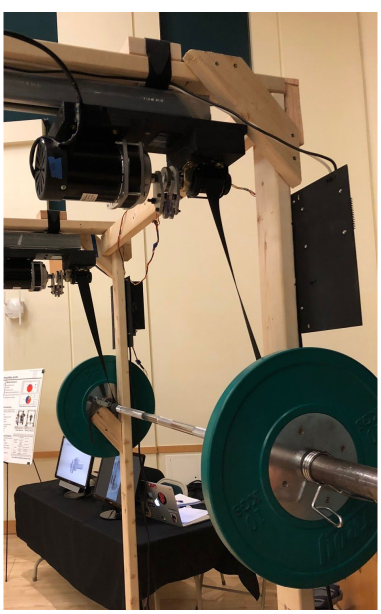
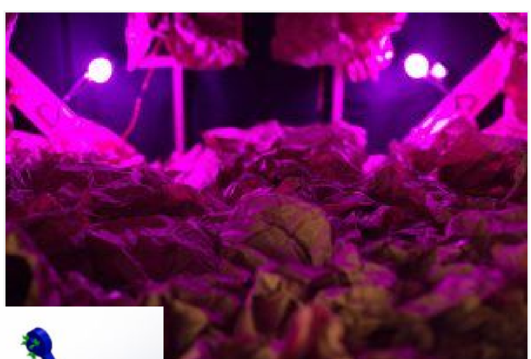
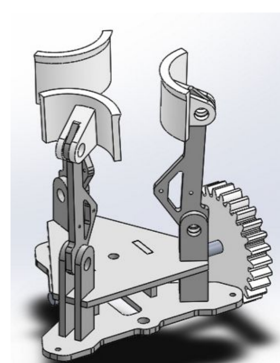
Wade Lacey

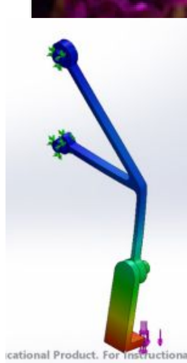
Design Portfolio

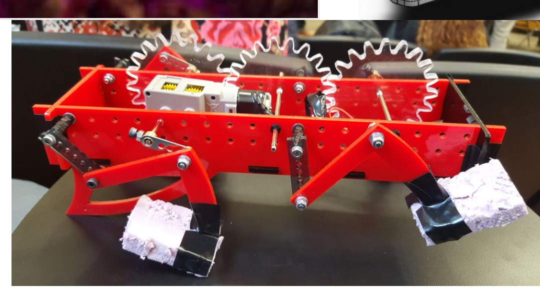
Projects:











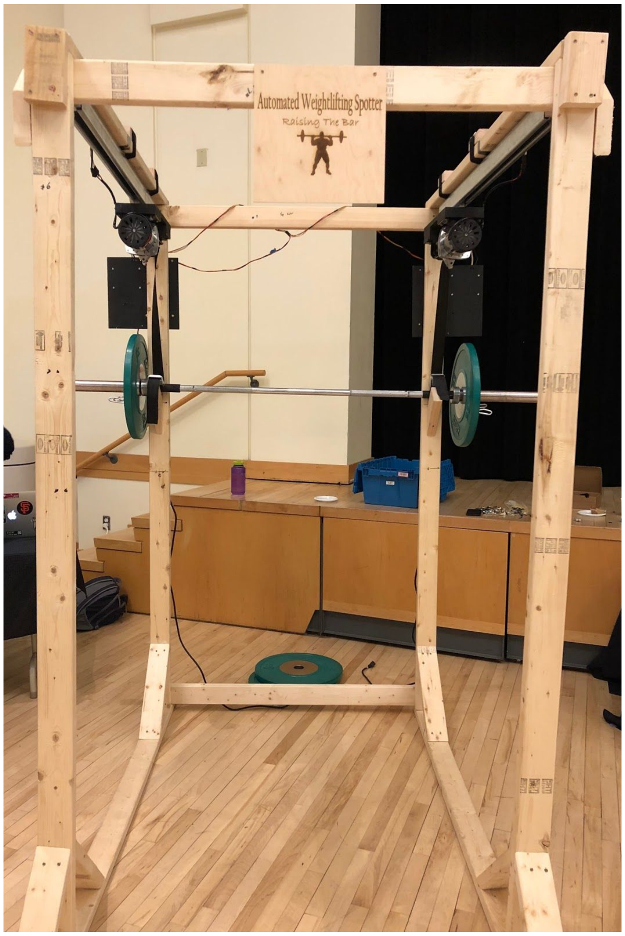
Automatic Weightlifting Spotter (Fall 2018)

