Lara Zlokapa
Mechanical Engineering Design Portfolio

Mechanical Engineering, B.S., Class of 2020
University of California, Berkeley

I am passionate about

INNOVATIVE MECHANICAL DESIGN

achieved though

CREATIVE PROBLEM SOLVING

that

IMPROVES OUR QUALITY OF LIFE

Project Highlights

Mechanical Gripper for Quadriplegics

Aerodynamic Tricycle Fairing Shell

Tensegrity Robot End Caps

Mechanical Gripper for Quadriplegics

UC Berkeley **Spring 2018, Spring 2019**

My objective

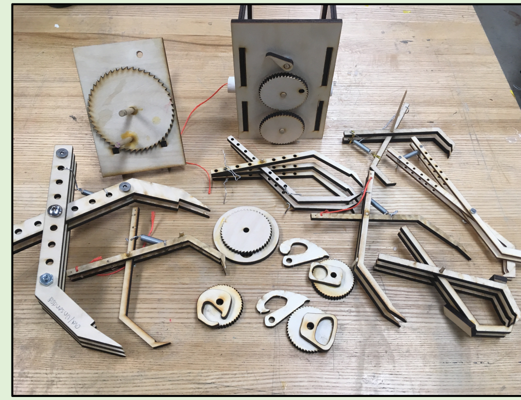
Design and build a durable, easy-to-use, customizable, and mass-producible gripper device for a quadriplegic person in a wheelchair to pick items from the floor and table.

About the gripper

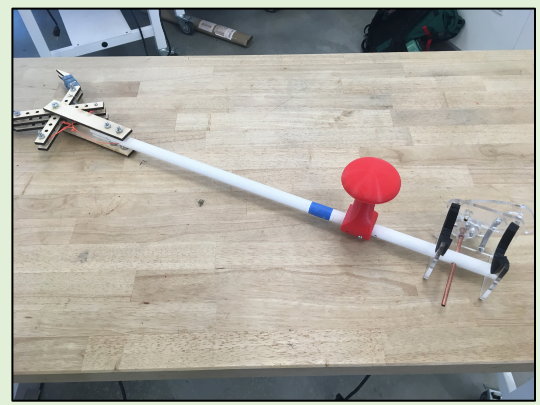
Our wheelchair-bound quadriplegic user needed a mechanical device to obtain diverse objects that were out of her reach. I worked in an interdisciplinary team of five in the assistive technology club EnableTech to develop this gripper for her. We drew on inspiration from fishing rod mechanisms and various latching methods to design our final product.

Design parameters

- Must pick up paper, coins, and pens from the ground.
- Must pick up cans from shelves.
- Can be used in the grocery store.
- Must be completely mechanical (no electronics).
- Must be simple to repair.
- Must be cost-effective to produce.
- Must be manufacturable within UC Berkeley Jacobs Hall resources (3D printer, laser cutter, wood shop, water jet).



