Project Portfolio

Mechanical Engineering + Machine Learning/AI
Duke University ‘24

ALANNA MANFREDINI

Slide Summary

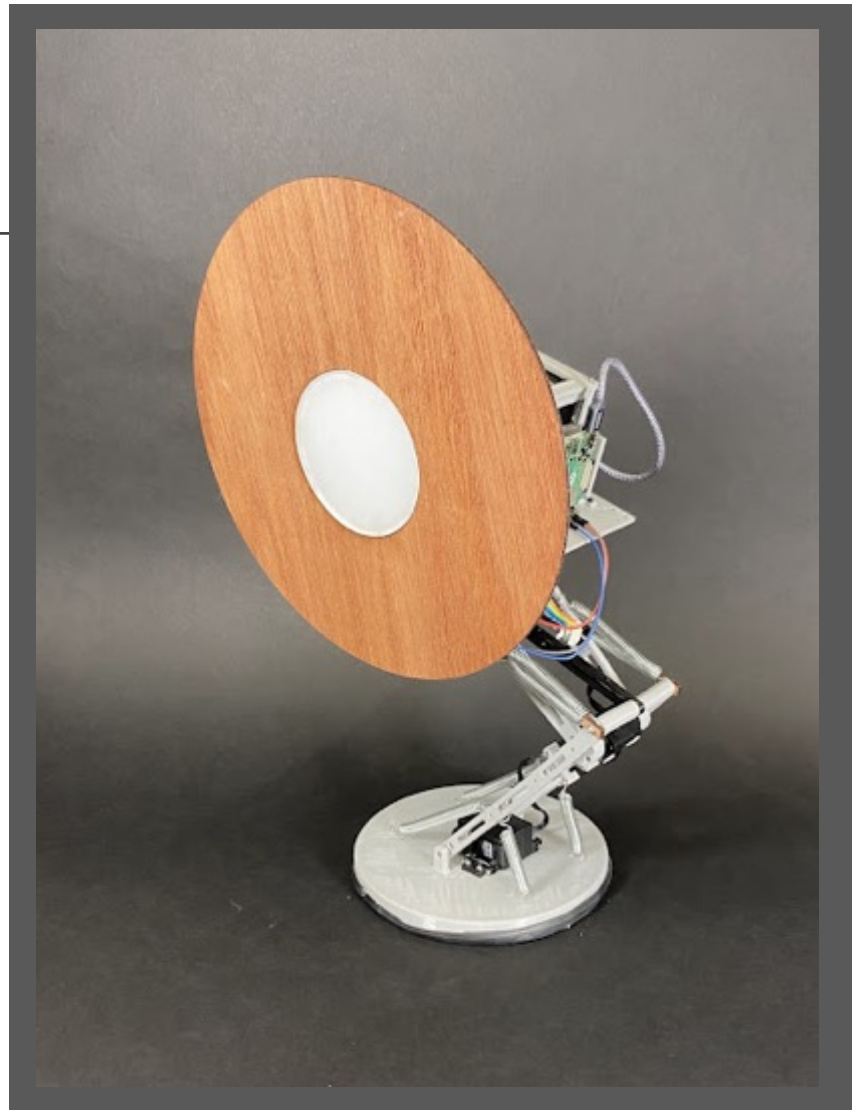
A Few of My Projects

Some Work Experience

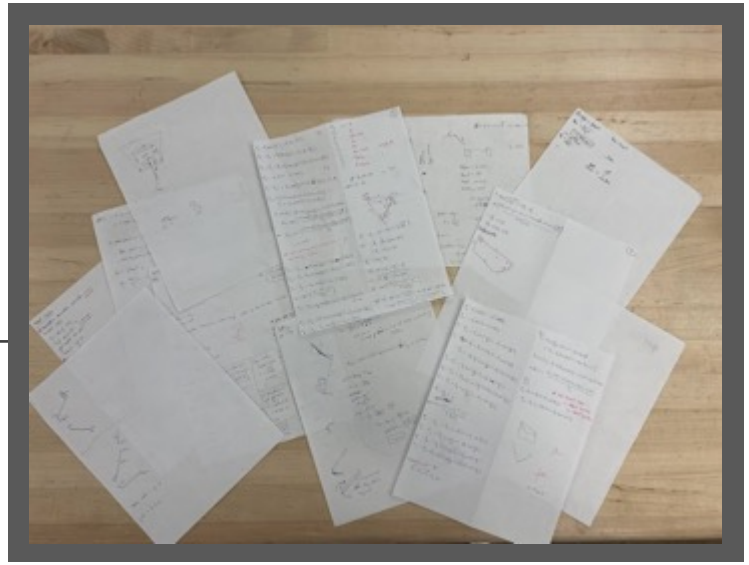
Pixar Robot

Robot Summary

- Hopping
- One legged
- Linkage actuated
- RaspPi + LX16A powered
- Spring balanced
- Fully detailed CAD



Feasibility Analysis



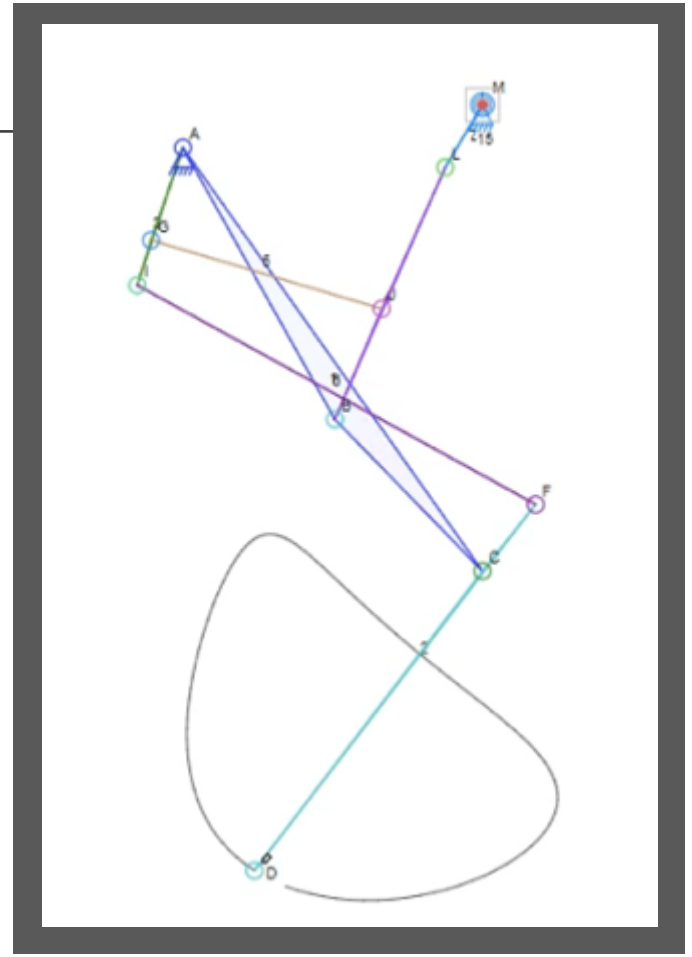
Considerations:

Force for jump	4.43N @ max dist < max **motor torque**
Speed for jump	Launch speed for 4cm jump < max **motor speed**
Restoring force	Counterweight can effectively restore **base moment**
Motor current	Battery can provide power for **an hour** @ max torque

Design Calculations Analysis

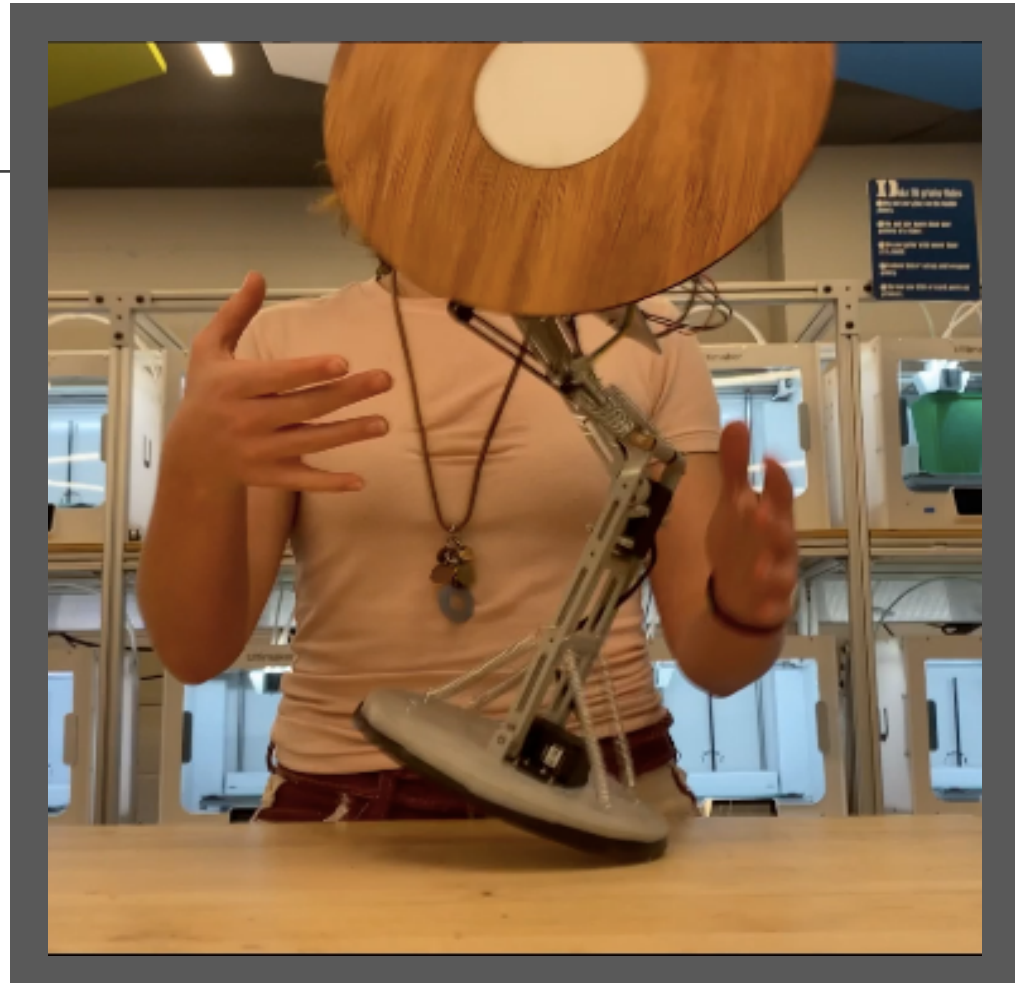
To guide my design choices, I used first principles calculations:

- Inverse kinematics for linkage
- Curve fitting for empirical force analysis
- Current, voltage and power calculations
- Bending, torsion and buckling
- Motor protection with FFT sin waves
- PLA glass transition temperature comparisons



Features

- Calibration programs
- Motor protection abort lines
- Vibration prevention screws for electrical mounts
- Countersunk holes
- Assembly access holes
- Low print time
- LED lights



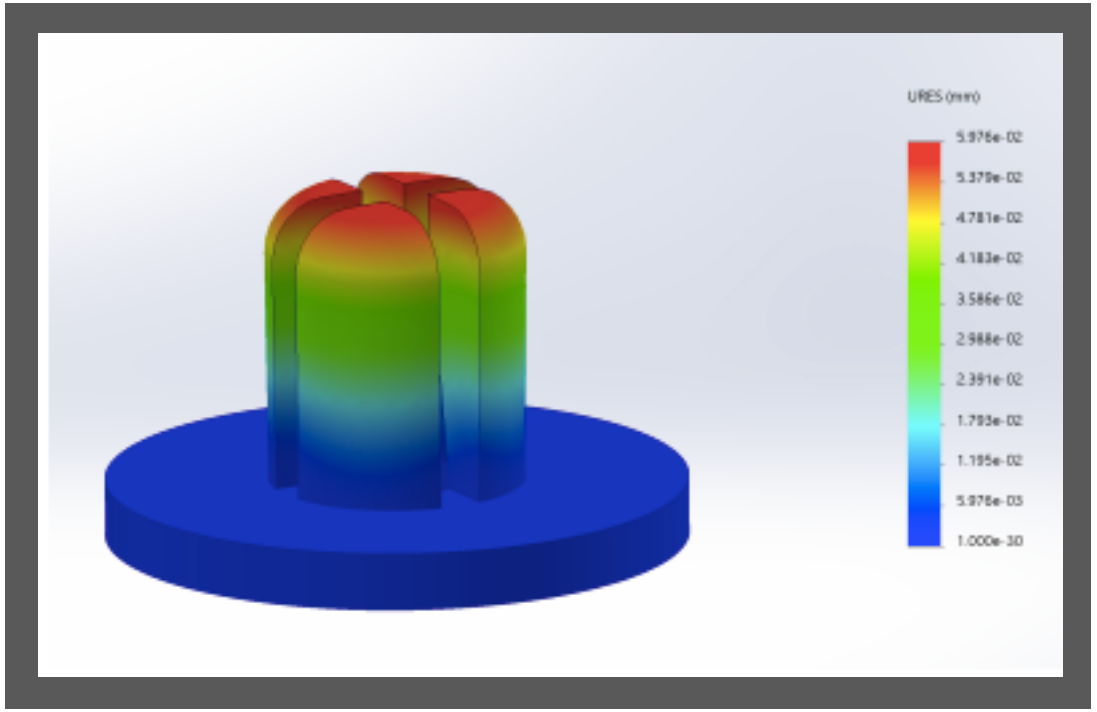
Modular Assembling Robot

Purpose

- Fabricate multiple robotic modules
- Individual modules can connect without human intervention
- Multiple connected modules can move as one unit
- Robotic modules can be located with computer vision
- 5 axis motion