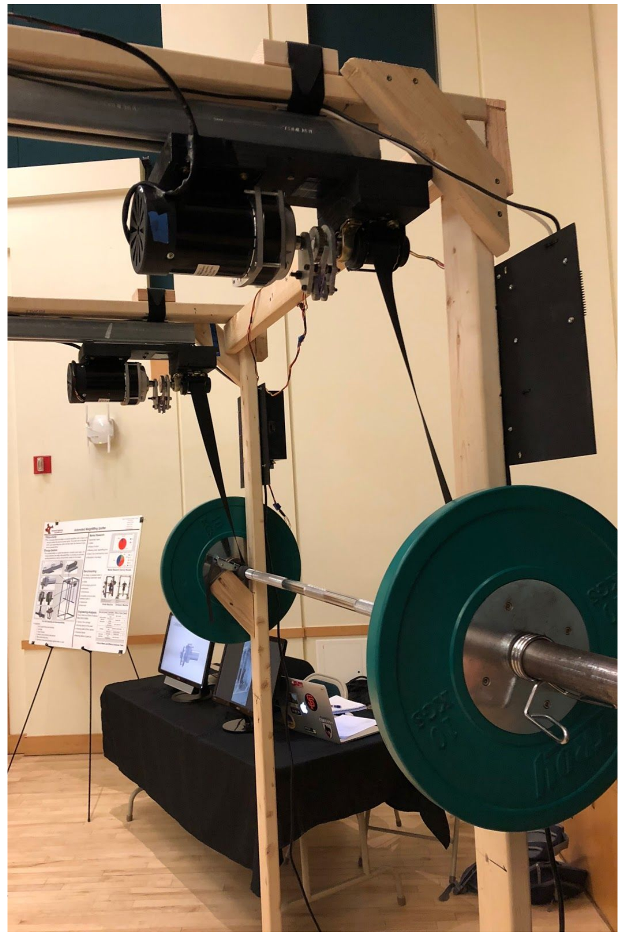
Project Description

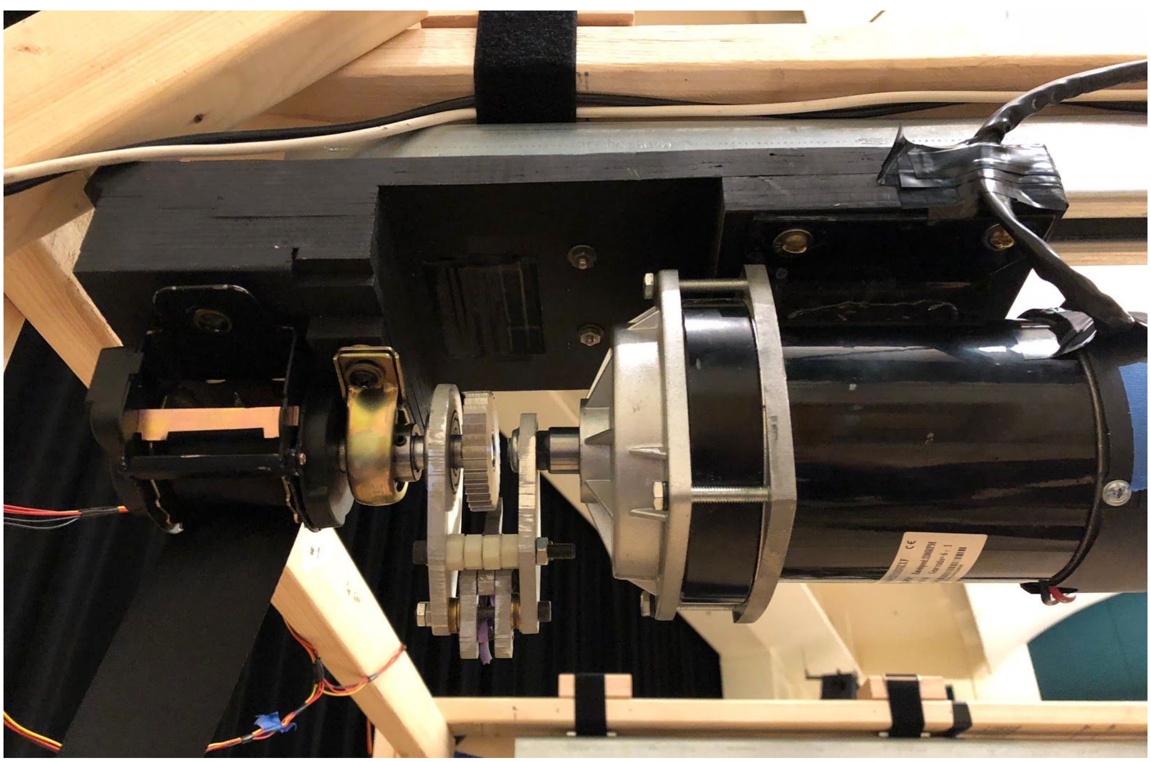
My team designed and prototyped a automatic spotting device for weightlifting. Our design is a system that attaches to standard squat cages in a gym. The system enhances user safety while weightlifting by providing an automatic spotting mechanism as well as a fall-prevention system for the barbell. For reference, spotting in weight training is defined as the act of supporting another person during a particular exercise.