Laser cut claw and reel prototypes



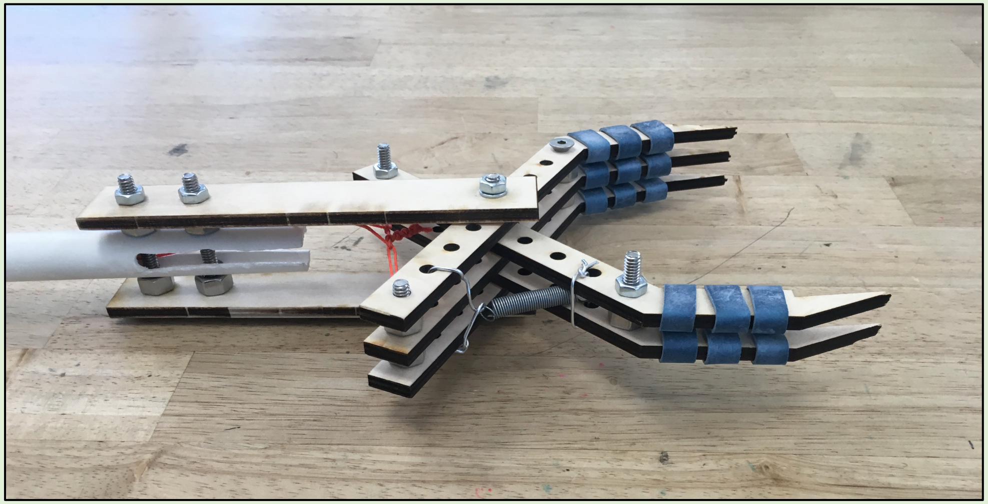
Final prototype

Mechanical Gripper for Quadriplegics

UC Berkeley | **Spring 2018, Spring 2019**

The Claw

The claw was laser cut and attached to the PVC pipe arm of the gripper with wood glue, nuts, and bolts. I was responsible for the claw point angle and notch (tested and optimized for picking up coins paper from the ground), the string configuration to close the claw (run through the rod from the claw pivot to an axle attached to the reel on the other end), and the two versus three claw finger arrangement.



Final prototype

Design highlights

- Two versus three finger claw to safely and effectively grasp objects.
- Notch at claw tips to pick up coins.
- Thin claw tip to pick up paper.
- Rubber bands to add grip.
- String inside PVC pipe for minimal interference with grasping.
- Spring between claw end and point to automatically re-open claw.
- ¼” wood for durability when lifting heavy objects.

Mechanical Gripper for Quadriplegics

UC Berkeley **Spring 2018, Spring 2019**

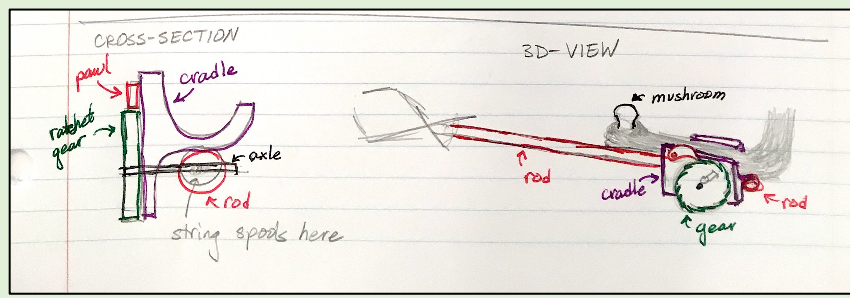
The Reel

To close the claw, our need-knower uses her finger to turn a ratchet (as shown in the picture), winding up a string connected to the claw. To spring the claw open, the pawl is simply lifted, and the object is released. Since quadriplegic users often experience significant muscular atrophy, I engineered the device to reduce the apparent weight of objects by placing the rod under her arm to counterbalance heavy weights in the claw. I designed and 3D modeled the reel, pawl, and red hand grip to be more user friendly, fitting the shape of the need-knower's arm and hand (she cannot fully open her hands).

Final prototype

Design highlights

- Ratchet and pawl system to lock the claw.
- User-friendly pawl, ratchet, and elbow rest designed for mobility constraints.
- 3D printed ergonomic hand holder (measured and sculpted to need-knower's hand).
- Spring-loaded pawl for ease of object release.
- Foam-lined arm rest for comfort.
- Lightweight, durable PVC pipe arm extension.



Design sketch

Delta-Leaning Recumbent Tricycle

Human Powered Vehicles Club, UC Berkeley — **Sept. 2017 – Mar. 2018**

My objective

Design (1) an aerodynamic fairing shell to increase vehicle speed and (2) a "grocery" basket to carry a carton of eggs. Assist with carbon fiber frame layups, bike part machining, and bike assembly.

About the vehicle

For the ASME (American Society of Mechanical Engineers) E-Fest West Human Powered Vehicles 2018 Competition, we built a leaning tricycle. The design allowed the vehicle chassis and rider to lean into the turn while keeping all three wheels on the ground. The competition evaluates the vehicles based on their design, innovation, and performance both in the sprint event and in the 2.5 hour endurance relay event involving slalom, speed bumps, and the ability to carry eggs without breaking them.

