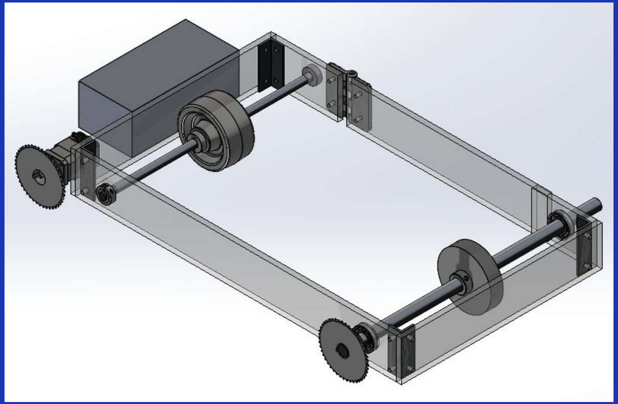
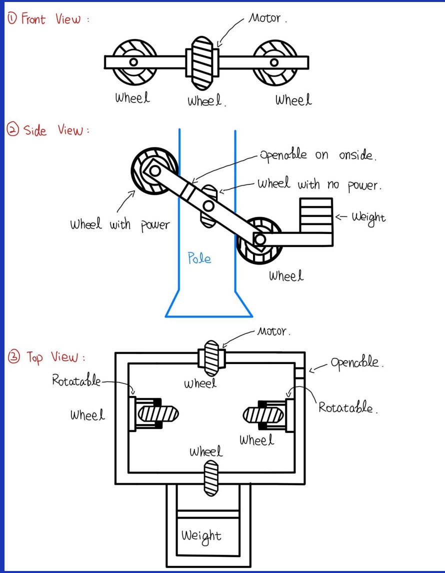
Portfolio

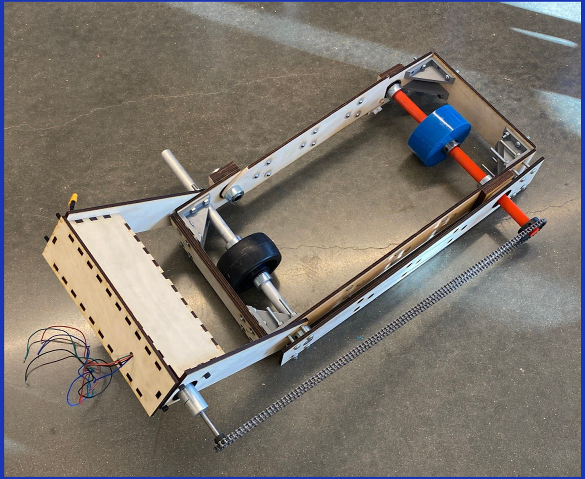
Peter Nesin
1/20/2025

Pole Climbing Robot

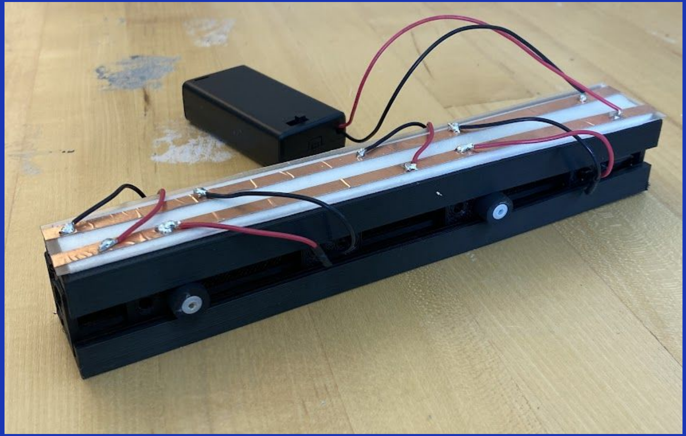
September - December 2024 I worked on a robot intended to climb one of the light posts shown in the top right picture. I worked in a group of 4 and was the only mechanical engineer in the group, so I was responsible for nearly all of the design and fabrication of the robot, while they worked on the electronic components and programming.

