Engineering Portfolio

Ian Hudson

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Glenair Mechanical Eng Internship | May 2024 - August 2024 |

Objective: Work with the circular connector division to develop new 38999 connectors, respond to customer requests, and solutions to production issues of existing products.

- Create CAD models and engineering drawings
- Redline and adjust existing components
- Participate in design reviews for projects I was working on

Results:

- Used MIL-STD-38999, AS39029, MIL-STD-1560, and related AS specifications to create and modify Glenair products
- Designed shell size 25 interfacial seals, front insulators, and connector assembly for custom applications
- Worked with machinists and operators to ensure proper assembly of connectors and to learn how to best communicate instructions.
- Redlined engineering drawings
- Performed axial load testing per EIA standards
- Utilized SOLIDWORKS and CADKEY to create engineering drawings with GD&T, DCNs (change orders), Assembly Procedures, and Subassembly Procedures
- Prepared samples for EIA fluid immersion and age maintenance testing to certify new fluorosilicone vendors
- Created 40+ BOMS for new line of connector

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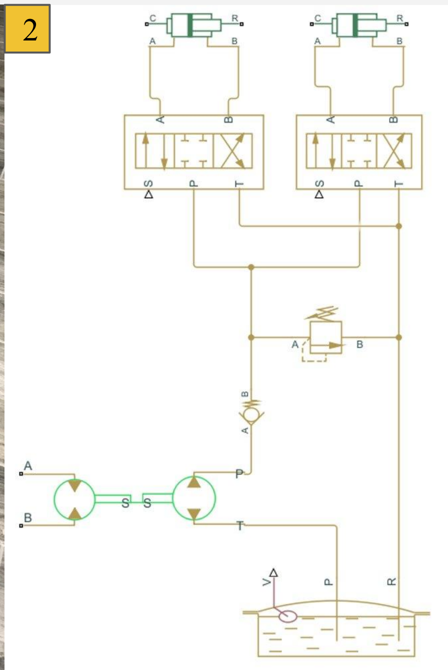
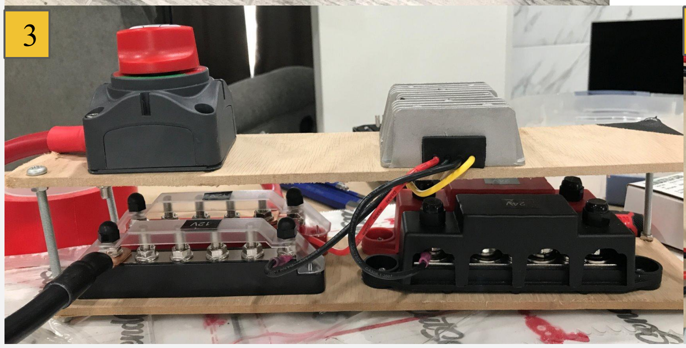
Hydraulically Powered Robot Arm | May 2023 - Present |

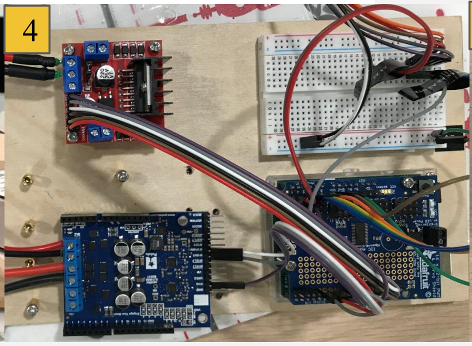
Objective: Design and construct a robotic arm that reflects the building methods used in Rose Float to be used as a demonstration and educational tool

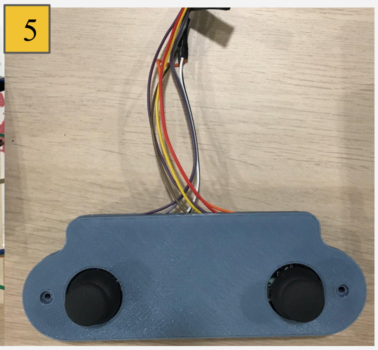
- Utilize hydraulic cylinders and have a fully functioning hydraulic system
- Implement inverse kinematic control



1. Assembled arm
2. Hydraulic system schematic
3. Power distribution system
4. Arduino + motor controllers
5. Joystick controller







Results:

- Completed mechanical and control system. Partial completion of hydraulic system.
  - 3 DOF arm with end actuator allowing for manipulation of objects in a 3 ft sphere
  - Inverse kinematic control of hydraulic cylinders through string pot feedback
  - Design and ordering of hydraulic system and components
- The project is currently still in progress due to pump and reservoir lead time from KTI

Technical:

- 500 psi system using: KTI 12V 3.0” OD Permanent Magnet Motor
- 2 1.25” bore, 4” cylinders controlled by 2 RexRoth 4 way, 3 position valves
- 5V, 12V, and 24V lines for hardware, motor, and pump respectively
- Arduino R4 used for control
- Welded ¼” carbon steel plate for arm structure

