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VEX-U Robotics

Rachel Meyer
Olivet Nazarene University, rrmeyer22@gmail.com

Coby Mollema
Olivet Nazarene University, cobym8@gmail.com

Kalvin Quackenbush
Olivet Nazarene University, kalvinquack@gmail.com

Senior Project Final Presentation
2022-04
VEXU Robotics

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Members: Kalvin Quackenbush, Rachel Meyer, Jacobus Mollema
Faculty Mentor: Dr. Manjarrés

Special Thanks To

Olivet Robotics Club

Kollin Gallegos

Ricky Nyguen

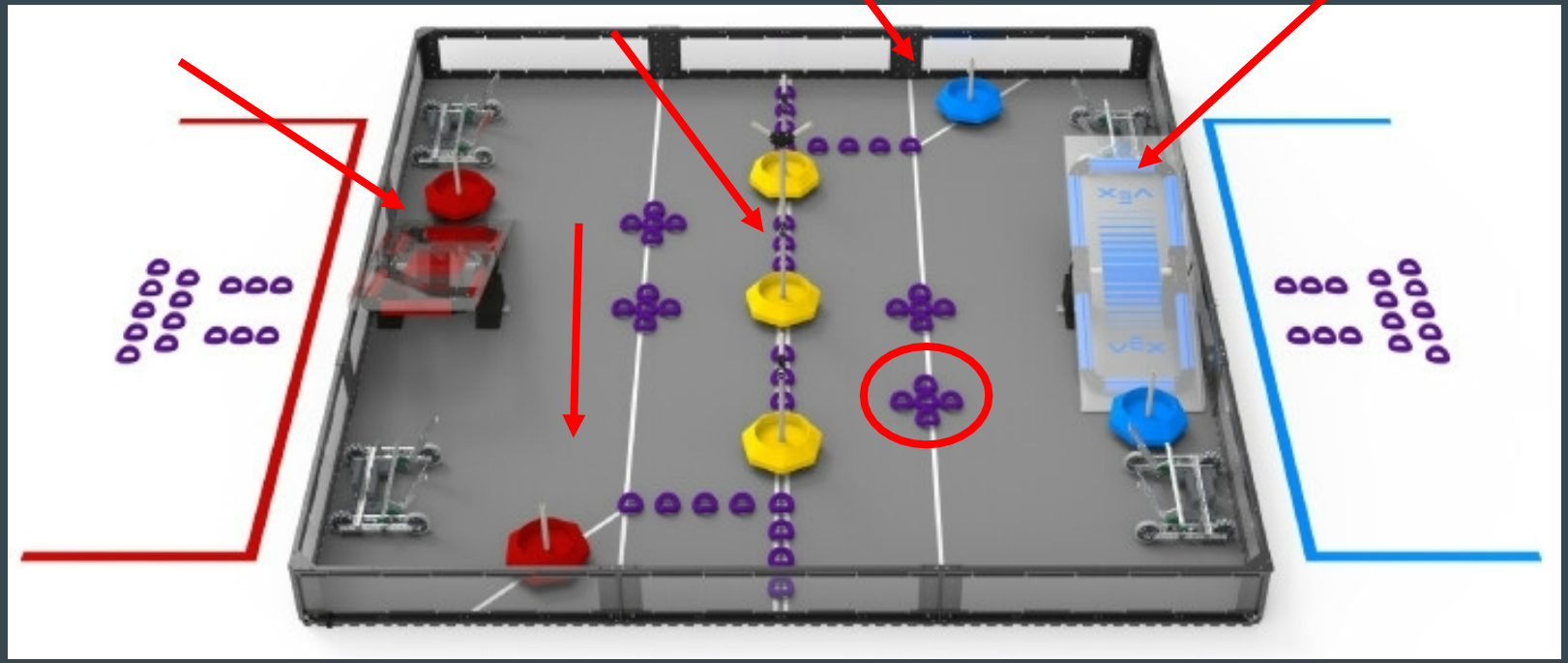
Dr. Manjarrés

Sponsor Background

ONU Robotics:

- Located at Olivet Nazarene University
- Founded in 2018 by the Olivet Nazarene Engineering Dept.
- Focuses on VEXU competitions
  - Turning Point (2018-2019)
  - Tower Takeover (2019-2020)
  - Change Up (2020-2021)

Tipping Point (2021-2022)



Need Statement

“Build two functioning robots capable of performing in the 2022 VEX Robotics Competition: Tipping Point”

Design Objectives:

- Highly reliable
- Easily repairable
- Durable design
- Cost efficient

Functional Requirements

Large Robot:

- Contain a drivetrain that can a max speed of 300 RPM
- Must lift two 3.7 lbs goals off the ground
- Must lift one 3.7 lbs goal above 19”
- Must contain and autonomous routine to run tasks independently from the driver

Small Robot:

- Contain a drivetrain that can reach a max speed of 400 RPM
- Must lift one 3.7 lbs goal off the ground
- Needs to intake the oblong rings from the playing field
- Needs to score the rings either on or in the mobile alliance goal

