2021 FTC Robot Presentation

9721

Overview

- Introduction
- Robot Performance
  - Autonomous-Luke
  - TeleOp-Kenny
  - End Game-Andrew
- Design and Performance
  - Luke-Chassis
  - Kenny-intake and conveyor
  - Luke-shooter
  - Andrew-lifter/gripper
- Out Reach
  - Helped develop new model of FTC-rookie->JV->varsity
  - Mentored team 16295 for robot arm and gripper
  - Helped form two new rookie teams
  - Mentored FLL team 3958 with PID algorithm

Origins-FLL 3958

2012-Senior Solutions

The team finished dead last at the NH qualifier at Nashua. Their project was a Scratch choose your own adventure based on the lives of seniors they interviewed. The game was designed to help the seniors connect with their extended families.

2013-Nature's Fury
The team designed a video game on Scratch that taught students how to prepare for a natural disaster.

The team won the Judges Award at the Nashua Regional Event.

2 irst Class

The team won the robot design award at the Nashua Regional Qualifier.

They designed a game using GameMaker where an ally converted bystanders into other allies to combat bullying at school.

2015-Trash Trek

Team won the VT State FLL Championship and were Semi-Finalists in the Global Innovations Award for an app they created to teach people how to sort waste. The game was launched on both the Apple Store and the Google Play score. The app was created in Unity.

2016-Animal Allies FLL

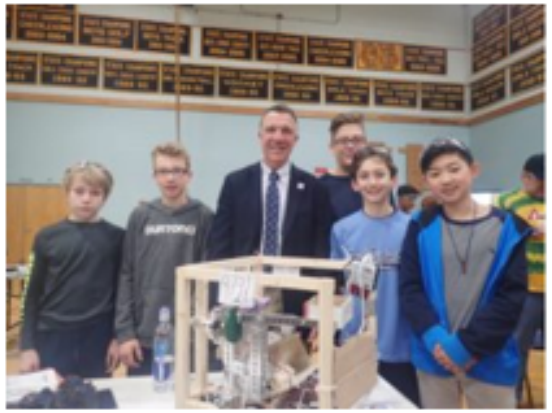
Programming Award at Vermont State FLL Championships

Team designed a 3D printable bee box to help people get over their fear of bees.

We have been doing FTC since 2015
We won Think Award in 2020 and made semi-finals
We won Best of Vermont FTC in 2019 and were Alliance Captains in Semi-Finals
We won best of Vermont in 2018

2014-2015 Cascade Effect

Team built a lego based FTC robot. The robot operated but did not earn any points.



2016-17 Velocity Vortex

The team build a robot with a wood frame that could used a cam gear and a spring to fire wiffle balls into a scoring device.

The team discovered that they could score points by hitting the beacons.

2015-16 ResQ

Team build a tetrix robot with off-road tires that could climb the ramp and hang.

2017-18-Relic Recovery

The team built a tetrix robot that used color sensors and motor encoders to operate during autonomous.

The robot stacked blocks during teleOp.

The robot parked on the ramp in end game.

The team won the "Best of Vermont" Award.

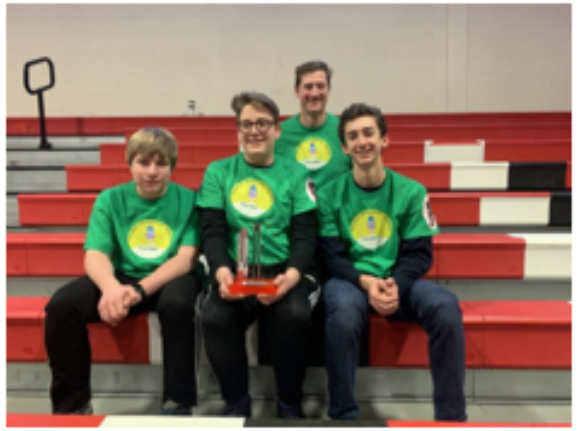
2018-19-Rover Ruckus

The team designed a robot that integrated tetrix and REV materials.

During autonomous, the robot lowered itself and used tensor flow to identify and deliver minerals using motor encoders.

During teleOp, the robot placed minerals in the correct location.

During end game, the robot lifted itself. The team won the "Best of Vermont" award for the 2nd year. The team was an Alliance Captain during the semi-finals.



2019-20 Skystone

The robot can do the foundation and skystone during autonomous.

During driver control, the robot can stack 4-5 stones using a cabinet slider and drive under the alliance bridge.

During end game, the robot can place the end cap on a stack, move the foundation and park.

The team was the first Vermont team to win the "Think" award and the team was a member of a Semi-Finals Alliance. The team also helped to form the first all-female FTC team in VT and they created a series of rookie tutorials to help new teams, including videos of robot design, robot fabrication, robot programming and robot operation during competition including several scrimmage events where both teams worked the fame field at the same time.