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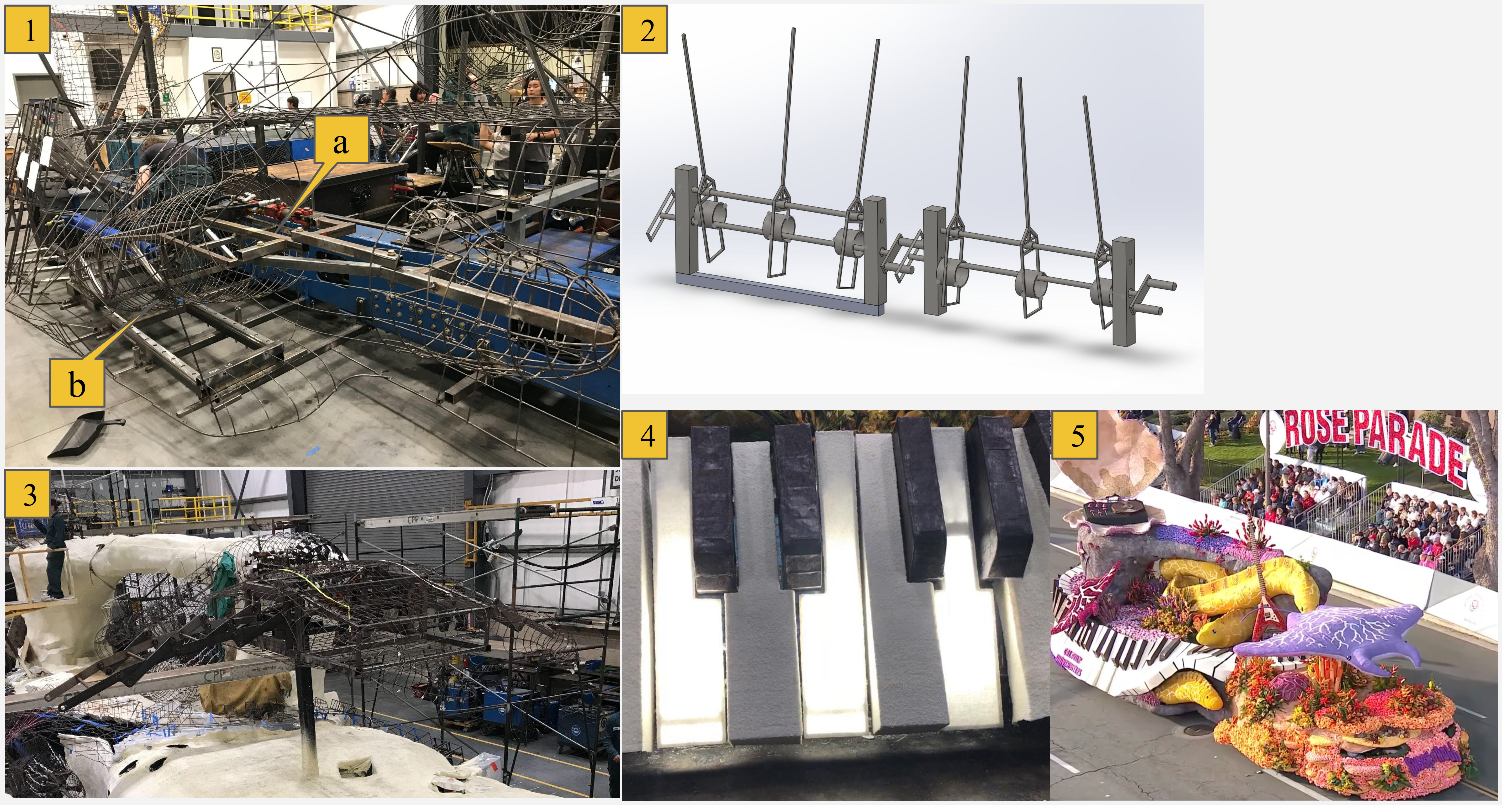
2024 CP Rose Float Mechanisms | March 2023 - January 2024 |

<u>Objective:</u> Design and build a mechanical systems to create movement on the Cal Poly 2024 Rose Parade Float

- Lead the construction team in the design and fabrication phases of mechanism development
    - Moving piano keys, manta ray wing flap and tilt, eel linear and head tilt motion, fin ripple, speaker
- Utilize pneumatics to sync movements of piano to music played by float



1. Eel mechanism before covering and decorating
    a. Head turn cylinder mech
    b. Linear rails for linear motion
2. CAD model of Fin Ripple mechanism
3. Mounted manta ray mech before covering and decorating
4. Piano key mech after covering decorating with lights installed
5. Completed float on parade route

<u>Results:</u>

- Lead the design process throughout the year, provided advice to team in mechanical design, and lead design reviews for each mechanism
- 5 functioning mechanisms, designed to withstand transport and parade day temperatures and vibrations
- Float won the Crown City Innovation Award for the most outstanding use of imagination, innovation and technology

<u>Technical:</u>

- Hydraulic system run at ~3000 psi
- Pneumatic system run at 50 psi
- 5 hydraulic cylinders, 1 hydraulic motor, 8 pneumatic cylinders
- Utilized Gilderfluke animation and control system