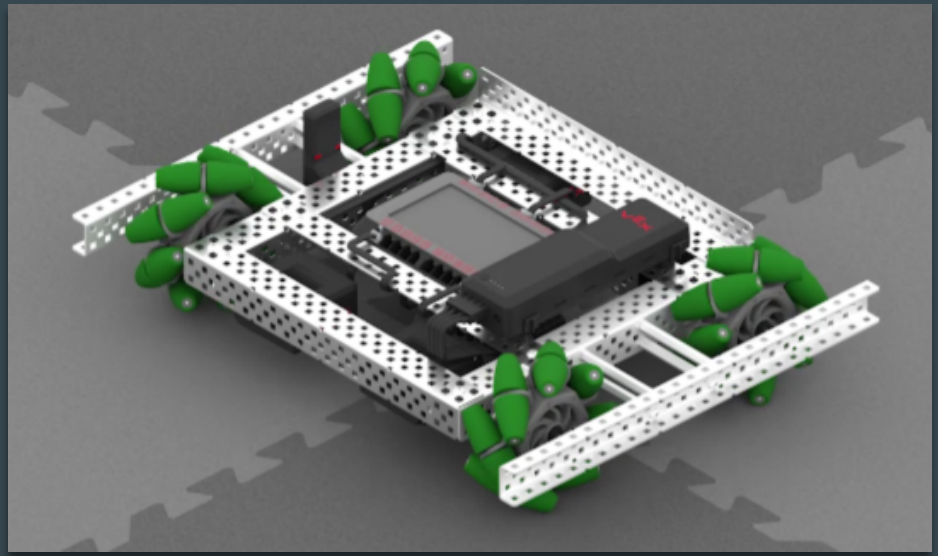
Design Constraints

- Both robots may only be built by:
  - Official VEX parts
  - Materials fabricated by the team
  - Commercially available fasteners and springs
  - A legal electronics system
- One robot must be smaller than 24” x 24” x 24” at the beginning of the match
- One robot must be smaller than 15” x 15” x 15” at the beginning of the match
- There shall be no form of communication between the two robots

- Both robots must not exceed a budget over $1000 USD
- Both robots must be safe to work with

Design Alternatives: Drivetrain

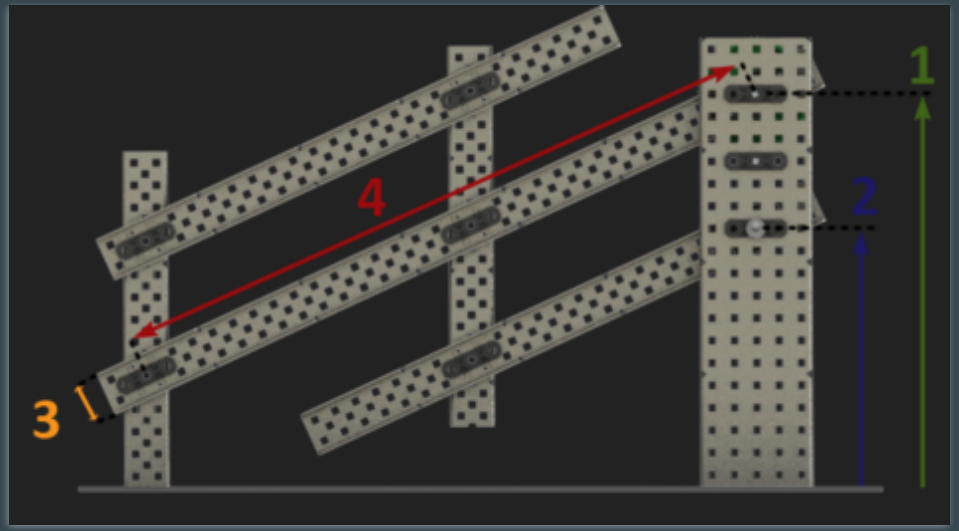
- X-Drive
- H-Drive
- 4-Motor Standard Drive
- Mecanum Drive
- 2-Motor Drive



Tank Drive. VEX Drivetrains - BLRS Wiki. (n.d.). Retrieved December 15, 2021, from https://wiki.purduesigbots.com/hardware/vex-drivetrains