Awards:

- *3rd place overall*
- *2nd place Design Award*
- *Best Craftsmanship Award*

Our leaning tricycle at the competition

Riding in a straight line

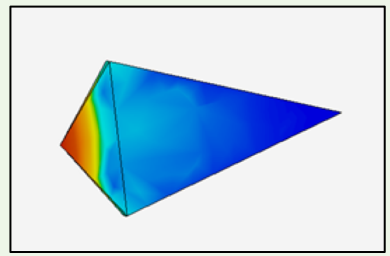
Leaning into the turn

Delta-Leaning Recumbent Tricycle

Human Powered Vehicles Club, UC Berkeley — **Sept. 2017 – Mar. 2018**

The Fairing

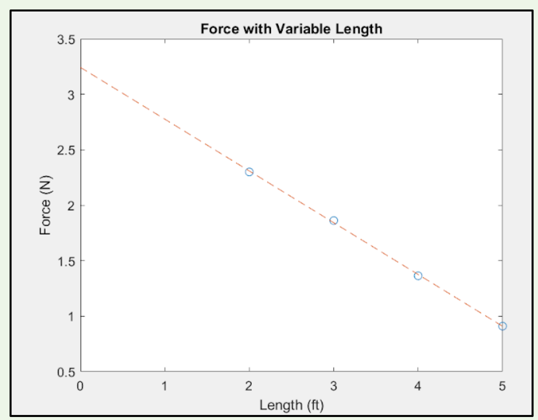
I worked in a team of four to design the fairing. We selected a rear fairing since the bike would be racing at approximately 20 mph, so a lighter rear fairing outweighed the aerodynamic advantage of a full fairing. I used SolidWorks and ANSYS to create 3D models, simulate fluid flow, and perform FEA testing to determine the optimal length of the fairing. I also participated in all stages of the manufacturing process, creating the fairing from carbon fiber fabric and layering the fabric in a foam mold to create the final fairing.



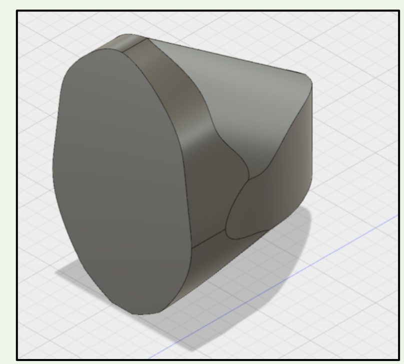
Sample fairing parameter model

Completed fairing

During the competition, we found that the bike raced faster without the fairing and removed it. Our fairing did, however, help earn us the design award.



Graph of drag force vs fairing length



Fairing model
Autodesk Fusion 360

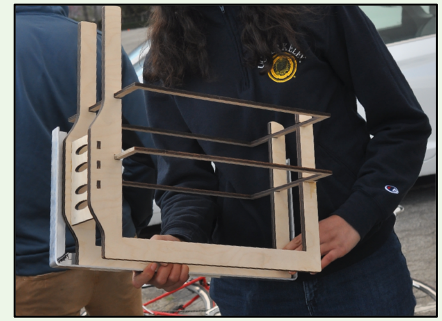
Design highlights

- Lightweight carbon fiber fairing
- Height and width match exact dimensions of the rider and frame to reduce drag
- Shorter length for lighter fairing

The Basket

The endurance event in the competition involved carrying surprise "groceries" for four laps over speed bumps and slalom stretches. Since the grocery items were only revealed on the day of the race, the grocery basket had to be built to carry fragile or heavy items that fit within the given size and weight constraints. The groceries were four cartons of eggs, and only one egg broke.

I independently designed and built the grocery basket. It consisted of a box held by a laser-cut wooden frame mounted to two aluminum flat bars (that I shaped and bent by hand), which were bolted to the acrylic flags on the side of the bike (where the yellow number 7 is). The entire grocery basket was spray painted black.