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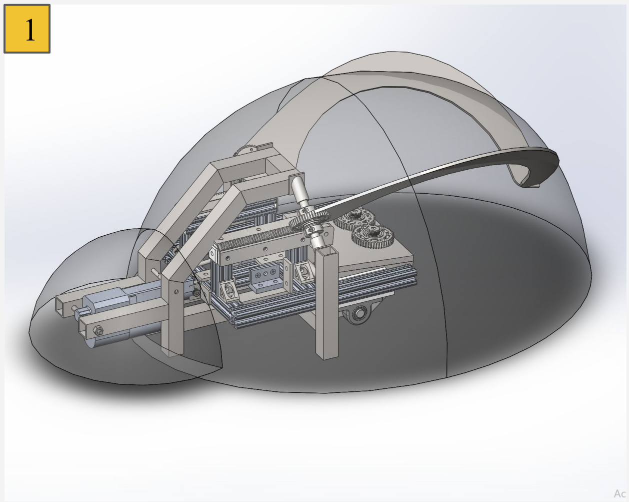
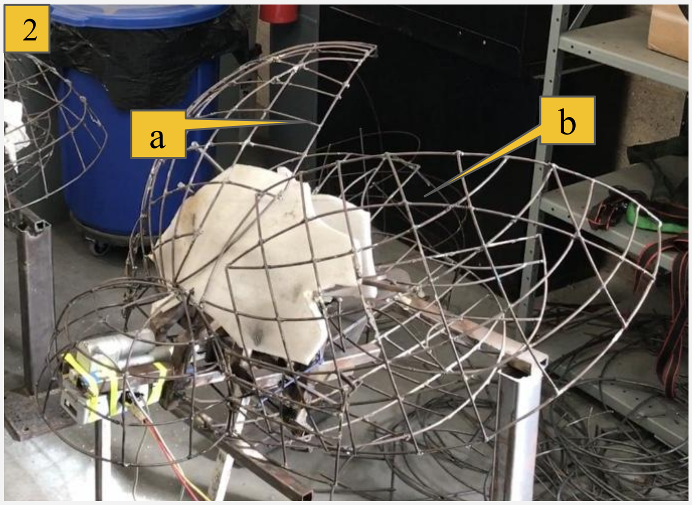
Rose Float Ladybug Animatronic | June 2022 - January 2023 |

Objective: Design and build a mechanized ladybug for the 2023 Rose Parade
- Obtain life-like shell and wing motion while minimizing motor/hydraulic components
- Manage a team to fabricate 2, 3ft long ladybugs by the end of november
- Work with other departments to integrate ladybugs into overall float design





1. CAD model
2. Ladybug before screening is put on
    a. Shell part
    b. Wing part
    c. 3D printed electronics enclosure
3. Finished and decorated ladybug

Results:
- 2 animatronic ladybugs that open shells and swings out wings
- Flexible mounting system that could be installed anywhere on the float allowing for greater artistic control
- Automated electronic system running on **arduinos**, requiring only 12V DC power
- Simplistic design, requiring only a single linear actuator for multiple animations
- **Design for manufacture** allowed for project to be finished 1 week ahead of schedule

Technical:
- Linear 8020 rail and linkage system allows for a single 180 lb linear actuator to unfold both wings and shells in a single motion
- 3ft long, 2.6 ft tall
- Welded carbon steel 1”x1” square tubing
- Plasma cut ¼” plates interface with wings

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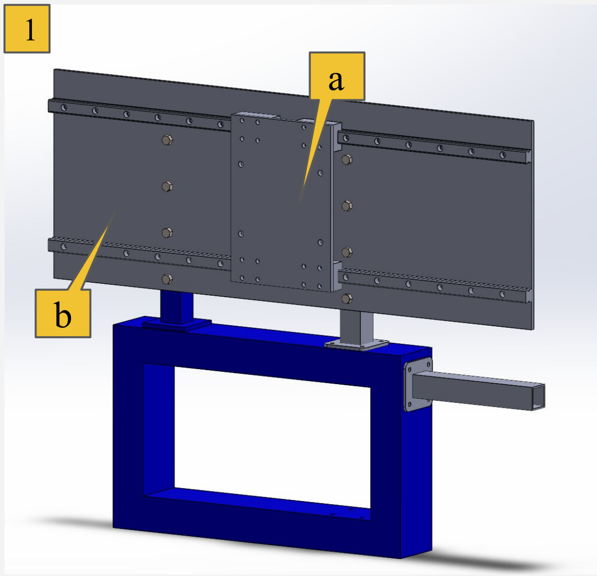
Rose Float Sliding Door System | November 2023 |

Objective: Design and build sliding doors for the float's diver compartments
- Allow for easy access and escape for divers in case of fire
- Create better opportunities for concealment than traditionally hinged doors
- Attach to existing float chassis without extensive modification



1. CAD model made in SOLIDWORKS
    a. Sliding carriage
    b. Base plate
    c. Measurements taken to minimize interference with other elements on float
2. View of right driver door with foam. Open and closed positions shown
3. View of left driver door in out position with decorations

Results:
- Fully functional doors that slide out of float
- Rose Float Tournament legal
- **Reusable design** for future use
- Easy to integrate into existing float profile and limits the unwanted interference of previous designs
- Praise from Tournament of Roses associates for unique design
- Allows for safer exit and entry in case of emergencies

Technical:
- Each door uses 2, 1.5" linear rails with 4 carriages riding on them
- Can support upwards of 120+ lbs at the farthest end of the door
- Secured with ⅜ grade 8 bolts
- Swappable plate design allows doors to be separated from the rail system and not permanently attached