Design Alternatives: Lifts

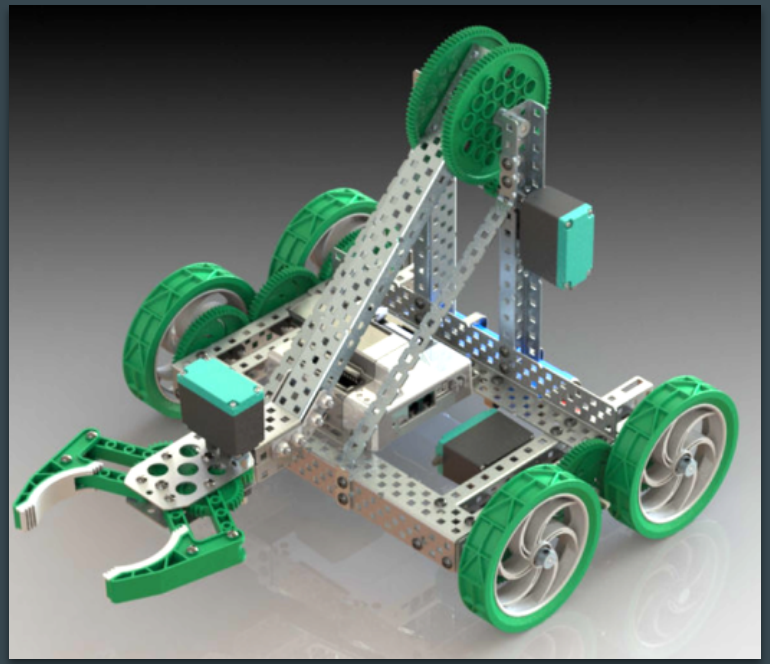
- Scissor Lift
- 4-Bar Lift
- 6-Bar Lift
- Lever Lift



JesseCRN. (2014, February 14). *Formulas used in VEX robotics*. VEX Forum. Retrieved December 15, 2021, from https://www.vexforum.com/t/formulas-used-in-vex-robotics/24322/9

Design Alternatives: Intake

- Elevator
- Claw
- Sweeper
- Escalator



Free CAD designs, Files & 3D models: The grabcad community library. Free CAD Designs, Files & 3D Models | The GrabCAD Community Library. (n.d.). Retrieved December 15, 2021, from https://grabcad.com/library/vex-clawbot-1

Large Robot Decision Matrix: Drivetrain

Evaluation Criteria	Multiplier	X-Drive	H-Drive	4 Motor Standard	Mechanum Wheels	2 Motor Drive
Speed	3 (extremely important)	1(better than average)	0 (average)	1(better than average)	-1 (worse than average)	-1 (worse than average)
Strafe	1 (normal)	1(better than average)	1(better than average)	-1 (worse than average)	1(better than average)	-1 (worse than average)
Force	3 (extremely important)	0 (average)	1(better than average)	1(better than average)	1(better than average)	-1 (worse than average)
Turnability	1 (normal)	1(better than average)	-1 (worse than average)	0 (average)	1(better than average)	-1 (worse than average)
Weight	3 (extremely important)	1(better than average)	1(better than average)	1(better than average)	-1 (worse than average)	1(better than average)
Buildability	1 (normal)	-1 (worse than average)	1(better than average)	1(better than average)	1(better than average)	1(better than average)
Total		5	7	9	4	4

*Numbers based on measurements gathered

from video provided below

https://www.youtube.com/watch?v=Py14YTHCth0&t=298s *

Small Robot Decision Matrix: Drivetrain

Evaluation Criteria	Multiplier	X-Drive	H-Drive	4 Motor Standard	Mechanum Wheels	2 Motor Drive
Speed	3 (extremely important)	1(better than average)	0 (average)	1(better than average)	-1 (worse than average)	-1 (worse than average)
Strafe	3 (extremely important)	1(better than average)	1(better than average)	-1 (worse than average)	1(better than average)	-1 (worse than average)
Force	3 (extremely important)	0 (average)	1(better than average)	1(better than average)	1(better than average)	-1 (worse than average)
Turnability	1 (normal)	1(better than average)	-1 (worse than average)	0 (average)	1(better than average)	-1 (worse than average)
Weight	1 (normal)	1(better than average)	1(better than average)	1(better than average)	-1 (worse than average)	1(better than average)
Buildability	3 (extremely important)	-1 (worse than average)	1(better than average)	1(better than average)	1(better than average)	1(better than average)
Total		5	9	7	6	4

Large Robot Decision Matrix: Front Lift

Evaluation Criteria	Multiplier	Scissor Lift	4-Bar Lift	6-Bar Lift	Lever Lift
Center of Gravity	3 (extremely important)	1(better than average)	0 (average)	1(better than average)	1(better than average)
Outreach	3 (extremely important)	-1 (worse than average)	1(better than average)	-1 (worse than average)	-1 (worse than average)
Force	3 (extremely important)	1(better than average)	1(better than average)	1(better than average)	1(better than average)
Size	2 (very important)	0 (average)	0 (average)	1(better than average)	1(better than average)
Lift Height	3 (extremely important)	0 (average)	0 (average)	-1 (worse than average)	-1 (worse than average)
Total		5	6	1	2

Small Robot and Large Robot Decision Matrix: Back Lift

Evaluation Criteria	Multiplier	Scissor Lift	4-Bar Lift	6-Bar Lift	Lever Lift
Center of Gravity	3 (extremely important)	1(better than average)	0 (average)	-1 (worse than average)	1(better than average)
Outreach	1 (normal)	-1 (worse than average)	1(better than average)	1(better than average)	-1 (worse than average)
Force	3 (extremely important)	1(better than average)	1(better than average)	0 (average)	1(better than average)
Size	3 (extremely important)	0 (average)	0 (average)	-1 (worse than average)	1(better than average)
Lift Height	1 (normal)	0 (average)	0 (average)	1(better than average)	-1 (worse than average)
Total		5	4	-4	7