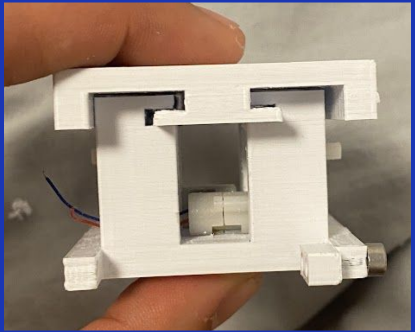


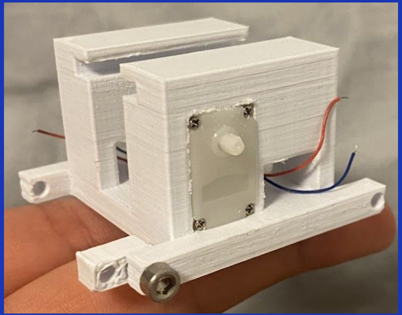


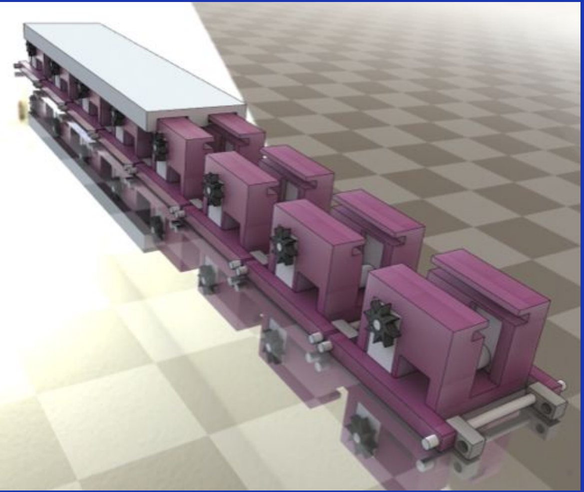


Cilia-Bots







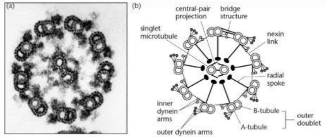


May-July 2023 I worked on designing robots to mimic the movement of cilia, a type of organelle found on many cells of the human body. I have included images of one of my earlier designs made of flexible filament, a module of one of my later designs, and a render of the final design. Additionally, I have attached my research poster on the following slide.

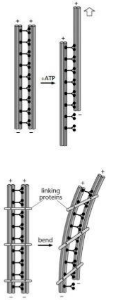
Developing a Roller-Based Robotic Model of the Cilium

Peter Nesin, Dr. Louis Woodhams, Dr. Philip Bayly
Washington University in St. Louis MEMS Department

Background



Cilia are a type of organelle that can be found on various cell types. Their distribution spans a multitude of human body systems, including key areas such as the lungs, brain, and the reproductive system, showcasing their extensive functionality and importance. The core architectural feature of cilia is the axoneme structure which is made up of microtubule doublets; which form the skeleton of the cilia The characteristic motion of cilia, can be attributed to the action of dynein filaments, specific motor proteins that enable sliding of adjacent microtubules against each other.



All non-original images courtesy of Bray Cell Movements

Previous (Bristle-Based) Designs

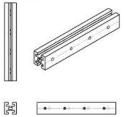
The Bristlebot model of the cilium utilizes vibrating motors along with flexible bristles to enable the movement of plastic pieces it interacts with.
The Bristlebot model has progressed to successfully produce sliding and bending movements. However, the model has not yet been able to replicate the characteristic motion exhibited by natural cilia.

Objectives

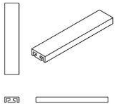
This project aims to develop a human-scale mechatronic version of a cilium which uses motors and rollers to produce sliding between flexible ribbons. This body should be able to produce sliding between filaments, and we will evaluate its capacity to create bending in the structure, overcome external resistance, and produce the same kind of oscillations that cilia and flagella do. The first aim is to produce two-part sliding, and then to form a larger structure using the same sliding mechanism to produce sliding in multiple directions.