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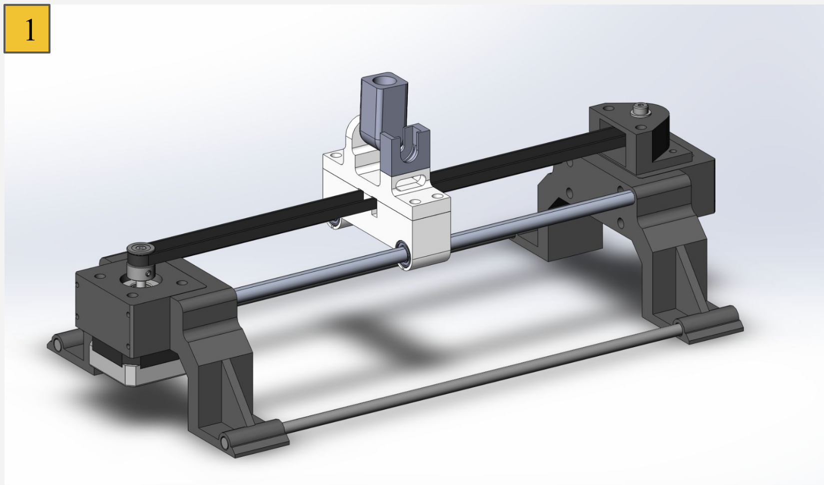
Inverted Pendulum Project | February 2023 - May 2023 |

Objective: Design and build a system to balance an upright stick using PID control
- Use discrete PID control to keep the stick with a mass on top upright
- Do so as cheaply as possible
- Learn how to properly tune a PID controller

1



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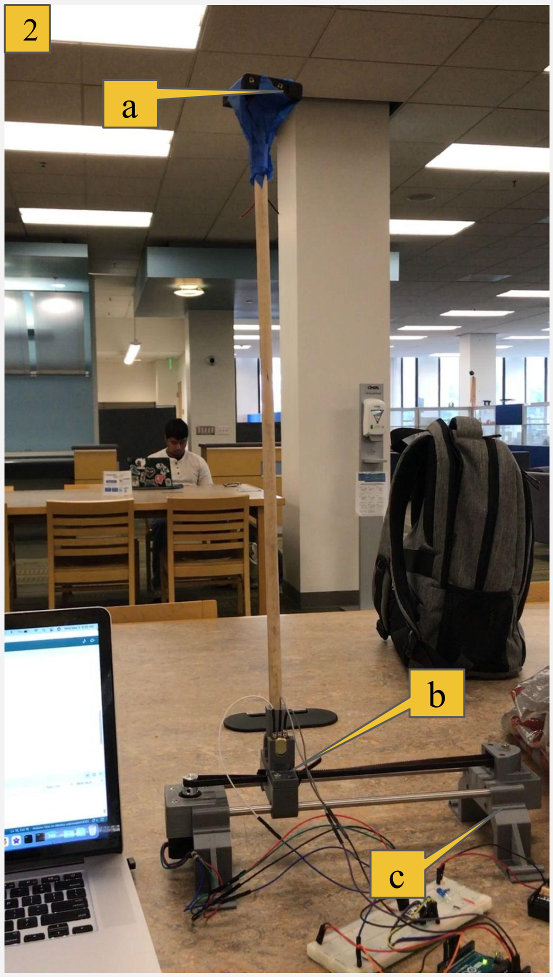

1. CAD model
2. Working prototype
   a. Mass on top of inverted pendulum
   b. Potentiometer
   c. Stepper motor

Results:
- Responsive controller that kept the pendulum upright under light side loading
- Within-budget design totaling ~$45
- **PID controlled system** through arduino
- Created impulse response graph to assist in tuning with the goal of reducing overshoot
- SIMULINK model of system

Technical:
- Arduino UNO control
- 10 Ohm potentiometer for error detection
- NEMA 14 stepper motor to drive system at ~6 in/sec
- Designed in SOLIDWORKS

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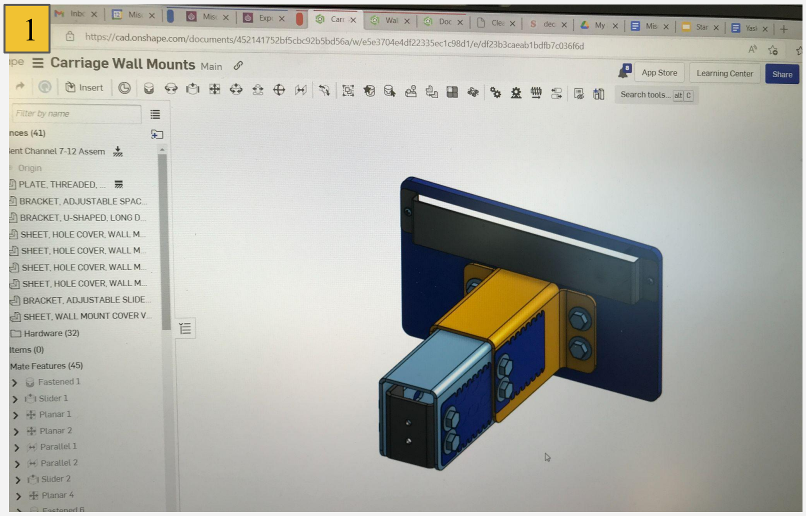
Miso Robotics Internship Projects | June 2022 - September 2022 |

<u>Objective:</u> Complete 2 projects over the summer to assist in the manufacture and testing of Miso Robotics' Flippy 2 robot

- Create modular 8020 fryer tub design that can replicate the dimensions of any existing fryer design
- Design a prototype for adjustable wall mounts to secure the Flippy 2 frame to the wall
- Assist around the lab and design other small parts for the Flippy 2 robot