Small Robot Decision Matrix: Ring Intake

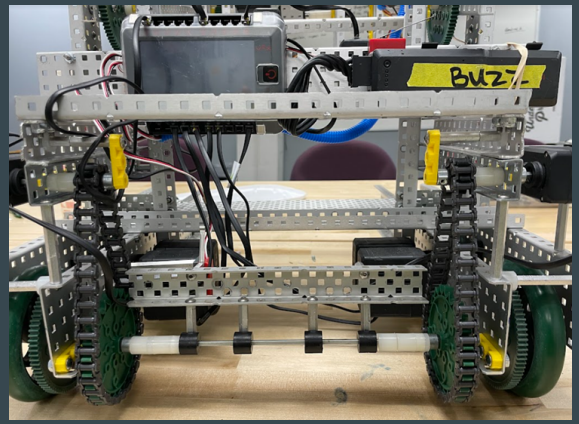
Evaluation Criteria	Multiplier	Elevator	Claw	Sweeper	Escalator
Speed of Intake	3 (extremely important)	1 (better than average)	-1 (worse than average)	0 (average)	1 (better than average)
Reliability	3 (extremely important)	0 (average)	1 (better than average)	1 (better than average)	0 (average)
Time of Scoring	2 (very important)	1(better than average)	-1 (worse than average)	0 (average)	1 (better than average)
Motors Needed	1 (normal)	-1 (worse than average)	1 (better than average)	1 (better than average)	1 (better than average)
Total		4	-1	4	6

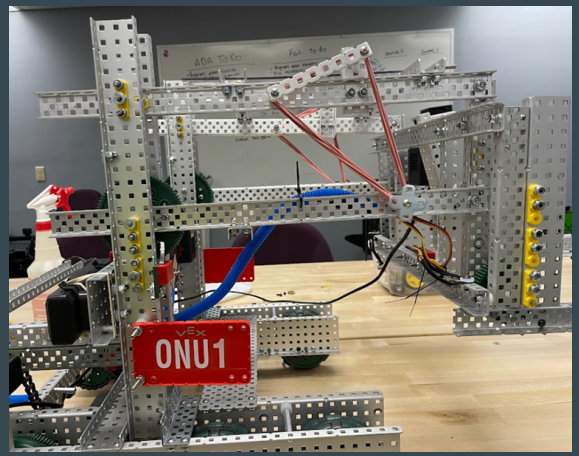
Broader Impacts of Our Design

- Influencing younger generations and future teams participating in robotics competitions
- Safety of those who physically handle the robots.
  - Watch for sharp materials, electrostatic shock, rotating mechanisms, and pinching points
- Economic impact on the school as our sponsor.
  - Make sure we as a team use these funds efficiently and that we buy materials and parts that we need, to not waste money and to be trusted in the future with a given amount of money

Large Robot Final Design

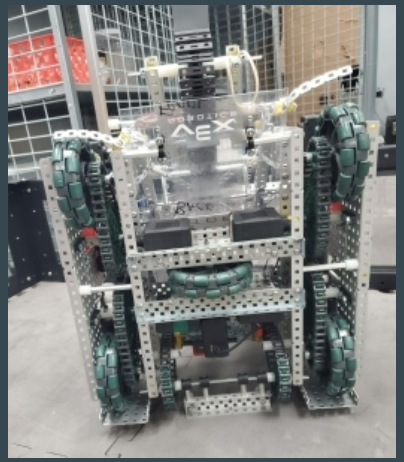
- Common parts
  - Four bar lift in the front
  - Lever lift in the back
  - 4 motor standard drivetrain
- Specialized parts
  - Tension rubber band supports
  - Tooth grabber for goals
  - Geared up drivetrain for more acceleration
  - Unfoldable parts to reach design constraints