Design Iterations

Version 1.0

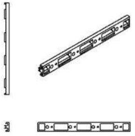


Spine
- Holds motors
- Printed from flexible materials
- Slit in top for assembly



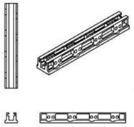
Ribbon
- Driven by friction from wheels
- Slides along spine
- Flexible for eventual bending

Version 2.0



- Center piece split for ease of assembly
- Cable managing piece removed
- Pockets created to increase flexibility
- Printed entirely from Ninjaflex

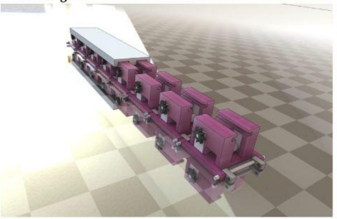
Version 3.0

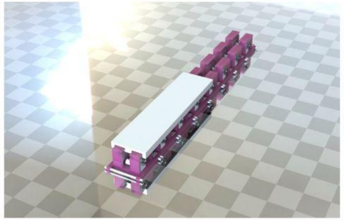


- Spine pieces and base combined
- Clearance created, wheels only in contact with top
- Less infill for greater flexibility
- Greater tolerances to reduce internal friction

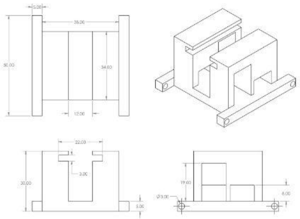
Final Design Specifications

Final Design SOLIDWORKS Renders





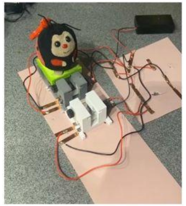
Version 4.0 Module



Parts List
- Printed Parts
  - Module
  - Ribbon
  - Connecting Rod
  - Link
  - Compliant Wheels
- Electronics
  - GM-24 Motors
  - Copper Conductive Tape
  - 3V Power Supply

Performance

- Sliding successfully produced w/ roller design
- Flexible ribbon unable to be printed to test bending, and only 3 modules fully assembled



Future Steps

- Create more link modules for correct length-width ratio
- Pursue bending and collect data on the motion produced by the structure