1



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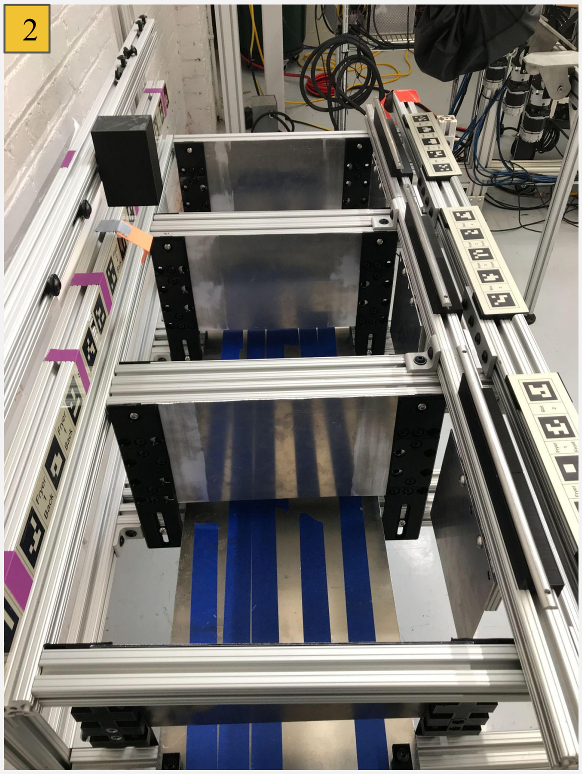

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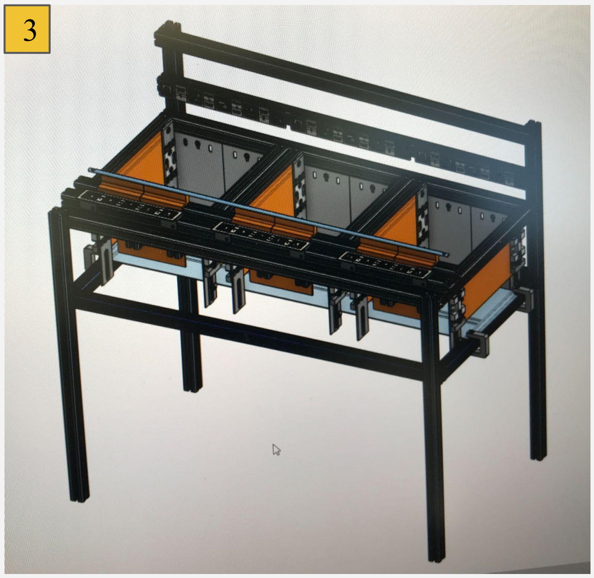

1. Adjustable Wall Mount CAD in Onshape
2. Assembled modular fryer mockup
3. 8020 mockup fryer CAD model in Onshape

<u>Results:</u>

- More accurate and modular fryer testing bed used for a Jack In the Box installation
  - Achieved more precise testing values for robot movements
- Created FDA compliant wall mounts that can reduce installation time and manufacturing cost through lower part count than previous versions
- Ensured parts are compliant with NSF/ANSI 51 standards
- Designed a reusable E-stop mount for a KFC installation in the UK that meets European standards
- Developed drawings for all parts in **Onshape**

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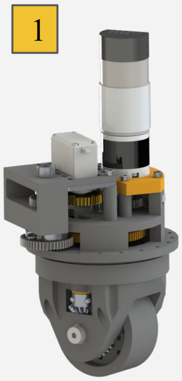
Robotic Swerve Drive Project | 2020 July - 2022 |

Objective: Design and build a powered caster drive system for FIRST Tech Challenge Robots

- The system was to utilize one or two 14 watt motors to drive a single wheel along its axis and rotate it around a separate vertical axis.
- Balance capability and cost by using FDM and design for cost practices

Version 1

1



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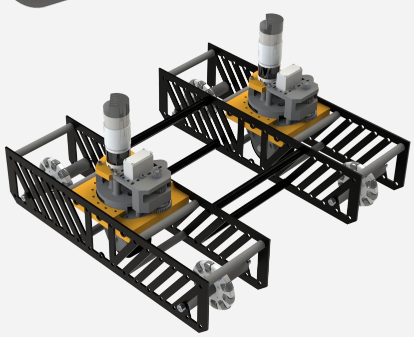
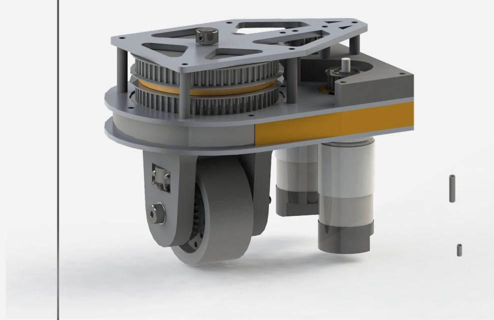


1. Traditional Swerve drive design driven by single motor and standard servo
2. Built assembly controlled through arduino and potentiometer
3. Version 1 integrated with robot drivetrain

Version 2

1



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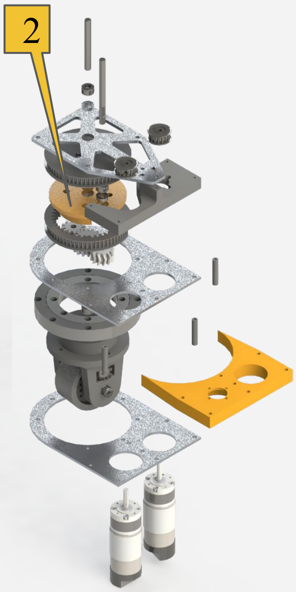