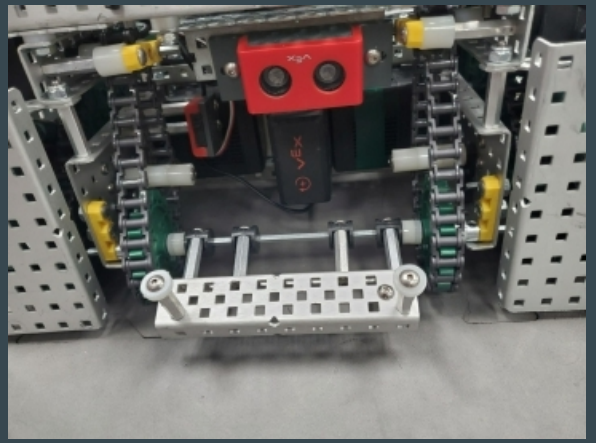




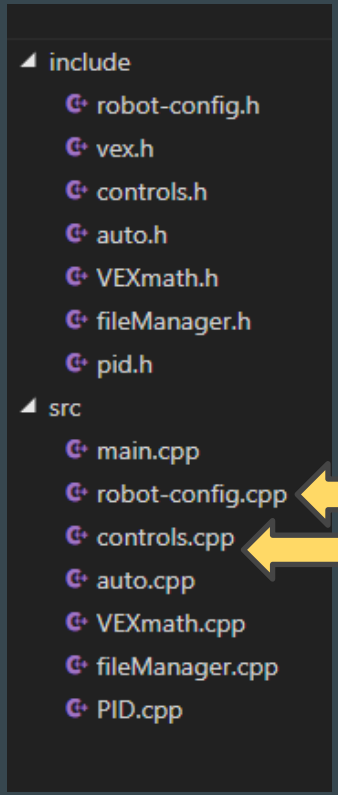
Small Robot Final Design

- H-drive drivetrain
- One-bar lift
- Folded elevator intake
- Ultrasonic rear sensor





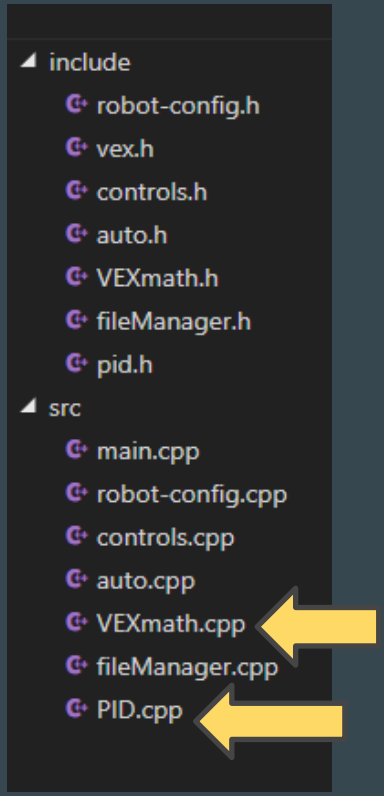
Autonomous and Driver Code

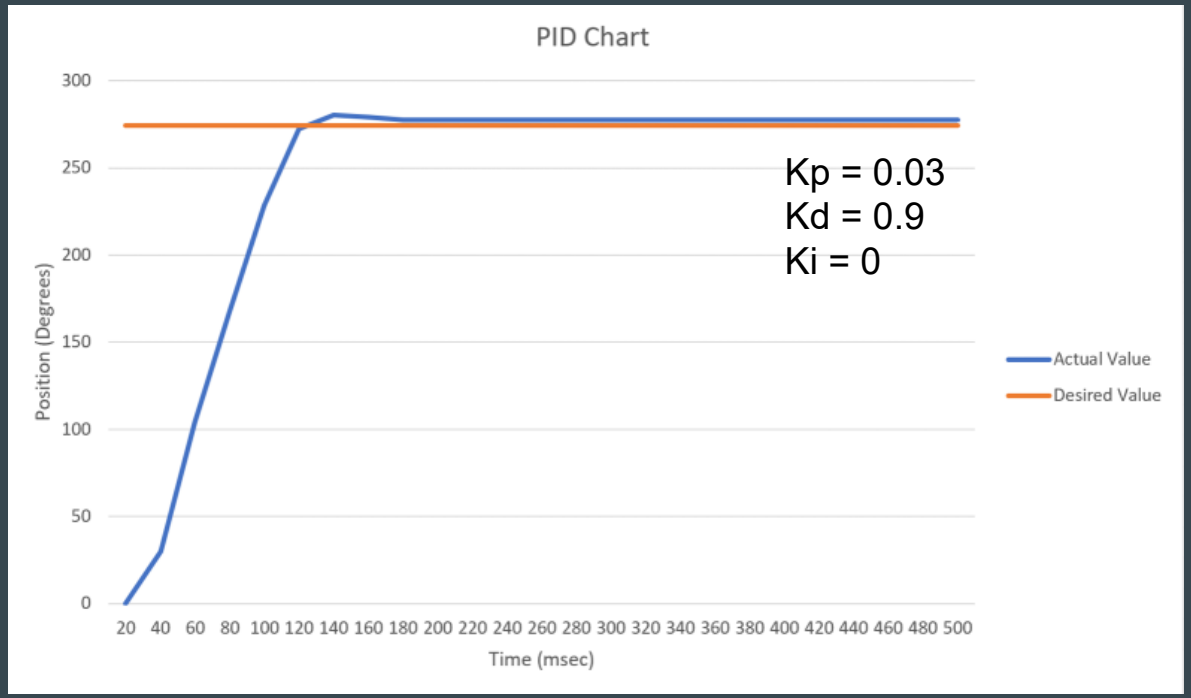



```
// VEXcode device constructors
controller Controller1 = controller(primary);
motor leftMotorA = motor(PORT15, ratio6_1, true);
motor leftMotorB = motor(PORT16, ratio6_1, false);
motor_group LeftDriveSmart = motor_group(leftMotorA, leftMotorB);
```

```
int _arcadeDrive_(){
  //indicator();
  if(RemoteControlCodeEnabled && !drive_state){
    int drivetrainLeftSideSpeed =
          Controller1.Axis3.position() + Controller1.Axis1.position();
    int drivetrainRightSideSpeed =
          Controller1.Axis3.position() - Controller1.Axis1.position();
    //get joystick values
    if((drivetrainLeftSideSpeed > 5 || drivetrainLeftSideSpeed < -5) ||
    (drivetrainRightSideSpeed > 5 || drivetrainRightSideSpeed < -5)){
        LeftDriveSmart.spin(fwd, drivetrainLeftSideSpeed, pct);
        RightDriveSmart.spin(fwd, drivetrainRightSideSpeed, pct);
      }else{
        Drivetrain.stop(brake);
      }
  }
    return 0;
}
```