Acknowledgements

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Samantha Feldman

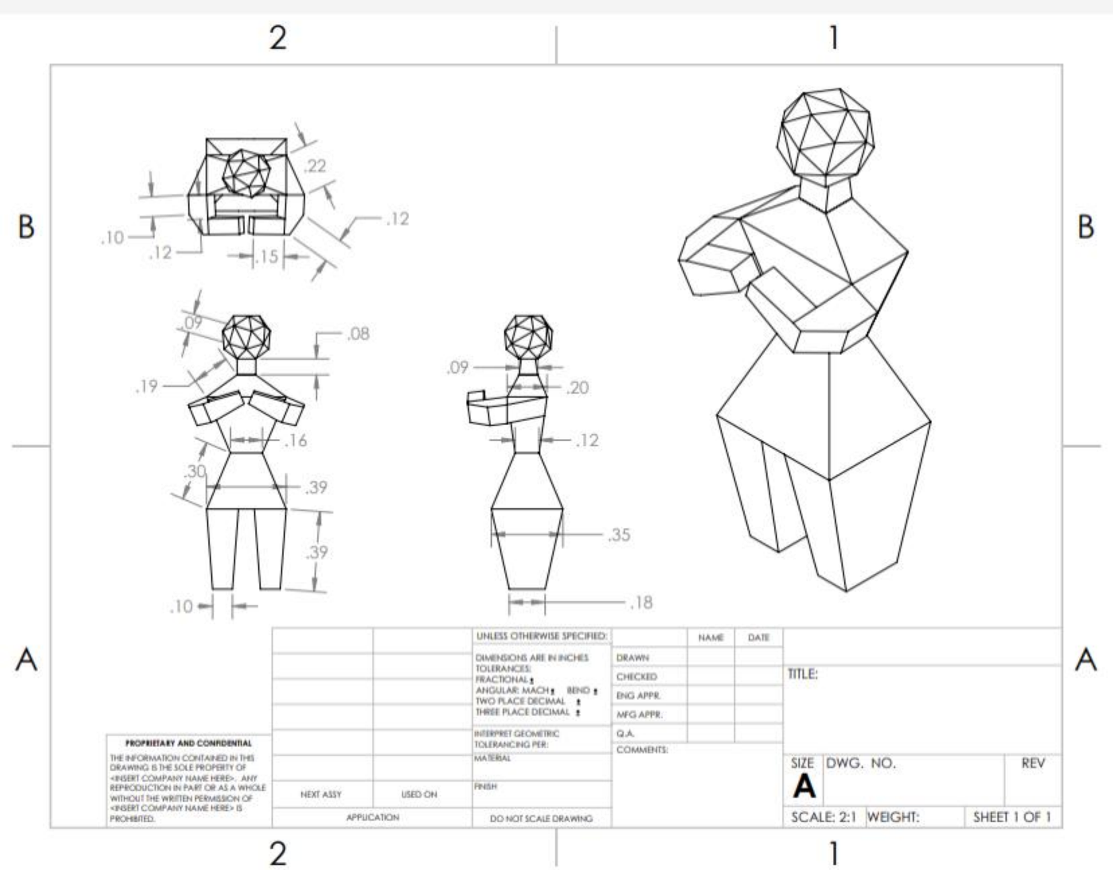
WUSEF:
Dr Brennan
Dr Boyd
Dr Holland

Sculpture

Anteater
2024

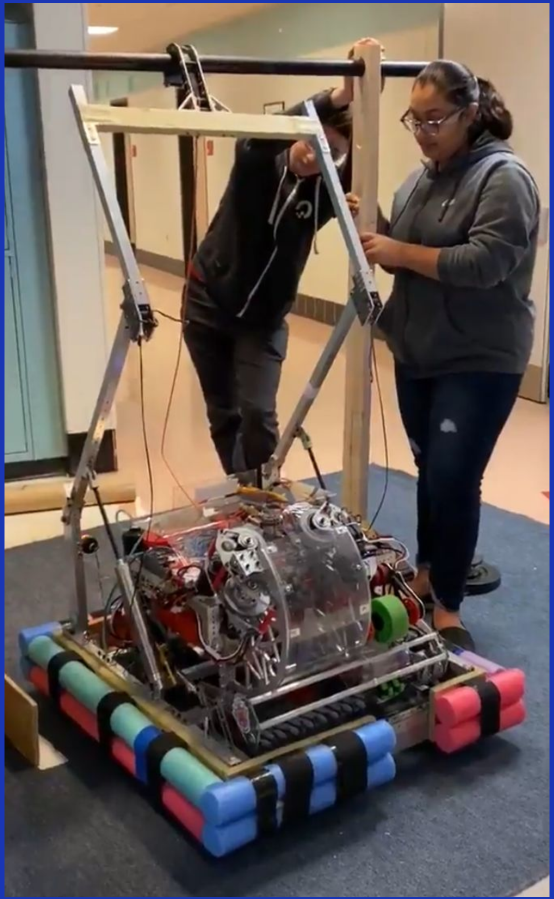
Anglerfish
2024

Sculpture Ctd.

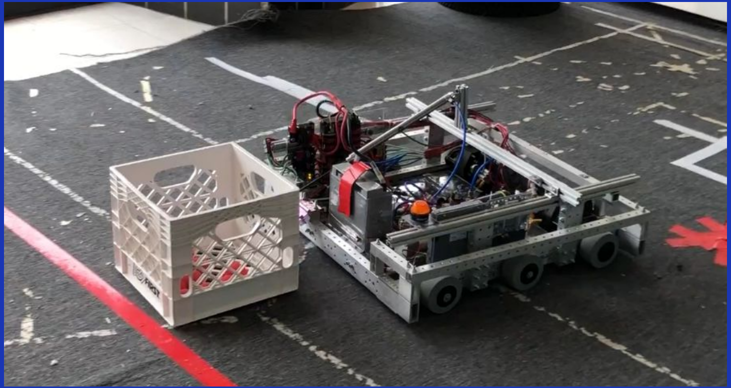


Climbing Mechanism

I was the project leader and primary designer of our robots climbing mechanism for FIRST Infinite Recharge, in which points could be earned if your robot could end the game at least 6 inches off of the ground. Our mechanism was a set of collapsible arms with a hook, which could extend during the endgame and hook on to a swinging pole. Then, cordage attached to the hook was used to winch the robot up off of the ground.



Flipping Mechanism



Another project I led in 2019, a much simpler mechanism we designed during the offseason to flip over crates and knock the balls out. It was comprised of a sheet of polycarbonate cut into a T shape, a hinge, a piston and a simple pneumatic system.