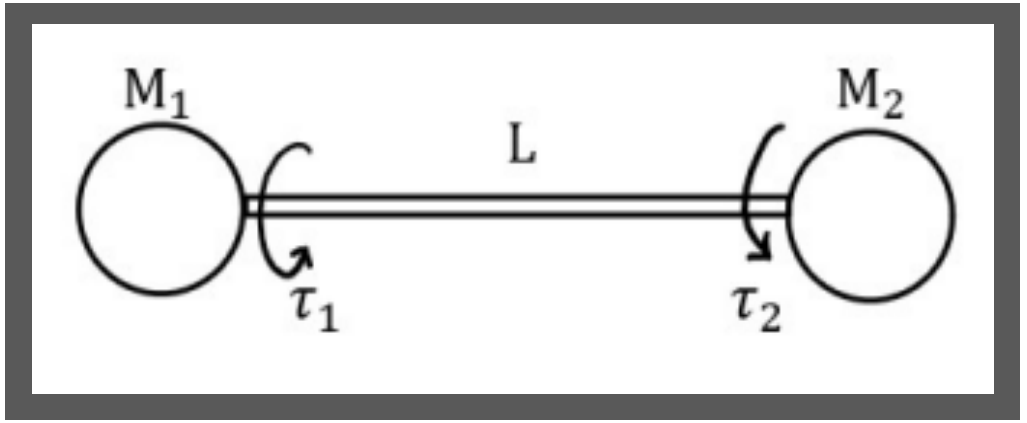
Analysis

- Electrical component circuitry analysis
- FEA
- Axial, torsion, bending, buckling calculations
- Deflection calculations
- Life cycle



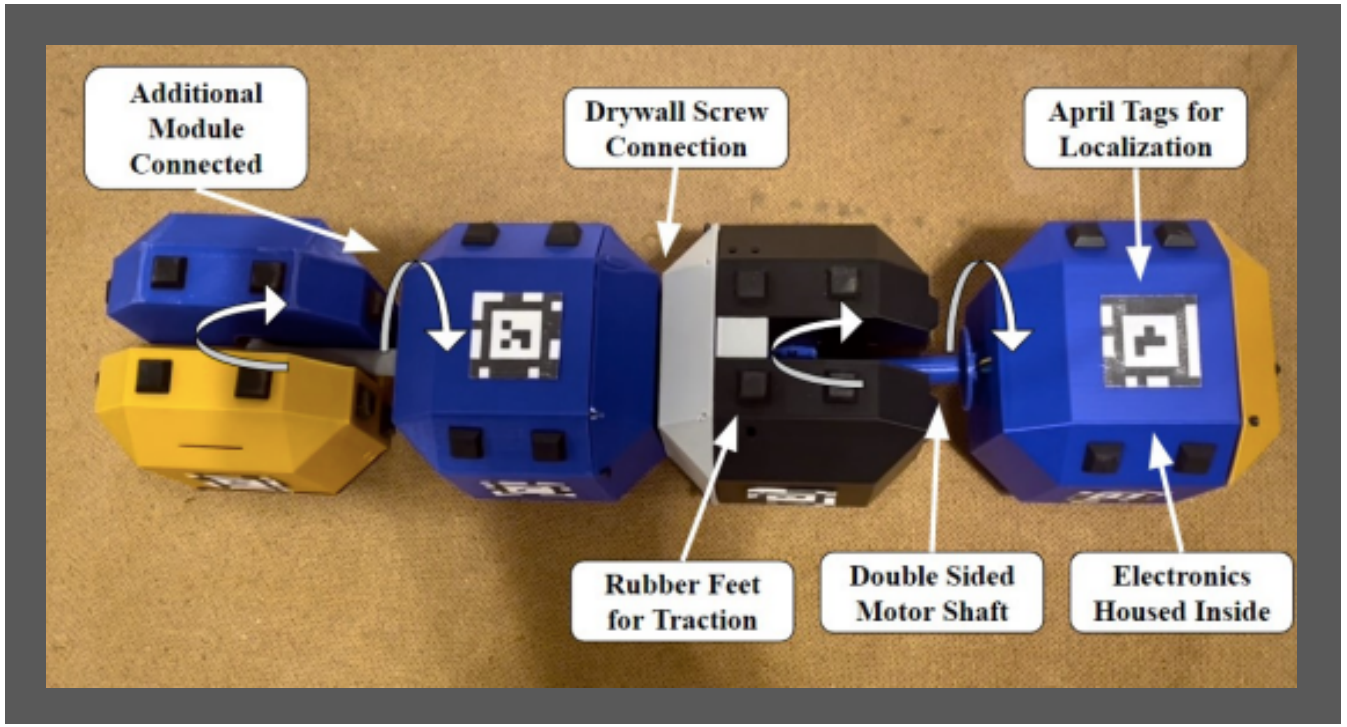
Testing

- Force resistance
- Electrical
- Fatigue
- Central bar
- Localisation



Product

- Engineering drawings for each part with GD&T
- BOM
- Costing
- Fabrication instructions



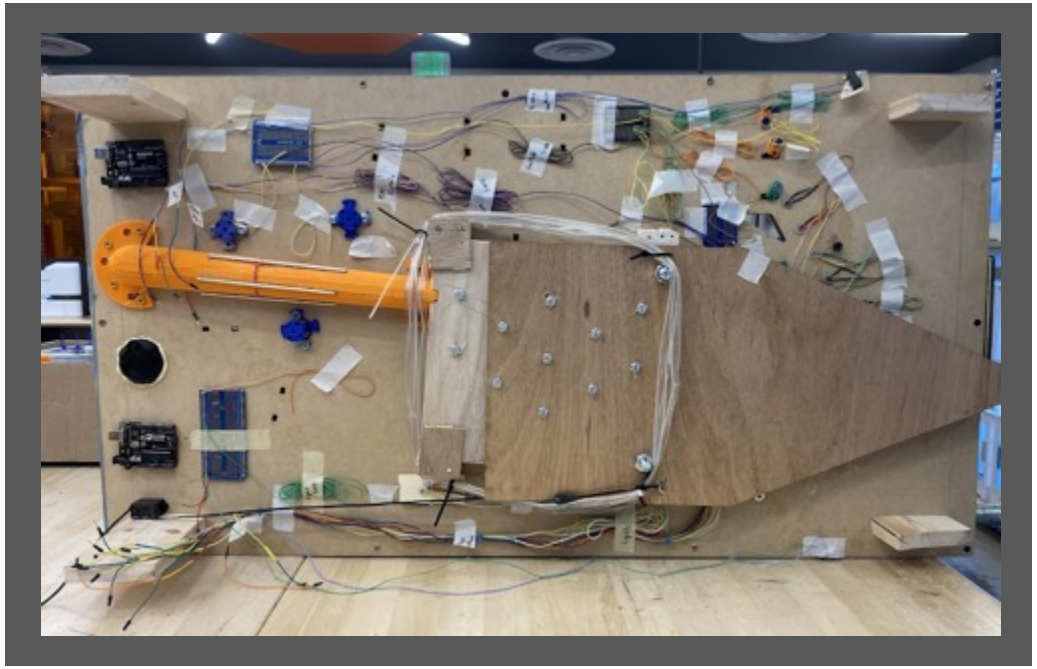
Pinball Machine

Fabrication Techniques

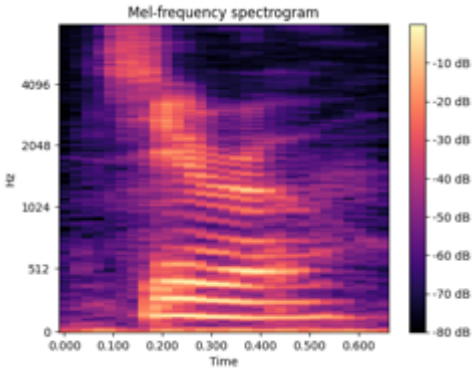
- CNC
- Laser-cutting
- 3D printing
- Moulding
- Water jet cutting
- Metal bending