1. Swerve drive with differential mechanism that allows 2 motors to spin the wheel and rotate it
2. Utilizes a planetary gearbox for gear reduction and differential mechanism

Results:

- Drivetrain able to move up to 40 lb robot with designed gear ratios of 20:1
- Use of BOM and **design for cost practices** limited price to ~$200 for Version 1
    - Version 2 used more 3D printed parts, lower price to ~$150 even with an additional motor
- Larger form factor than expected, but integratable with most FIRST Tech Challenge Robots
- Experience using **BOMs, rapid prototyping**, and file organizational practice in SOLIDWORKS

Technical:

- Runs on 1-2 14 watt Andymark Orbital 20 brushed DC motors and/or a standard servo
- 375 no load RPM for max robot speed of 1.3 m/s
- Uses Pololu Dual G2 High-Power Motor Driver 18v18 Shield for Arduino and and Arduino Uno
    - Drives 2 motors and a servo
- Rotational control through servo PWM control or motor encoder

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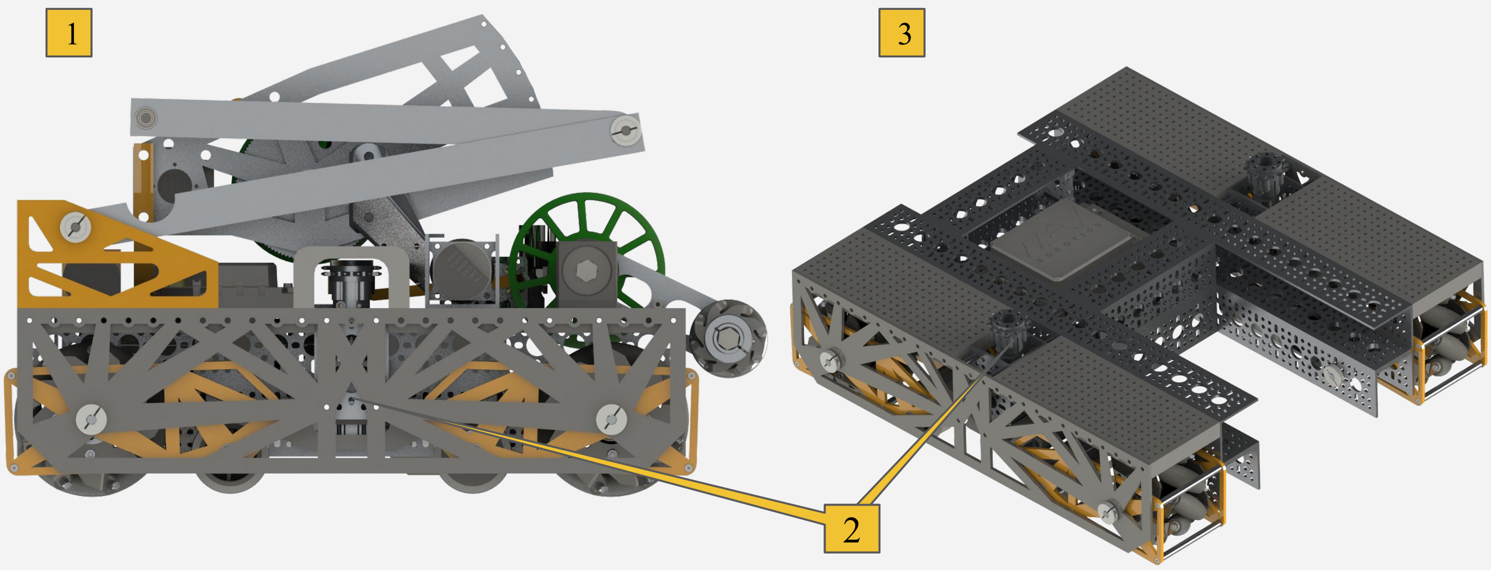
Robotic Butterfly Drive Project | June 2020 - September 2020 |

Objective: Design and build a multi-wheel drive system for FIRST Tech Challenge Robots

- The system was to switch between 2 sets of 4 traction and mecanum wheels
- Switch between sets of wheels using a 14 watt motor or servo
- Design robot around drivetrain to be manufactured (if possible)



1. Side view of robot CAD in SOLIDWORKS, additional subsystems were added to collect and launch 3.5” wiffle balls and allow robot to lift itself on a bar
2. Wheel Switching mechanism
   a. Sprockets attached to linear screws drive down wheel carriages when turned, pushing inner, smaller traction wheels down and raising outer mecanum wheels
3. Isometric view of drivetrain without additional subsystems

Results:

- Buildable drivetrain for future FIRST Tech Challenge competitions that optimizes traction and maneuverability
- **Wheel shifting within 1-2 seconds**
- Greater knowledge of FDM and SM techniques required to fabricate drivetrain
- 1000+ part **SOLIDWORKS model** with basic version control practice

Technical:

- Uses 4, 14 watt bevel gear driven motors to drive all 8 wheels
- 4, 2 wheel pods, each housing 2” traction and 4” mecanum wheel
- Uses 2 linear screws chained to a single motor to actuate wheel switching mechanism
- 18”x18”x6” envelope, fitting most desirable robot layouts
- Integration of 2 REV Control Hubs to drive 5 required separate motors