Autonomous and Driver Code





Competition!

Validation (Large Robot)

- Satisfy all constraints? ✅
- Contain a drivetrain that reaches 300 RPM? ✅
- Lift two goals? ✅
- Lift one goal above 19”? ❌
- Contain an autonomous and driver-operated program? ✅

Validation (Small Robot)

- Satisfy all constraints?
- Contain a drivetrain that reaches 400 RPM?
- Lift one goal?
- Intake rings?
- Score rings on or in goal?
- Contain an autonomous and driver-operated program?

Experimental Tests

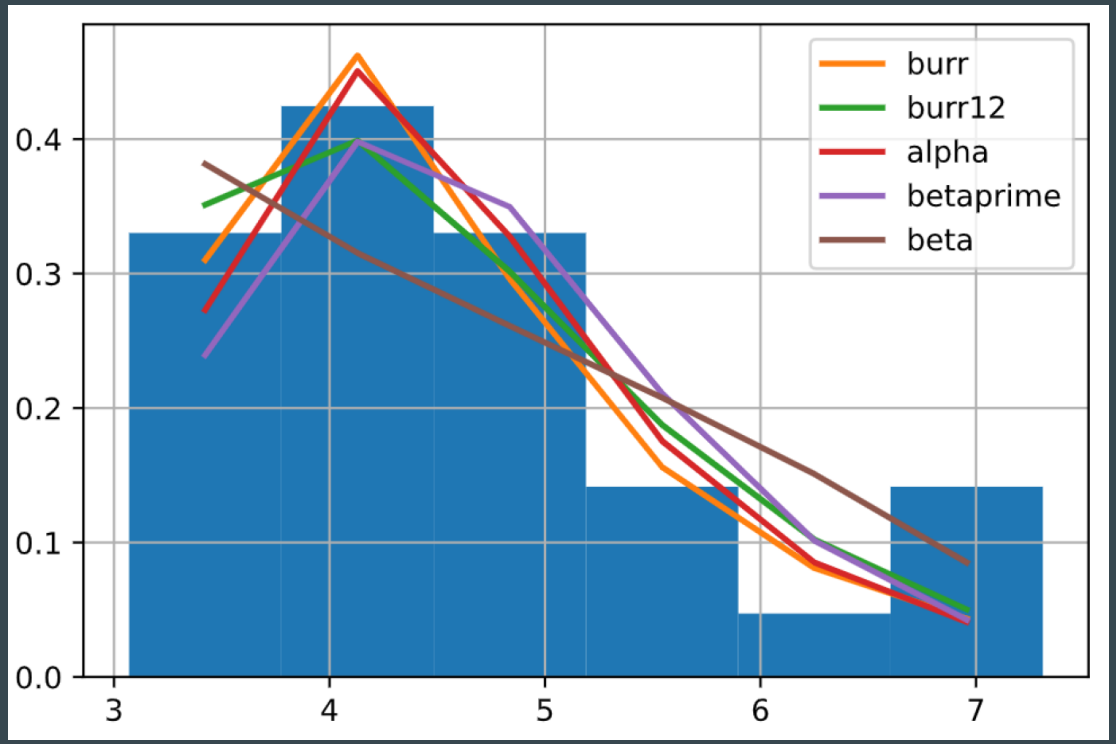
Large Robot

- Goal Grab Test
  - Front goal
  - Middle Goal
- Driving Test
  - Midpoint
  - Farside
  - Front goal
  - Middle goal
- Autonomous Routine 1 Test

Small Robot

- Goal Grab Test
  - Alliance goal on tape
  - Alliance goal on scale
- Driving Test
  - Midpoint
  - Farside
  - Front goal
  - Middle goal
- Autonomous Routine 1 Test