Laser cut basket frame

Finished grocery basket

Design parameters

- 5.5 kg maximum grocery weight
- 13" x 8" x 15" maximum grocery size

Design highlights

- Mounting points, location, and orientation selected to to minimize shaking and help transport fragile items
- Box frame designed to assemble and hold without glue, screws, etc.
- Padding inside box for safe transportation of fragile groceries
- Box opening designed for speedy loading and unloading
- Materials selected to minimize weight, maximizing speed
- Three-bolt basket mounting to ensure quick removal during the race

Tensegrity Robot End Caps

Berkeley Emergent Space Tensegrities (BEST) Lab **Summer 2017**

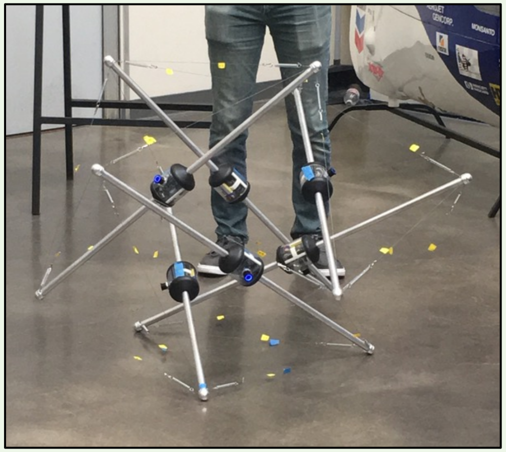
My objective

Design and build new end caps for each rod of the 6-bar tensegrity robot, minimizing friction while increasing durability and mobility.

About the robot

BEST Lab's versatile 6-bar tensegrity robot is intended for use in search and rescue and as a rover for Jupiter's moon Titan. The robot moves by adjusting the tension of cables running from inside a given bar to the end of an adjacent bar, causing the robot to change shape, shift its center of mass, tip, and roll over.

Finished end cap



6-bar tensegrity robot with end caps at the end of each rod

My project

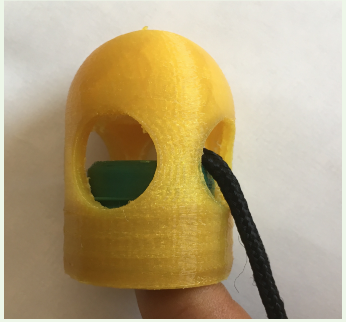
The end caps a former graduate student developed for his master's thesis were ultimately too complicated to implement and employ. I designed new end caps for the robot and completed all designs independently, working with tensegrity team members to ensure that my creations complemented the functionality of their components and discussing ideas with my Ph.D. student mentors for feedback.

Design parameters

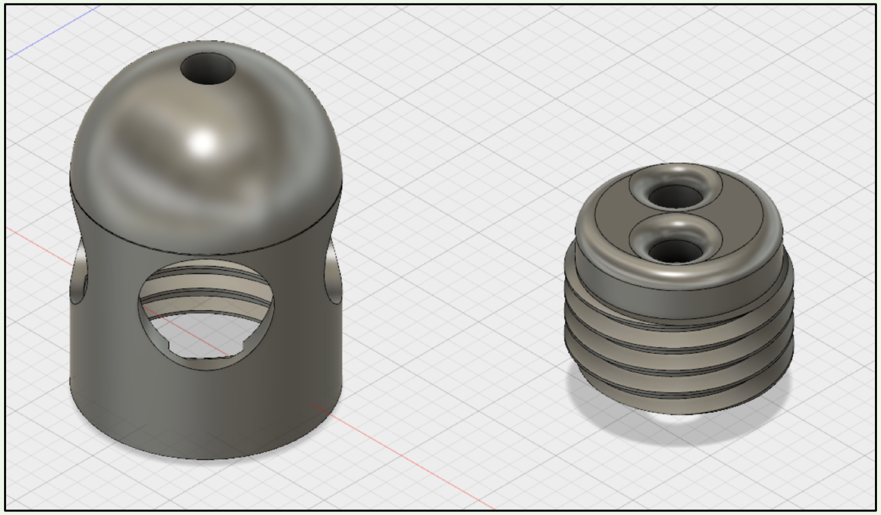
- Opening for cables to spool into and out of the rod
- Minimal wear and tangling of cables (two cables run through the rod)
- Frictionless cable movement with ±30˚ range of motion on all axes
- No debris able to enter the rod and impede cable movement
- Efficient assembly and removal (for robot repair)
- Easily machined in the campus machine shop