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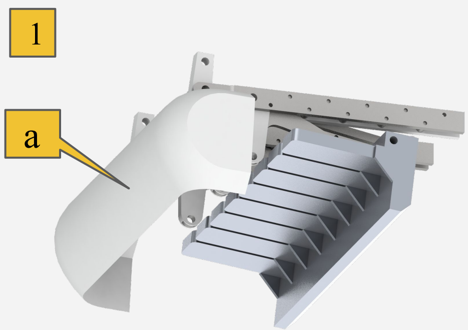
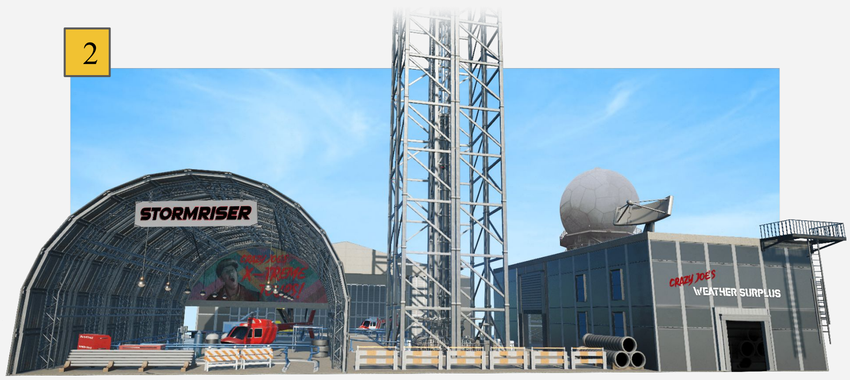
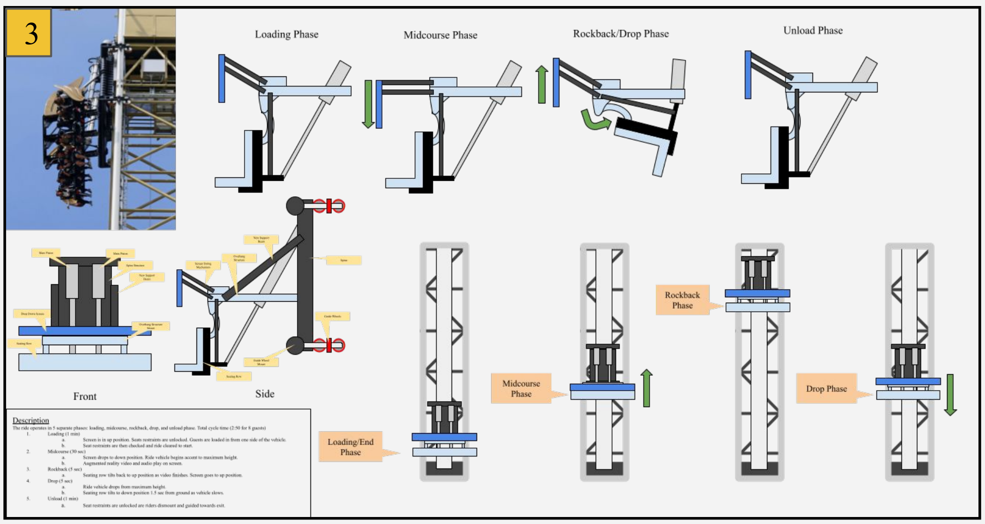
TEA Ride Design Competition | November 2021 |

Objective: Design and present a flat ride concept for a thrill centered theme park

- Must be themed to attract teenagers and provide a unique ride experience
- Possess a unique ride element
- Fit within a 13,000 sq ft site







1. CAD model of ride vehicle in SOLIDWORKS
    a. Drop down screen provides riders with unique experience when climbing the tower
2. 3D render of ride building and ride tower
3. Infographic of ride operation and ride vehicle breakdown
4. Site plan and ride layout

Results:

- **1st place in design competition**
- Multi page project proposal doc that includes:
    - Natural disaster theme and storyline
    - Feasibility plan

Technical:

- Used weighted design tables to select Intamin Sky Jump ride system
- Calculated ride cycle rate at 400 people/hr

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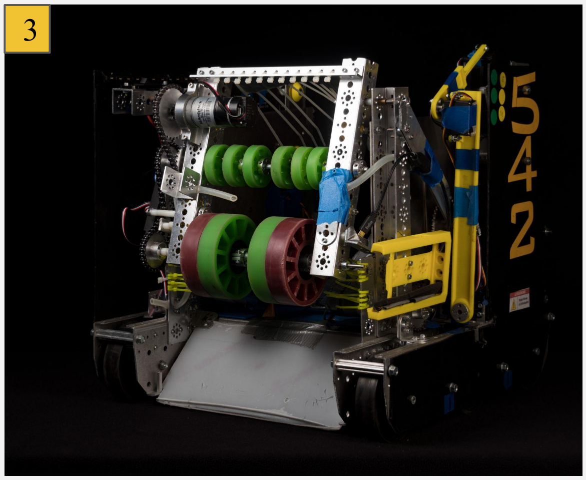
FIRST Tech Challenge Robots | September 2017 - July 2020 |

Objective: Design and build competition robots for FIRST Tech Challenge (FTC)
- Use the engineering design process, math, and other tools
- Utilize an **iterative design process** to improve on designs
- Ensure robots meet all system requirements mapped out at beginning of year



1. 2020 Season Robot, “Scorpion”
2. 2019 Season Robot, “Space Oddity”
3. 2018 Season Robot, “Stack Overflow”