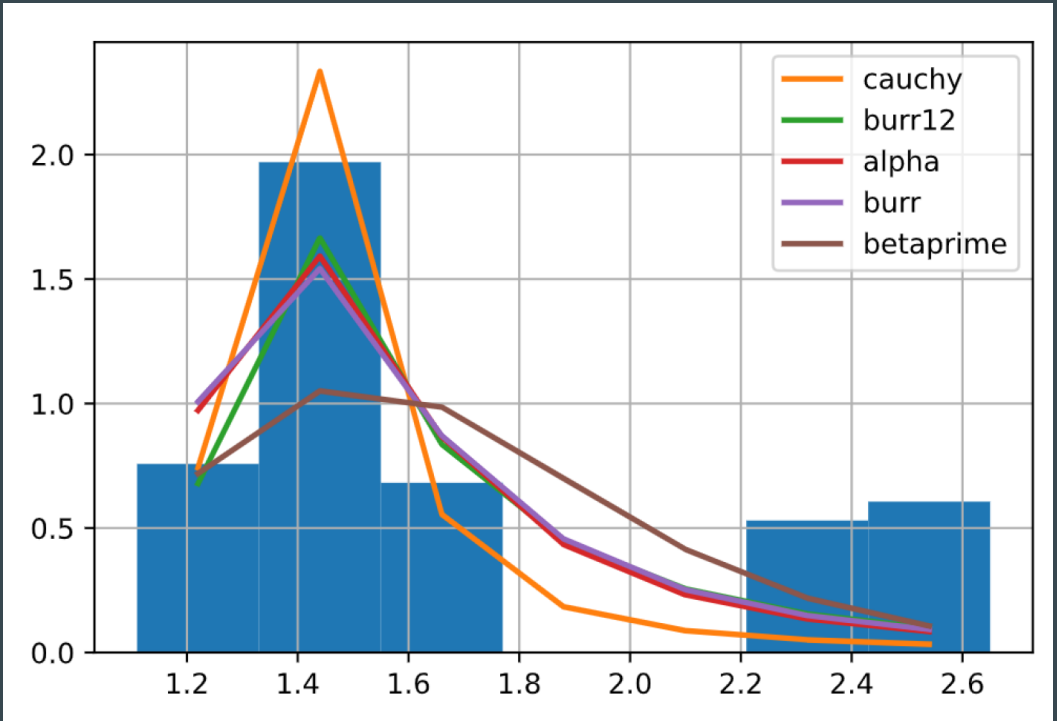
Results (Large Robot Goal Test)



H0: $\bar{x}$ <= 4 seconds
H1: $\bar{x}$ > 4 seconds
Fit: Burr
Confidence: 95%
Confidence Interval: (3.16, 8.24)

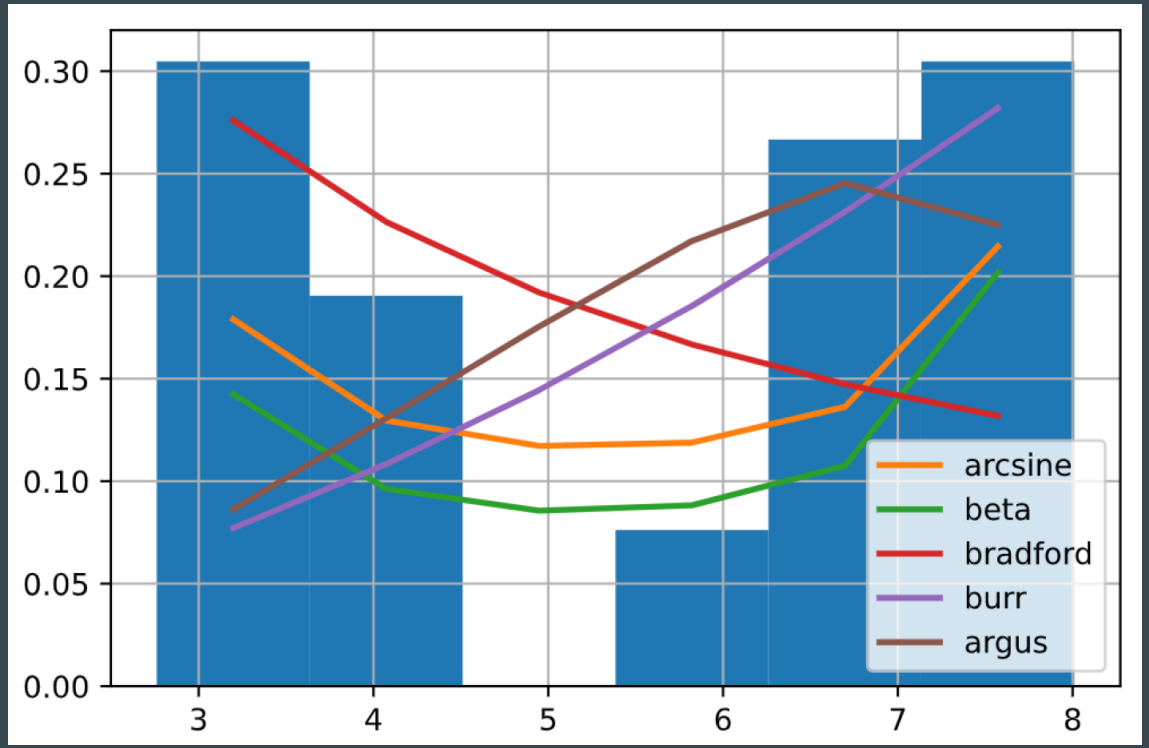
Conclusion: Hypothesis is not rejected

Results (Large Robot Drive Test)