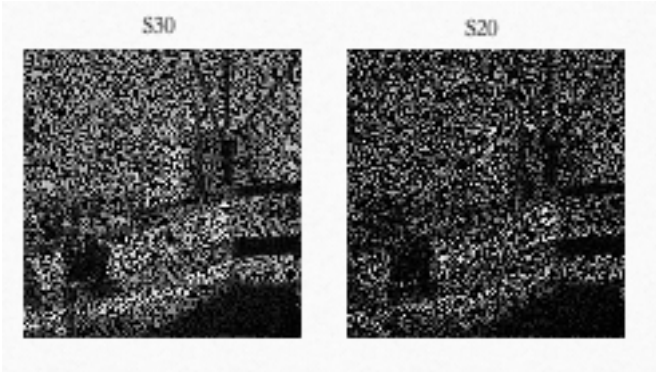
Technical Work

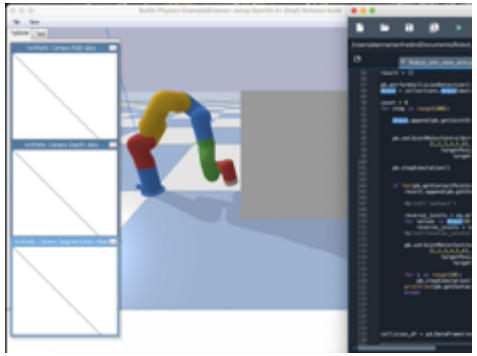
- State machine design
- Electrical harnessing
- Power calculations
- Solenoid force calculations
- Force transmission mechanisms

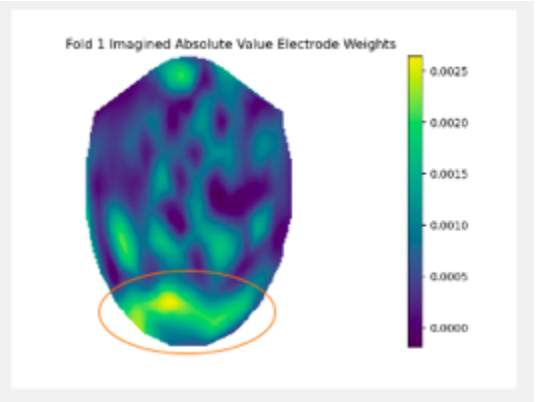


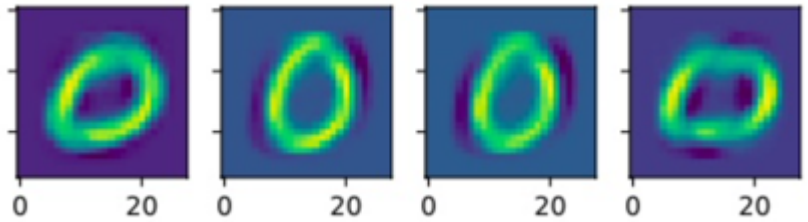
Machine Learning Projects

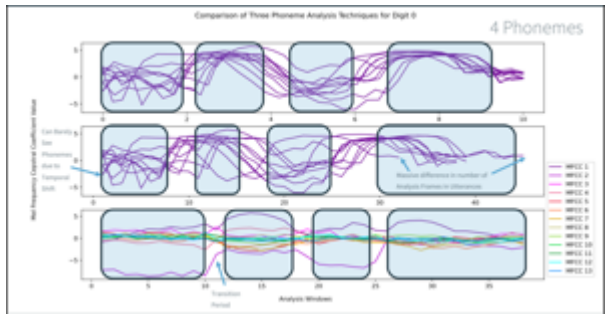


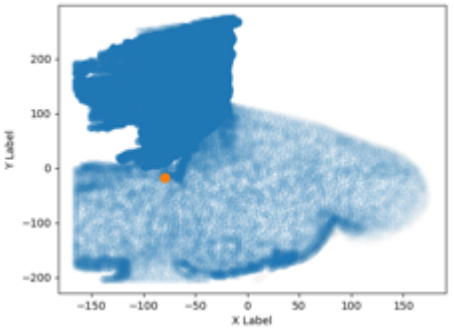








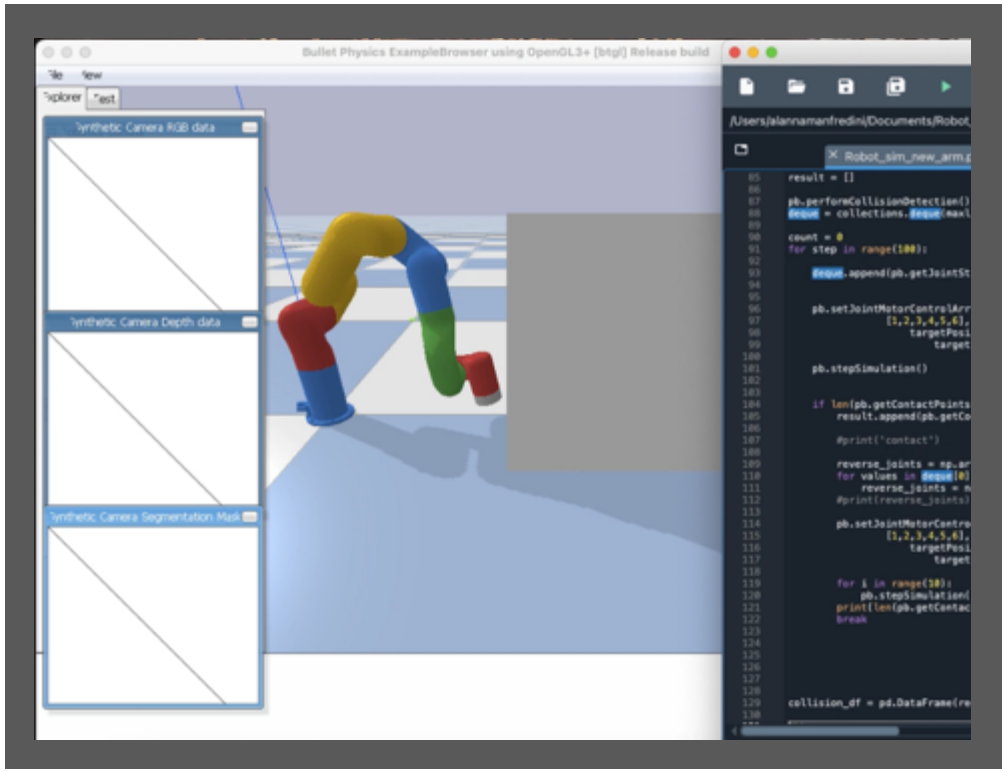




https://manfredini.design/machine-learning.html

Object Classification By Touch

- Used reinforcement learning to train a robot to interact with an object
- Collected location data about interactions
- Classified the object based solely off touch data