Using multiple forms of market research we identified the important stakeholder needs that we then designed our product to meet. Our system places an emphasis on allowing the user to push themselves and lift more weights than they could normally do safely. The main goal of this design is to provide lifters with a means to attempt heavy lifts without the need for a human spotter, fear of injury due to failure, and interference on the user's natural lifting form, which are all vital stakeholder needs.

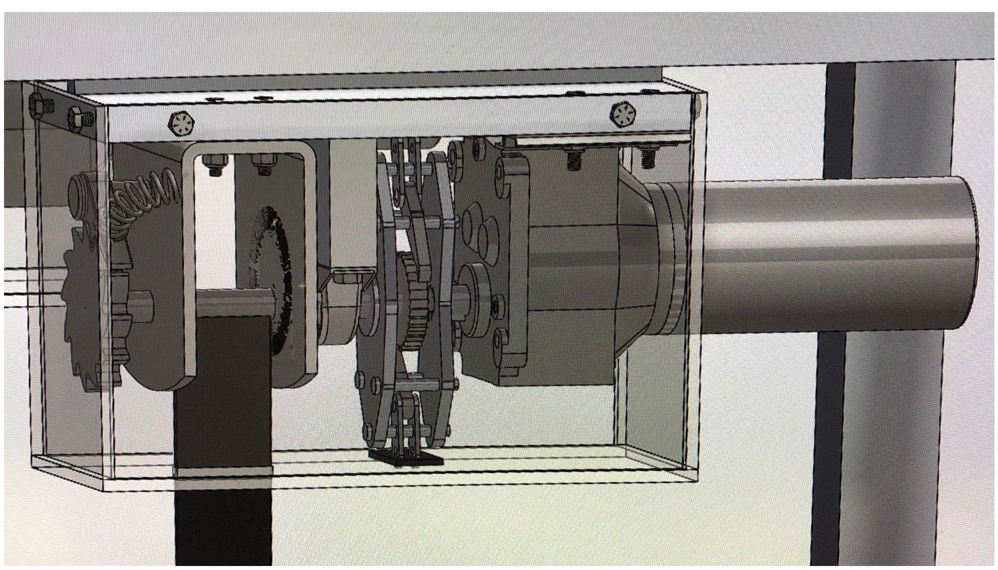
Prototype


Automated Weightlifting Spotter
Raising The Bar

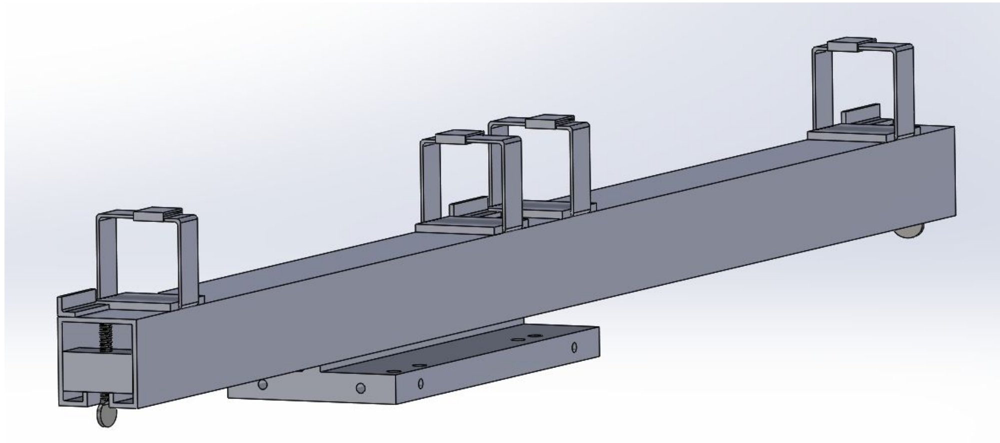




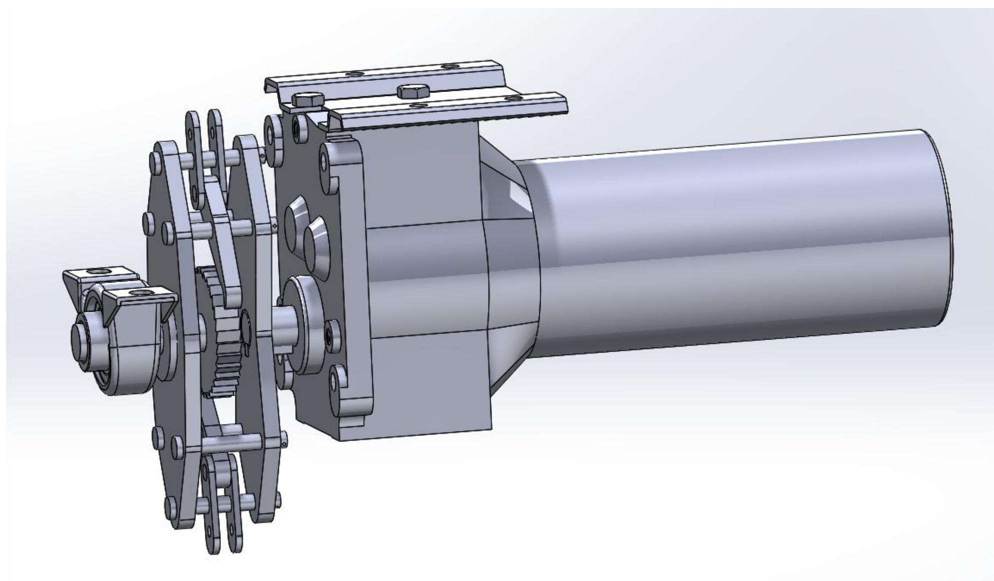
Final Design



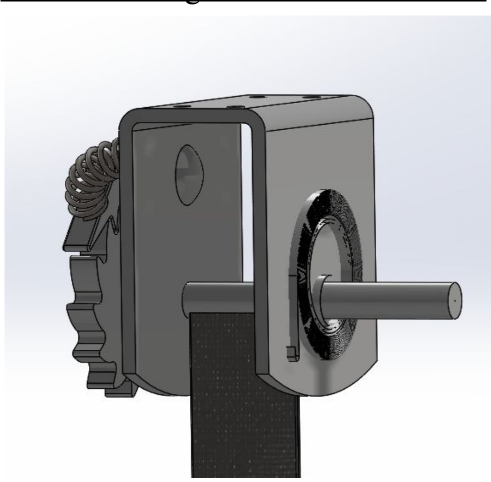
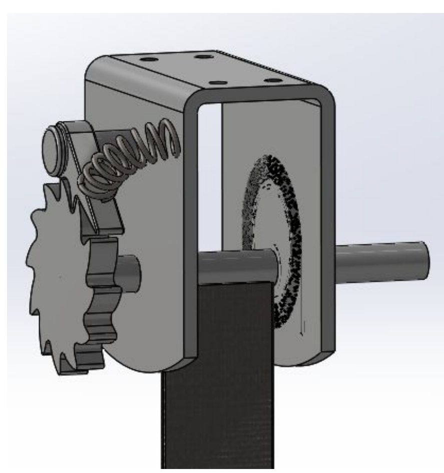
Rail and Carriage System



Powertrain



Inertia-Locking Retractor Mechanism

Awards

Awarded "Most Innovative" design at the Carnegie Mellon University Mechanical Engineering Fall 2018 Expo

Final Report

https://docs.google.com/document/d/1aSqO02E4XqvQx4f4p0ny5Oy4mjyZ4jGE3DNZRT0H1lE/edit?usp=sharing (complete project documentation)

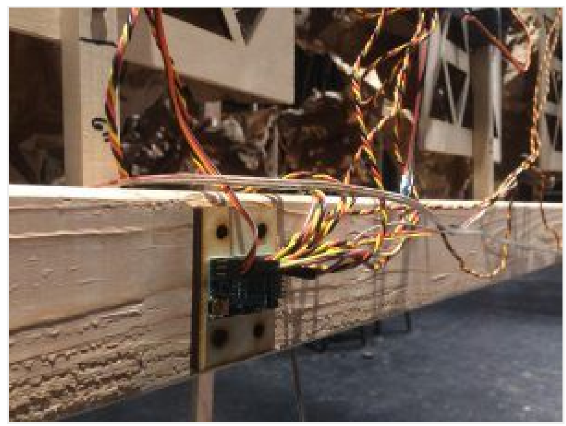
Head in the Clouds (Fall 2018)

Inspiration

This piece was inspired by multiple Zimoun pieces, we enjoyed the expressive movements derived from simple mechanics. Our goal for the piece was to create a unique and individual experience for each user. We conveyed a feeling of mesmerizing isolation, similar to how you would feel lying on the ground and looking up at the clouds.

Construction

To create the robot we built an enclosure made out of plywood and 2’x4’ pieces of lumber that encompassed the top half of the viewer and was supported on four legs, also made from 2’x4’s. Inside, there was lots of brown crumpled paper that was actuated by 40 servo motors. Our actuation system was comprised of these hobby servo motors and multiple micro-controllers. Each wall of the enclosure housed 9 panels, each with their own servo, all of which were hooked up to one mini-maestro, mounted to the side of the corresponding wall. The ceiling of the structure also had 4 panels, each of these panels was connected to the 10th channel of the mini maestro for one wall. The four mini-maestros were controlled by a single laptop via a usb port splitter. The Maestro Control Center installation was used to write the positions of the servos and put on a loop throughout the performance. Above the viewer in the enclosure, we mounted LED lights to the corners of the structure to add depth and vary color during the performance. The keep the experience private and surprising, we stapled black canvas to the exterior of our structure. This prevented onlookers from seeing what was happening inside without going in themselves as well as kept them focused on their personal experience with the enclosure once inside. Additional crumpled paper was hot glued in between panels to keep the modes of actuation unknown to the user.



