos)*

# Lara Zlokapa

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