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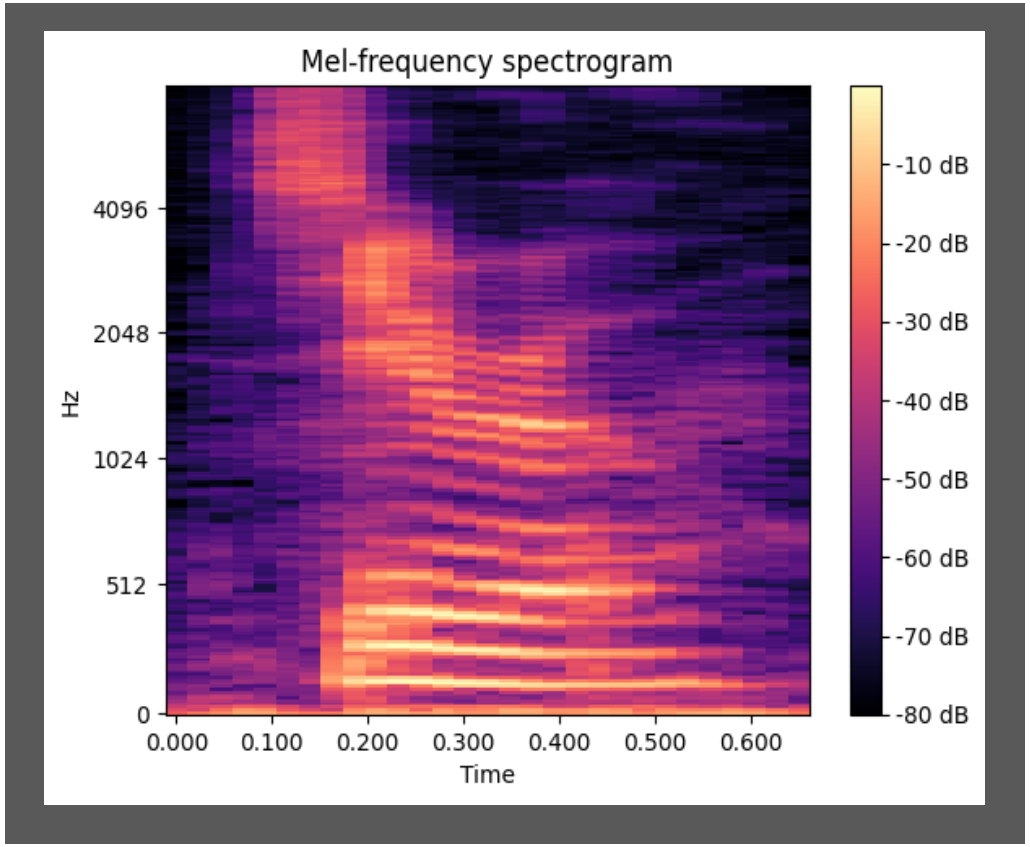
Adversarial Audio Patches

- Tricked a model into misclassifying audio by using a Neural Network to create a patch on an audio file
- Determined patch shapes and locations that were most effective at being undetectable to the human ear
- Trained a model to be robust against adversarial attacks



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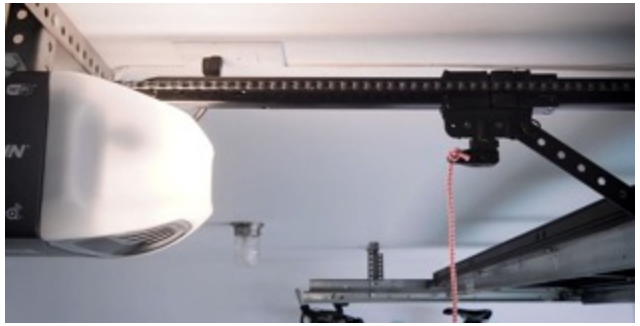
Tiller Design Projects

BioScout Space Efficient Package



Compact Chamberlain solution

ECG + Drug Delivery Arm

Paslode Nail Gun Attachment

KordTech Buttons

Aptera Motors

Individual Machine Design

- Designed robotic end effector heads for high volume soldering
- Designed vacuum heads for a cleanroom environment
- Managed vendors to design pick and place machines

Production Line Layout

Solar Panel Ownership (FAT)

Tesla Motors

Automated Storage and Retrieval (ASRS) Project

Autogenerating CAD

Entrance and exit buffer design

Cleanroom design

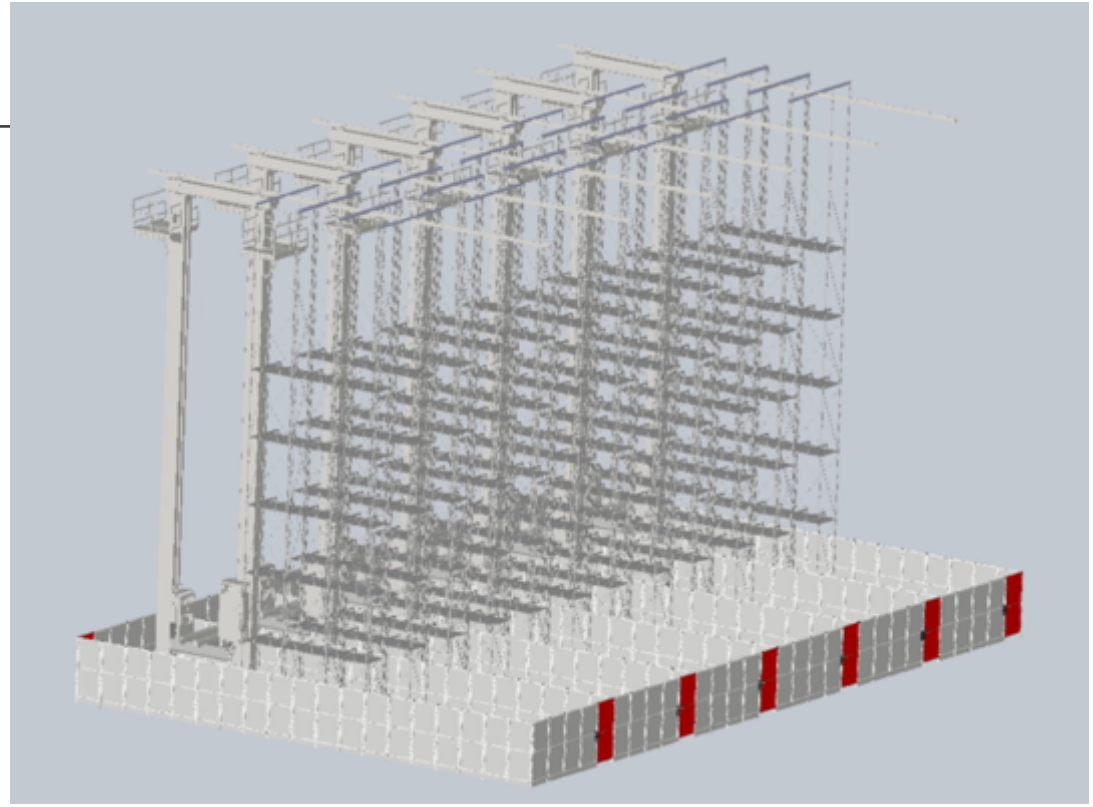
Material testing

Install plan

Autogenerating CAD

	Design Table	VBA - Human	VBA - Efficient	Python STL	.txt - Racking	.txt - Assy
No Errors	✗	✓	✓	✓	✗	✓
Space Representative	✓	✓	✓	✓	✓	✓
Fast	✓	✗	✗	✓✓	✓	✓
Good UI	✗	✓	✓	✓	✗	✓✓
Detailed	✗	✗	✗	✗	✓	✓
Editable	✓	✓	✓	✗	✓	✓