The Experience

The experience began with the viewer approaching the piece as a large plain enclosure from the outside. To enter they had to crouch down and walk/crawl into the enclosure or sit below it. Once inside they were fully surrounded by abstract moving crumpled paper forms and color shifting lights. The paper forms twisted and crumpled at differing rates over the time of the viewer's interaction. The space was designed to be reactive in a way that created a different feeling in each user; some felt suspense or overwhelmed from the constant motion while others were calmed by the experience. The depth of the space felt greater than the physical dimensions of the enclosure.

Project Documentation

https://courses.ideate.cmu.edu/16-375/f2018/work/2018/12/17/head-in-the-clouds-final/

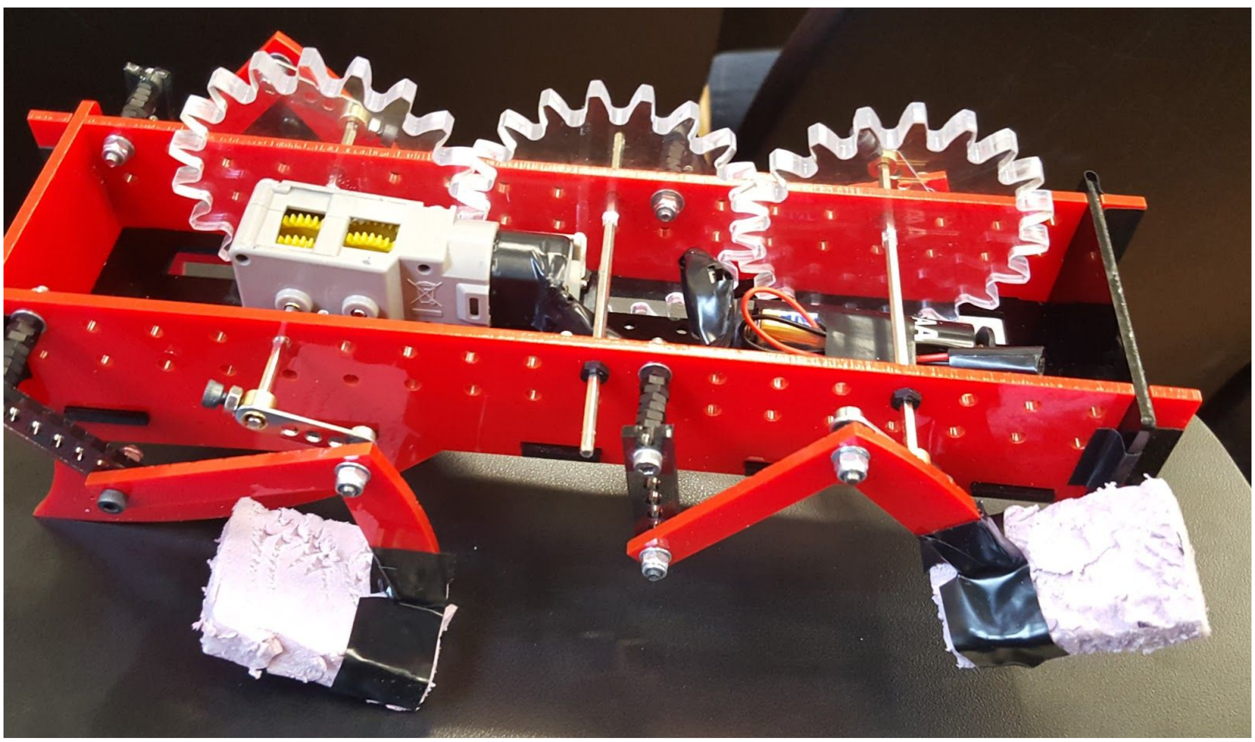




Walking Robot (Fall 2017)

Project Description

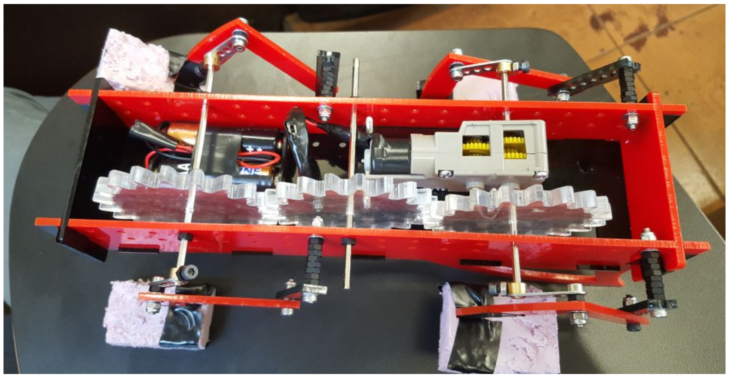
In a team we worked together to build and optimize a walking robot for search and rescue operations in confined spaces. The robot will be powered by a single motor, and the legs of each robot will consist of four identical four bar linkages (front right and back left in phase/front left and back right in phase). The robot consisted of a robot body and 4 four bar linkages that will be attached to the side of the robot. The robot was designed to perform on three different obstacle courses: rocks, stairs, and hurdles.