End Cap: Intermediate Version

From initial prototyping (in Fusion 360 and FDM 3D printing) and group feedback, I learned that the end cap tip must be round so as not to impede robot motion and that a cover attached to the end cap with tiny screws or bolts was difficult to accurately machine. I designed this intermediate version to solve those problems. Because preventing the cables inside the rod from tangling was an important design factor, the inner (right) piece of the end cap was press fitted onto the rod and contained two holes to separate the cables. The outer (left) piece would then be screwed on.



3D printed prototype



Elevated side view. Autodesk Fusion 360

Design highlights

- Rounded tip, enabling the robot to roll in any direction
- Hole on top of outer piece to prevent tangling during assembly
- Large holes for wide range of cable motion
- Easy assembly

Prototype drawbacks

- Difficult to machine threads and rounded edges of holes on inner part

Tensegrity Robot End Caps

End Cap: Final Version

This design, which originated with graduate student Alan Zhang, was ultimately selected because of its simplicity, ease of manufacturing, and ease of assembly. I learned that these three components are key in handmade projects, almost as important as optimizing design functionality.

I conceptualized, modeled, and prototyped all aspects of all previous designs. For this final design, I modified the holes and placement of the spring pins so that the cable had a wider range of motion and touched only the spring pins for minimal wear.

Design highlights

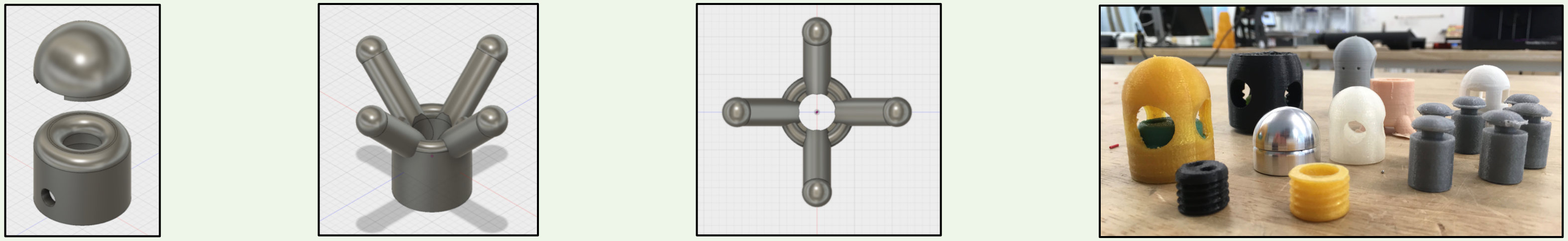
- Eye bolts through the bottom holes to securely attach end cap to rod
- Decreased cable wear by running cable over spring pins
- Large cable exit holes to prevent cable from touching end cap
- Easy to machine

Side View.
Autodesk Fusion 360.