1. Change Excel File
2. Close Excel
3. Press Run on Python
    1. Python gets values from Excel and generates .txt
4. Press rebuild in SW file



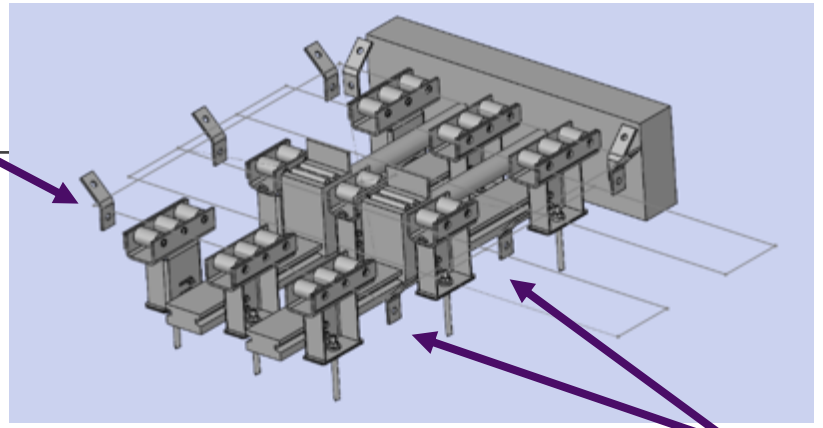
No Conveyance Configuration

Offload Conveyance

SAT Conveyance Concepts

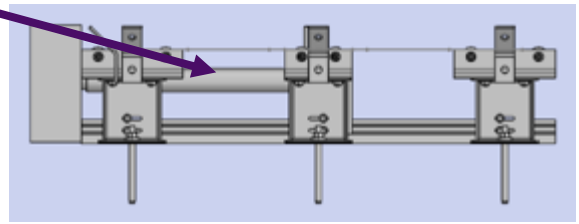
Initiated conveyance teams' design
Provided unique concept

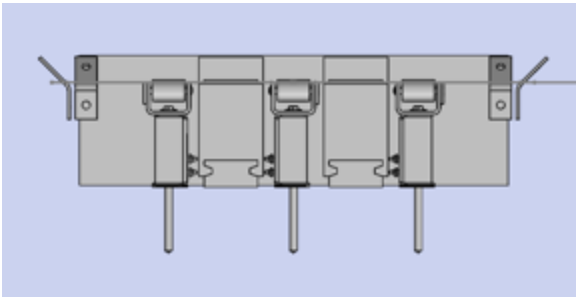
Simple Side Guides
to attach to 8020



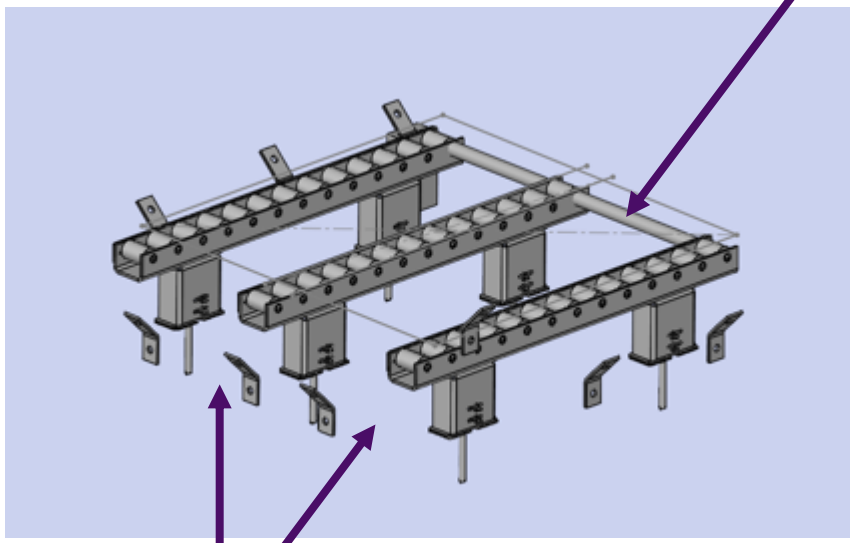
Linear Actuation to
reduce number of
motors