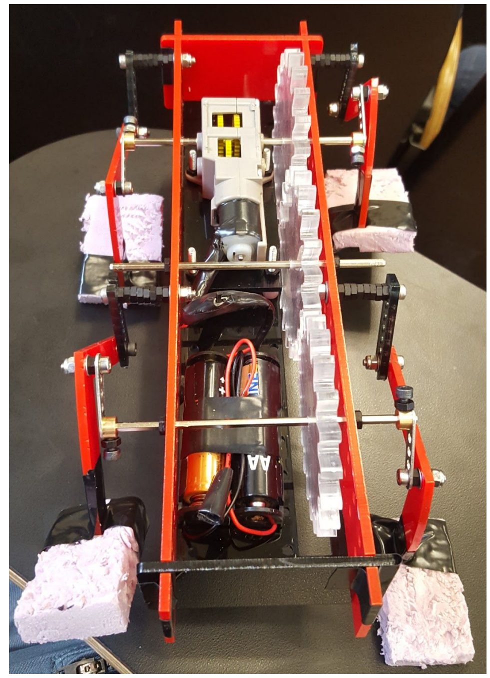


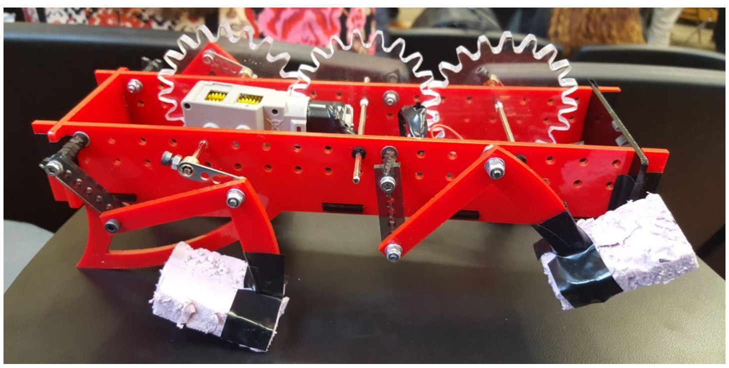
Design

Body: The housed the motor, battery pack and gears. The sides of the body extended down below the rest of the body in the back, this gave our robot stability to stay tall while moving. This was an important factor in the rocks obstacle, for it stopped our robot from getting stuck between uneven rocks.

Legs: We optimized for a tall ovular gait from our four-bar linkage legs, so to maneuver the hurdles obstacle. Using linkage simulators and iterative testing we determined the coupler curve and linkage lengths needed to complete the task.