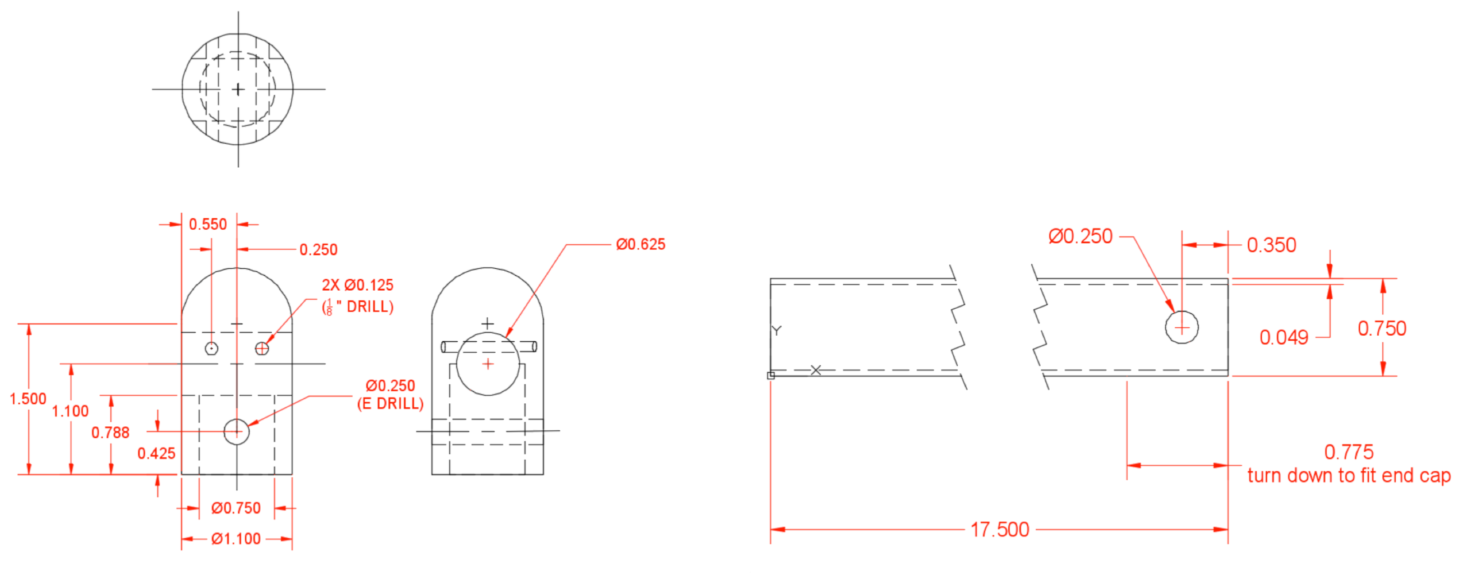
Final end cap attached to rod
with cables attached (but not taut)

Tensegrity Robot End Caps

Berkeley Emergent Space Tensegrities (BEST) Lab **Summer 2017**



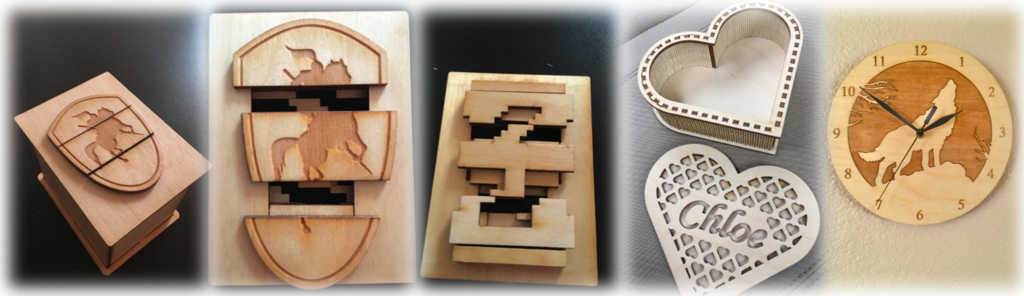
Autodesk Fusion 360 and 3D printed models of end caps from different stages of the design process



Dimension drawings of final end cap (left) and corresponding rod (right) design

About Me

Since learning how to laser cut,
I have created countless presents
for my friends and family.



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, playing violin in the UC Berkeley Chamber Orchestra, playing classical piano, baking bread, or swimming.

A few of my laser cut projects at top: trick box with hidden locking mechanism (3 photos), trinket box with living hinge, clock.

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