Space for Forks





Connected conveyance to
reduce number of motors



Space for Forks

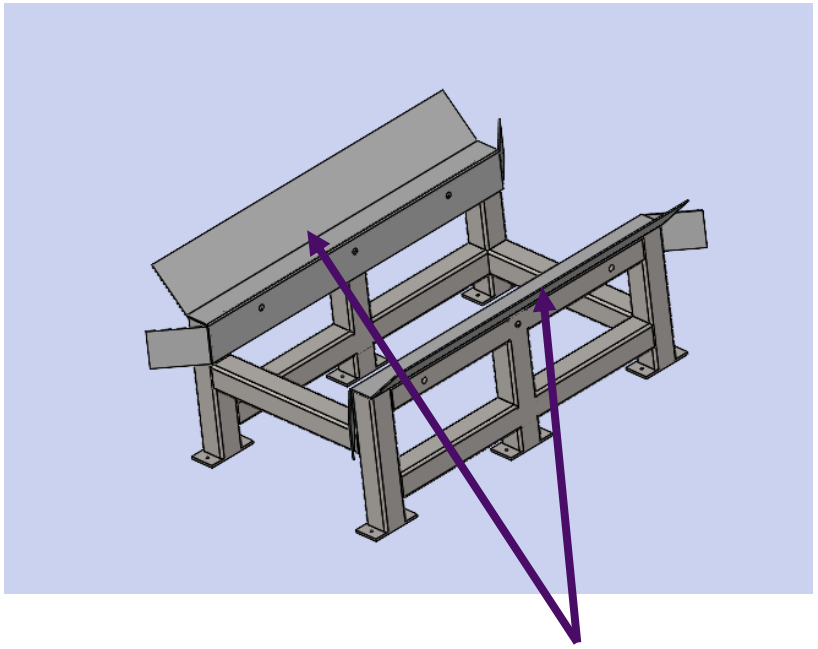
Parallel Conveyance

Perpendicular Conveyance

Offload Conveyance

FAT Table

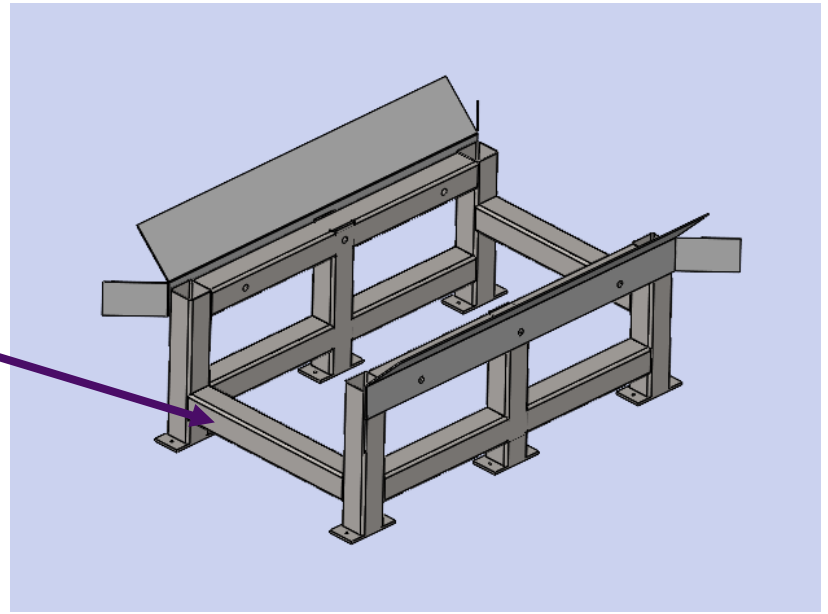
Internal Side Guide



Sheet metal guides

External Side Guide

Easy to manufacture table

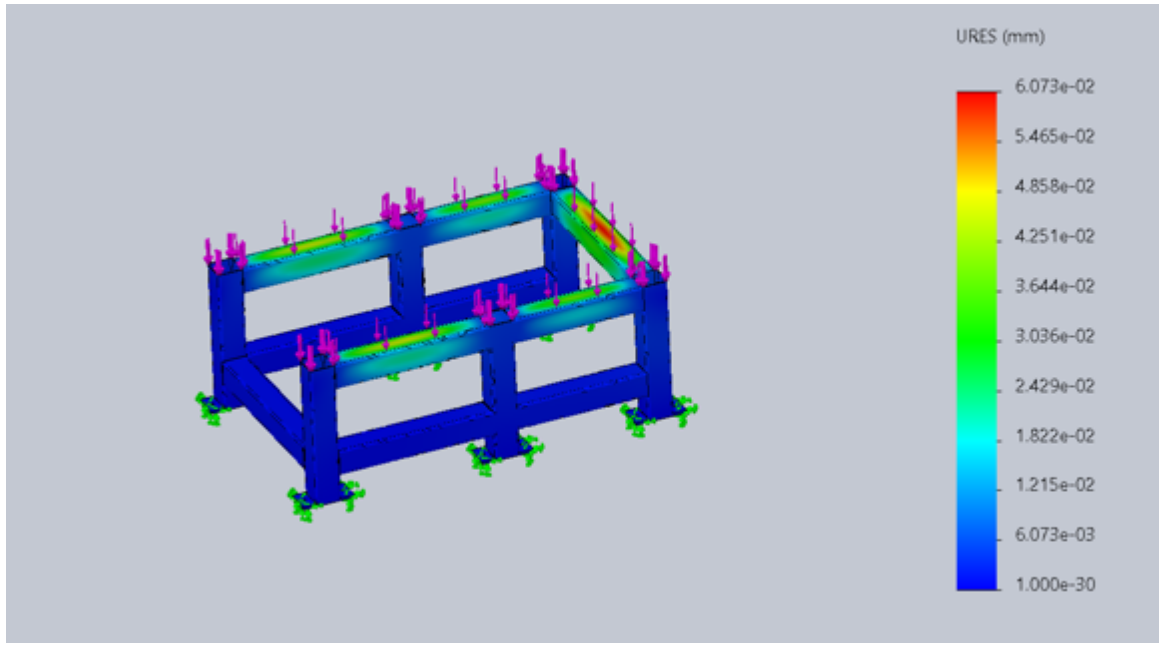


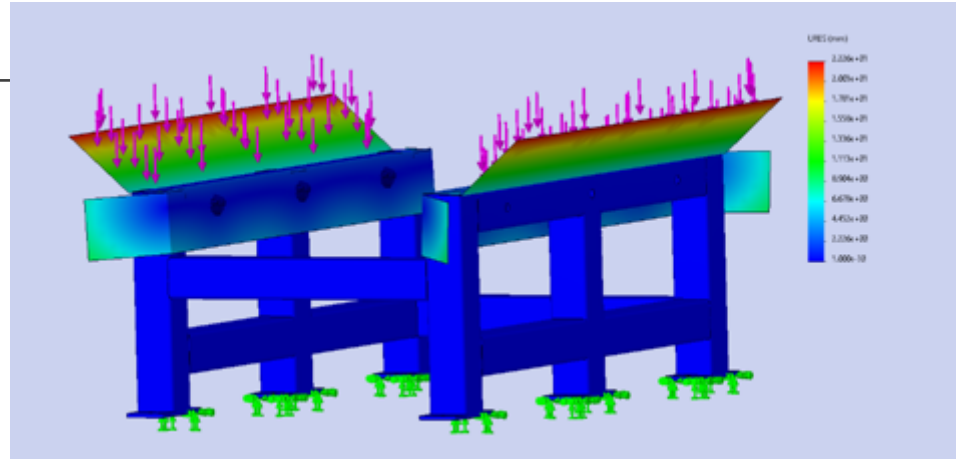
Offload Conveyance

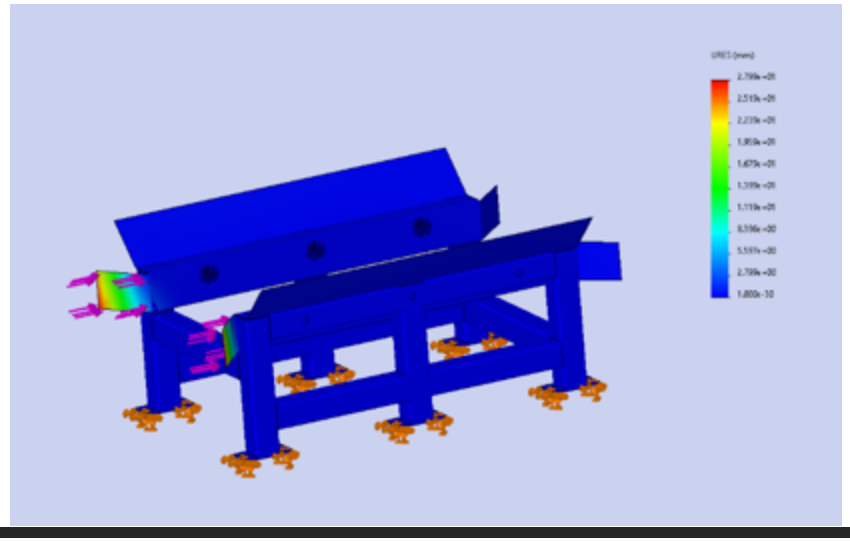
FAT Table FEA

Sturdy and Cheap
Side guides can be used elsewhere on crane

Loading (10000N)	Deflection (mm)
On Table	0.06
On Guides	22
Front of Guides	27







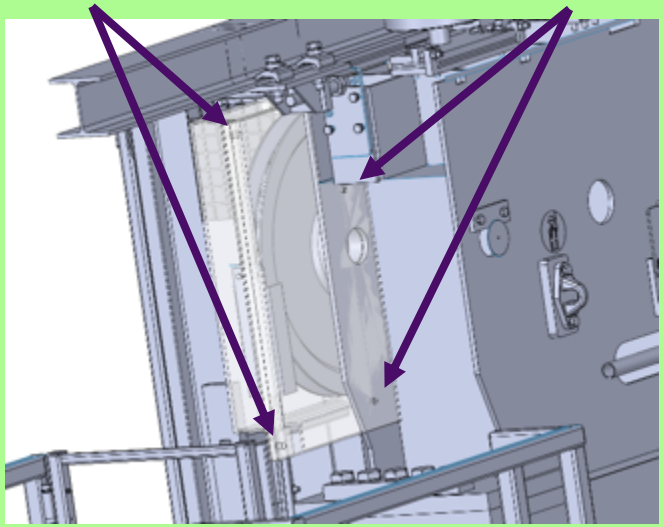
Cleanroom Designing

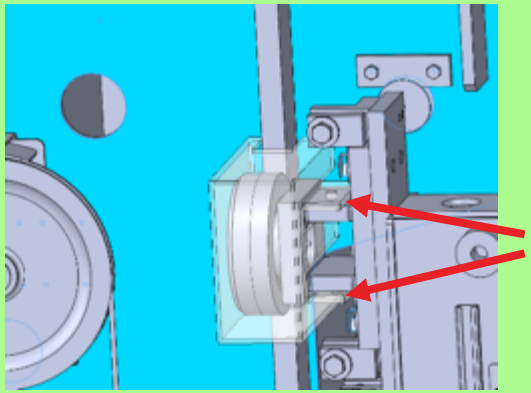
Covers

Initial designs:

Bolt Hole to Connect to Back Section