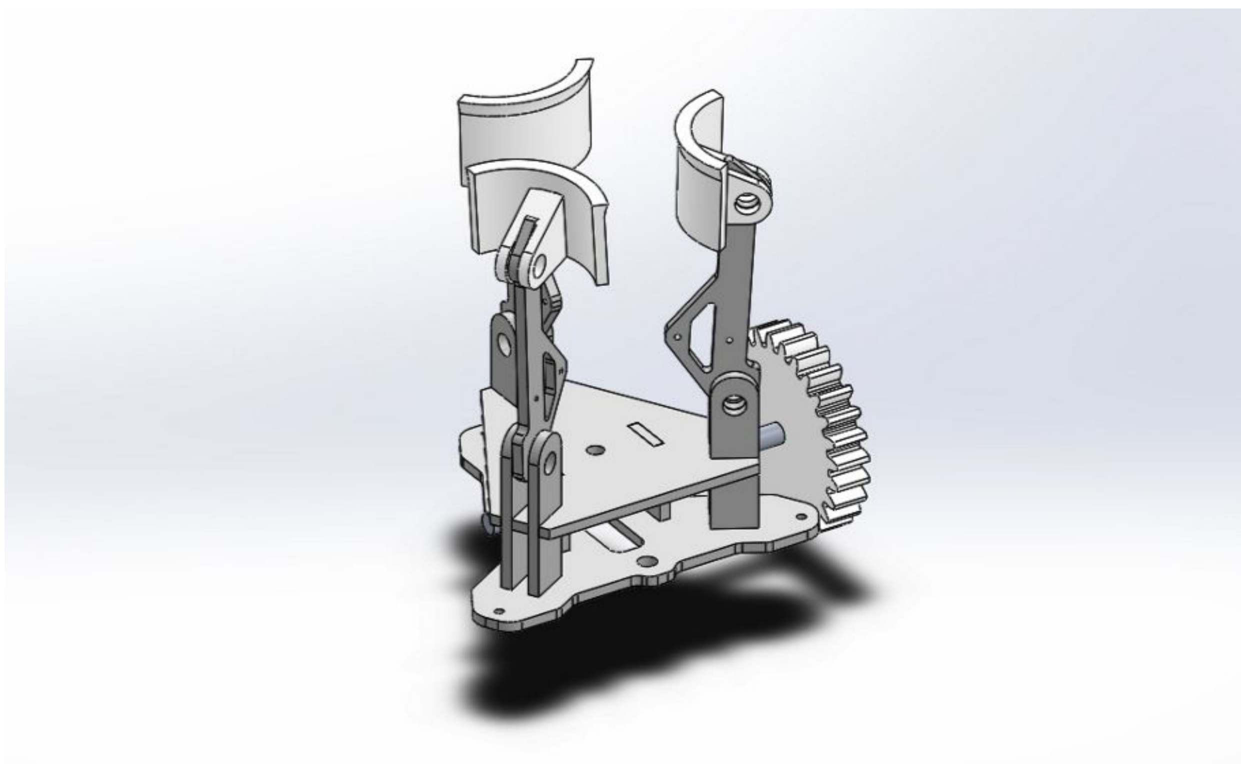


Final Report: Project 3 Final Report (complete design process documentation)

Gripper Project (Fall 2017)

Project Description

The task was as a team to create a gripper that could pick up, swing, and set back in the same position an object. This object was made out of aluminum, was the shape of a large fidget spinner, and weighed ~1.11 kg. Some specifications included that the gripper could not interfere with the support structure underneath the fidget spinner, nor can it touch the bottom of the fidget spinner. For testing the gripper will be attached to a swinging arm with a drive shaft and it will be moved into place along the same path as it will swing along. The gripper must somehow use the actuation provided by the drive shaft to hold the fidget spinner. When the motor is on, it will drive the shaft with medium speed when unloaded or medium torque when stalled.



Design Description and Rationale

Our design features acrylic for lightness, three arms which together act as clamps, and vertical supports that connect each arm to the base. The arms are attached to a triangular plate which mounts to the stand. One spring is attached to each corner of the triangle, with the other end connected to its respective arm underneath. These hold the arms up in a retracted position. String is attached to the shaft and connects to the hinged lower part of the arms so that when the motor turns, the string will be pulled taught and the gripper will close (into the position shown above). The strings are braided together to keep the distances of travel the same. Another string is also attached to the drive shaft to limit rotation when the motor is back-driven.

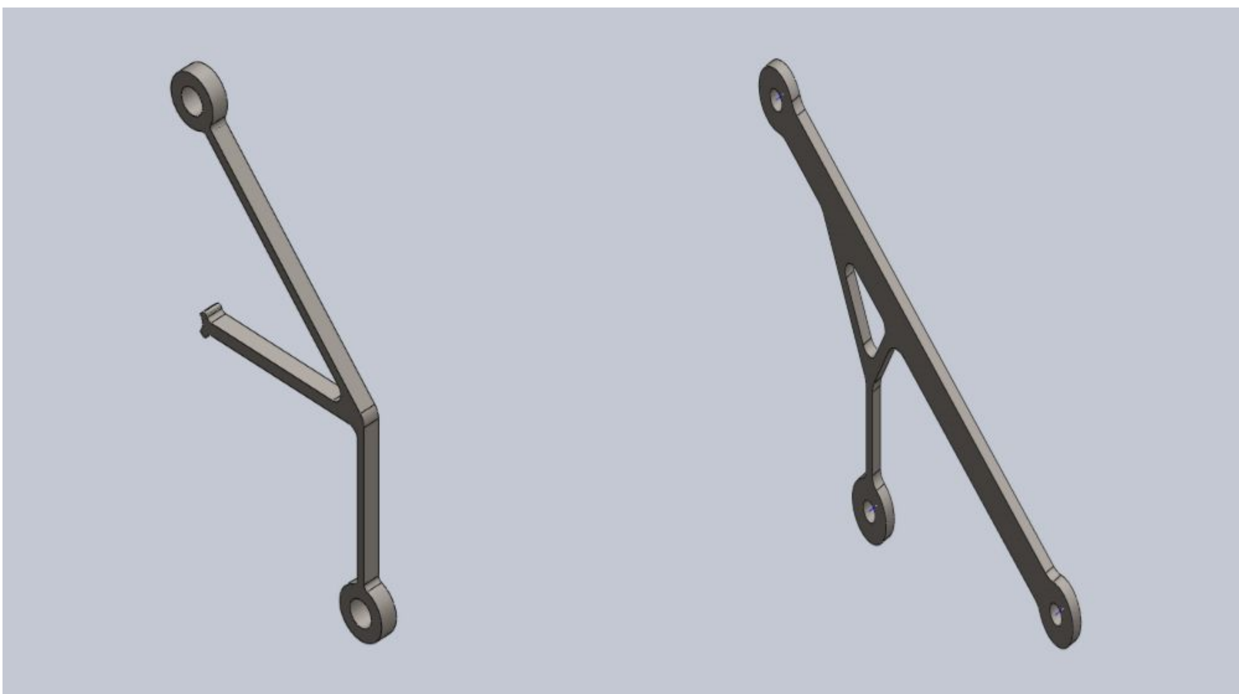
Because we cannot contact the object underneath, we determined the best action is to pick up the object by clamping against the sides. There are three arms equally spaced 120 degrees from each other to clamp the fidget spinner on the inner concave regions. At the end of the arms are Dycem pads that will allow the artifact to be held securely with friction forces from clamping. To mitigate bending in the vertical supports when the artifact is gripped, we have a triangular plate which braces the supports. This increases member stiffness and saves more weight than if a stiffer, but heavier, material was used to manufacture the supports.