Results:
- Successfully advanced to the FIRST World Championship in the 2019 and 2020 seasons
- Led a 15 person team from 2017-2020 to design 3 competitive robots
- Utilized **trade studies** and point time breakdowns to establish **system requirements** for robots
- Prototyped and tested subsystems before assembling them into a working robot
- **Led PDRs and CDRs** with industry professionals from Raytheon and SpaceX

Technical:
- Built using Tetrix, Andymark, Gobilda, and Acotobitcs build systems
- Uses REV Robotics hardware
- 18”x18”x18” size
- 8, 12V motors + up to 12, 5V servos

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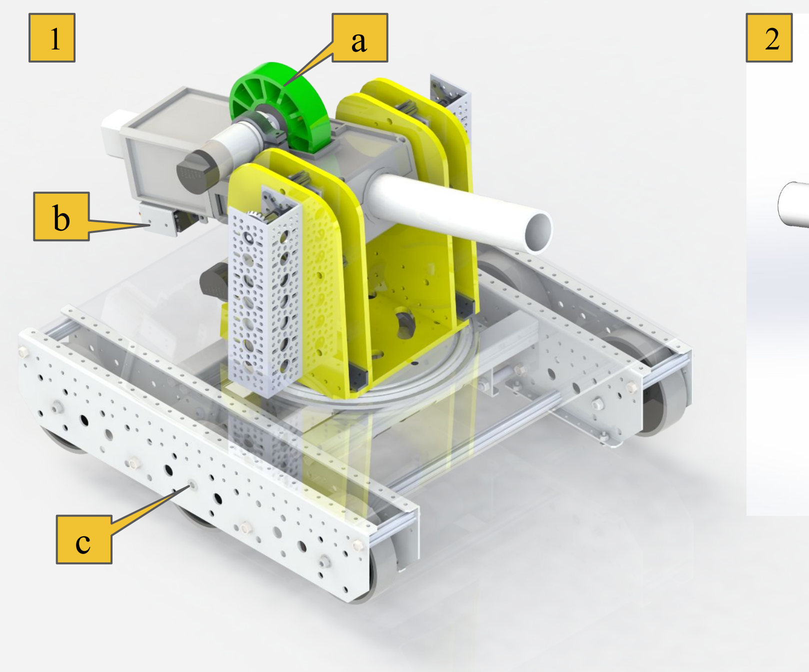
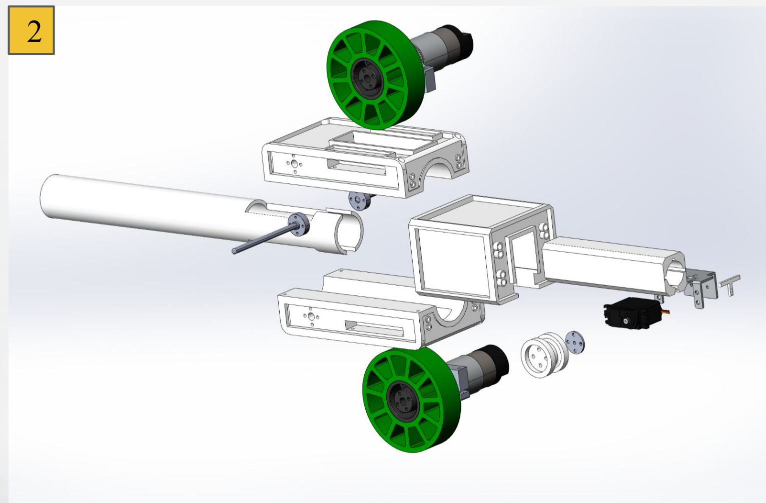
Robotic Nerf Tank

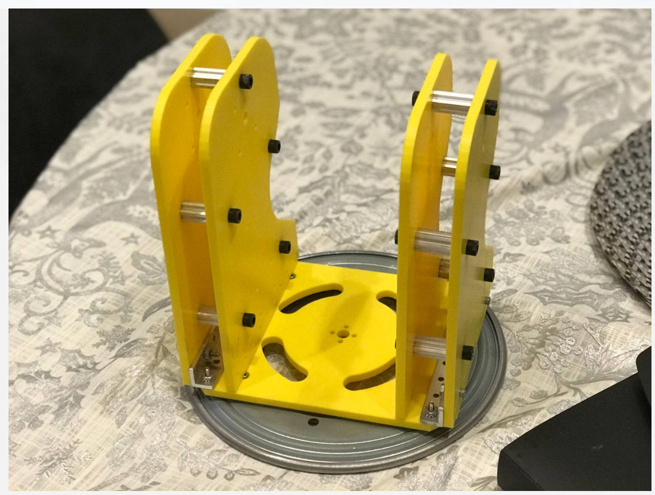
| January 2020 |

Objective: Design and build a robotic drivetrain and turret that can sheet nerf darts

- Drive ≥0.75 m/s
- Fire 2 darts/sec while have 60° of elevation
- Be under $300







1. CAD model made in SOLIDWORKS
    a. Flywheels
    b. Dart loading system
    c. Andymark Tilerunner drivetrain
2. Exploded view of turret assembly
3. Turret assembly in real life

Results:

- Tank met all system requirements and a demonstration was held in front of the class
- Used a **BOM** and supplier research to keep cost under $100

Technical:

- Uses 2, 12V DC motors to launch darts
- Continuous rotation servo and string system pushed darts through a magazine into the flywheels
- REV robotics hardware used programmed in Java

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