Bolt Hole to Connect to Mast





Bolt on to the top and bottom of Wheel Supports

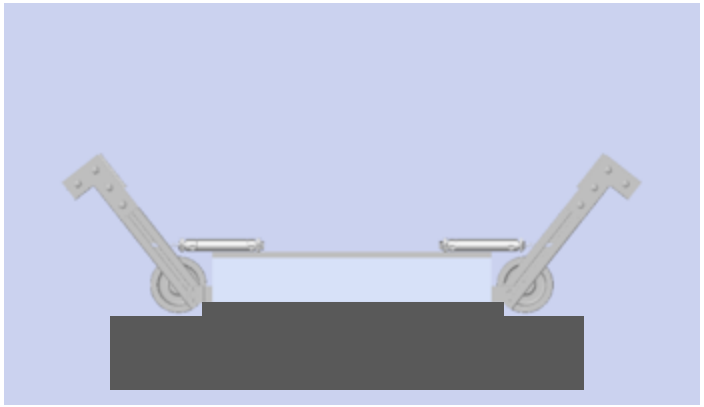
Crane Pulley Cover

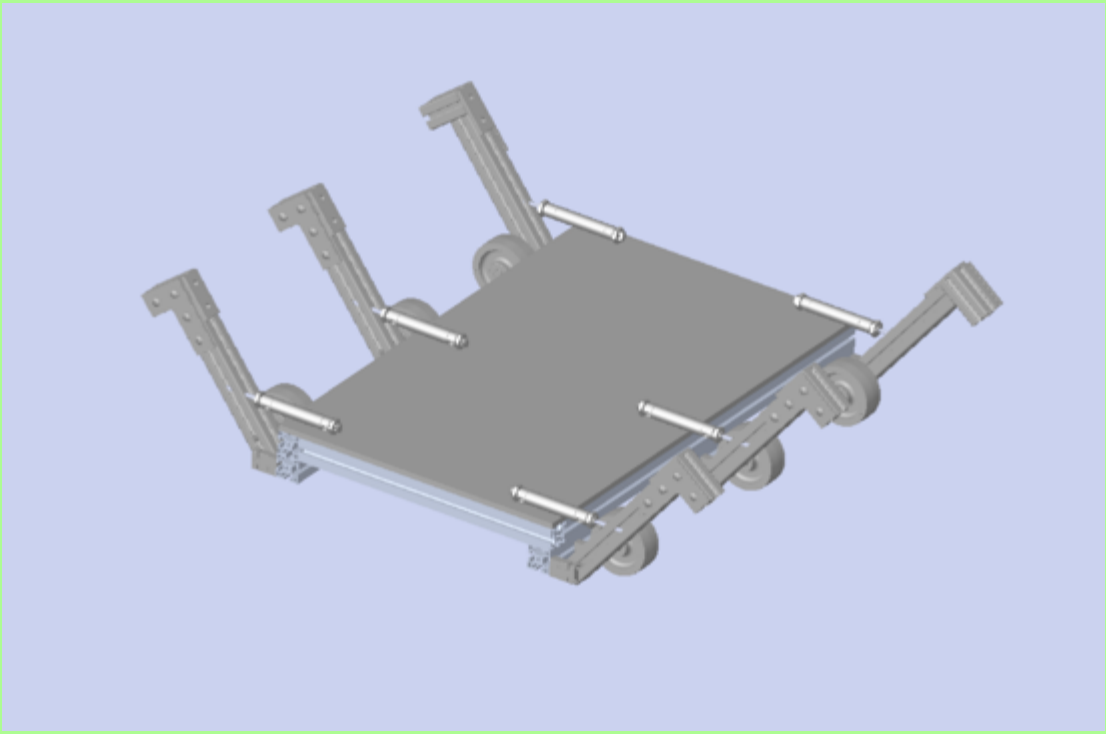
Dispersal To Vendors:

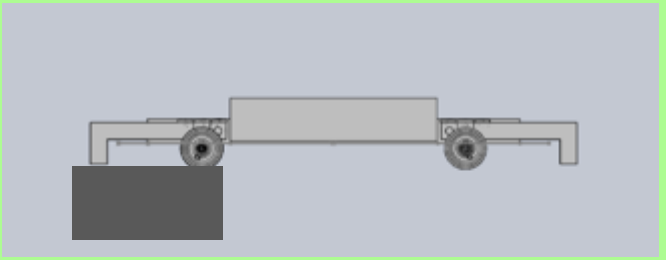
- Gave designs
- Design direction
- Checked progress

Cleanroom Designing

Racking Cleaner







Material Test

Material Selection

Tuff - n - Lastic	Non-Slip Liner	Safety Walk
$\mu = 0.6$ (Delrin)	$\mu \sim 0.32$ (Delrin)	$\mu > 0.6$
Vendor Recommended	Vendor Recommended	Used in Cell
Commercial Grade	Non adhesive	Heavy Duty
Rubber	Vinyl	Mineral
Salt Resistant	Slip resistant top and bottom	
Scratch Resistant		
Water Resistant		

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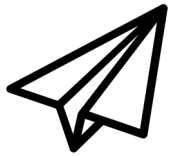

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