Full Final Report: Final Report (2) (complete design process documentation)

Bracket (Fall 2017)

Project Description

Design a bracket that will fit into a specific peg board set up and will support a suit clip, which will be loaded with 40 ± 1 pounds force, directed downward, one time, without failing, for at least 10 seconds. If the suit clip moves more than 0.25 inches from its initial position, due to breakage or excessive deflection, this constitutes part failure. The bracket will be made from 0.173 ± 0.010 inch thick sheets of Evonik CYRO Acrylite FF acrylic, a thermoplastic polymer and laser cutters will be used to produce prototypes for testing.



Design and Rational

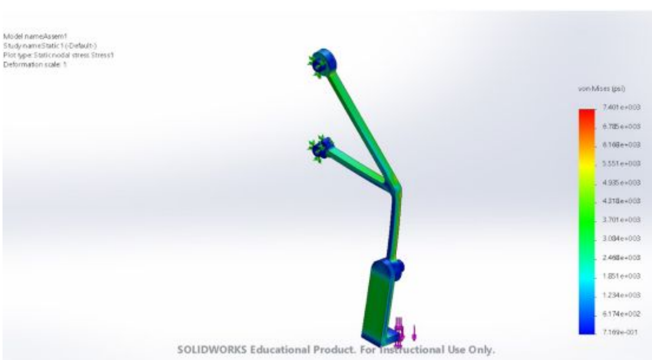
Original Design: Our design features a long member which spans the open space at a diagonal and attaches at each end to the test stand. Two oppositely angled members extend from this long diagonal member and then come together to support a single vertical member, to which the suit clip is attached.

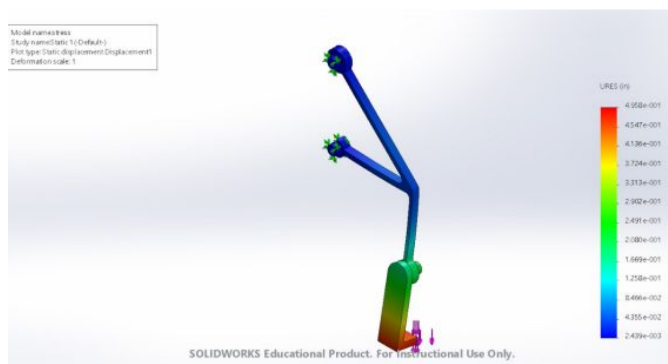
This design is suited to the task because it has few areas of highly concentrated stress and therefore uses minimal material to withstand a large load without yielding. The three members that extend down from the long diagonal member are all loaded in tension; therefore, the stress is evenly distributed throughout, and they can support large loads while remaining thin. The long diagonal member is more concerning due to high bending stresses at member connections; however, the fact that our design connects to this member in two different places helps to avoid high stress concentration at a single connection point.

Addendum Design: Our original part was too massive due to the amount of material needed to account for the bending stresses that the diagonal beam experienced. To remedy this we decided to change our design so that it only connected to the side closer to the suit clip and in a configuration that would not have such large bending stresses. This new design had a top member at an angle in tension, another member that is in pure compression. Where these two members meet an arm extends does to hold the weight in the correct location.

Stress and Displacement Analysis

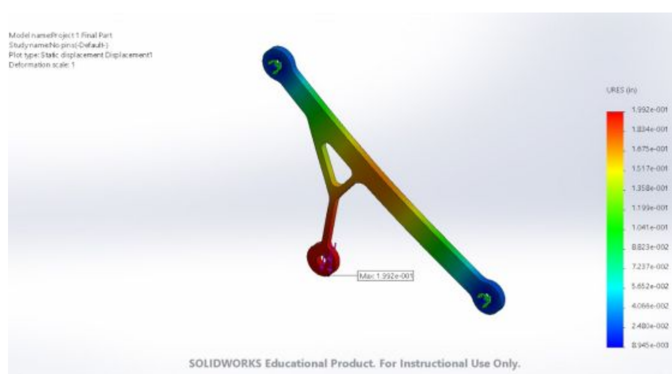
(completed in Solidworks)





Stress Analysis

Displacement Analysis



Mechanical Crane (Spring 2017)

Project Description

Task was to collaborate with a team to design a mechanical crane using a truss structure to lift a 1-pound weight 2 inches while considering stress and weight constraints.

Website Crane Detailed Website (complete design process documentation)

Design