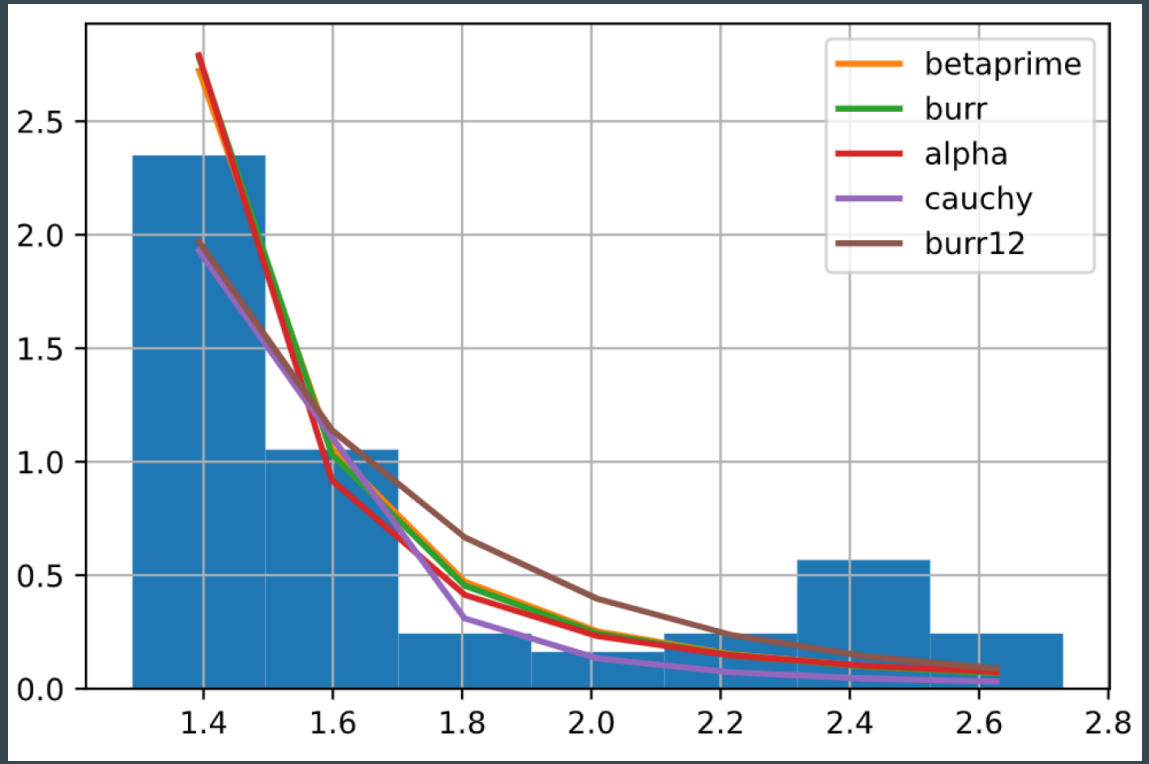
H0: $\bar{x}$ <= 2 seconds
H1: $\bar{x}$ > 2 seconds
Fit: Cauchy
Confidence: 95%
Confidence Interval: (-0.2688, 3.105)
Conclusion: Hypothesis is not rejected

Results (Small Robot Goal Test)



H0: $\bar{x}$ <= 3 seconds
H1: $\bar{x}$ > 3 seconds
Fit: Arcsine
Confidence: 95%
Confidence Interval: (2.50, 8.00)
Conclusion: Hypothesis is not rejected

Results (Small Robot Drive Test)



H0: $\bar{x}$ <= 4 seconds
H1: $\bar{x}$ > 4 seconds
Fit: Beta prime
Confidence: 95%
Confidence Interval: (1.30, 4.10)
Conclusion: Hypothesis is not rejected

Results (Small/Large Robot Autonomous Test) Note: Single Sample

Large Robot:

AVG: 13.12
STD. DEV : 0.87

Small Robot:

AVG: 10.41
STD. DEV : 0.16

Feasibility, Challenges and Risks

- Potential Injury-High
  - Proper training on equipment, and aware of potential hazards
- Failure of Systems-High
  - Proper test runs and redesigns
- Failure to build both robots-Medium
  - Make sure both robots are fully built and functional before competitions begin

Conclusion

Robotics competition placement

- 8th place

Ideas for changes in the future

- Different designs for lift Mechanisms
- More sampling data for testing experiments

Q&A?