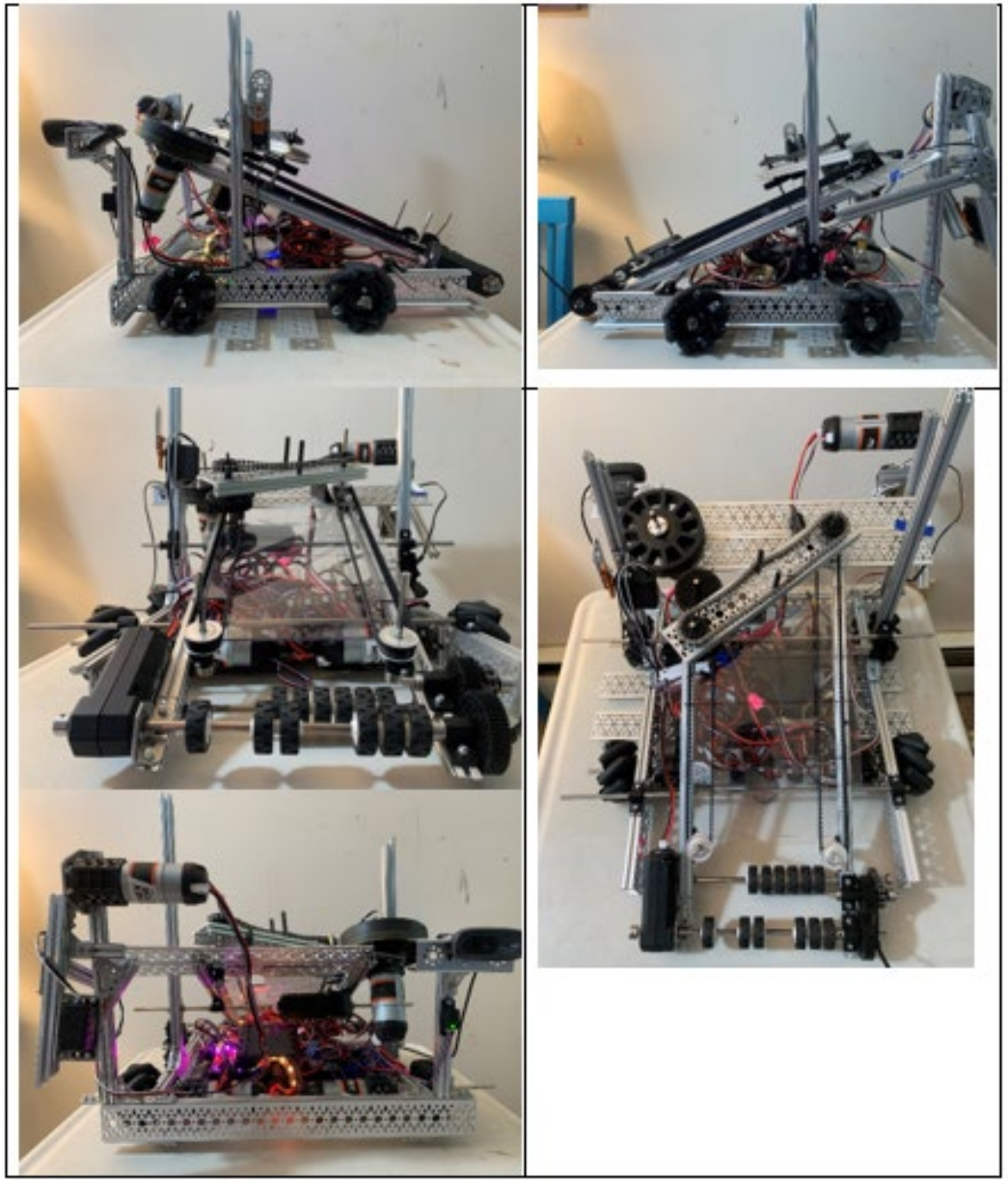
Robot Progression (inspired out-reach model)

- 2015-Robot operated during teleOp-made from legos-2 motor drive
- 2016-Robot operated during teleOp-made from Tetrix Kit-2 motor drive
- 2017-Robot operated during teleOp-scored points by hitting beacon-two wheel drive with omni wheels and wood frame
- 2018-Robort used Vuforia to place block but not consistently-operated during teleOp and parked during end game-4 wheel drive with omni wheels, used IMU and distance sensors
- 2019-Robot used tensor flow to sense objects and park in correct location-drop marker-collected blocks using arm, lifted itself off of ground using winch. 4 wheel drive with mecanum wheels, IMU and distance sensors. Used methods for the first time in java programming.
- 2020-Robot used tensor flow to read brick, placed brick on foundation, dragged foundation-made stack 5 bricks high with cabinet slider, dragged foundation in end game. 4 wheel drive with mecanum wheels, web cam, distance sensor, IMU

General Design Principles

- TeleOp to develop system design and programming before Autonomous
- Prioritize sub-systems and then research, build and test prototypes for each sub-system
  - chassis, electronics, shooter, intake, conveyor, wobble lifter/grabber, computer vision, wobble drop
- Each sub-system uses copy/paste code from demo programs in Android Studio
- Present subsystems for collective decisions about which to select and how to modify
- Integrate sub-systems together for teleOp-copy and paste code and integrate into increasingly complex opMode
- Copy and Paste computer vision code from templates and integrate with teleOp methods

2021 robot



Autonomous-33 Points

- Robot uses web cam with tensor flow to evaluate the stack of donuts
- Robot saves the stack size and uses this information to follow different pathways on the robot field
- Robot uses PID algorithm to balance power in order using IMU heading data in order to drive straight until the robot detects the image target using vuforia
- Robot uses navigation data from the image target to position the robot to fire donuts into the middle goal
- Robot uses the information from tensor flow to follow a specific pathway to position A, B or C and drops the wobble goal
- Robot consistently scores 18 points for 3 donuts, 15 points for the wobble goal and 5 points for parking for a total of 38 points

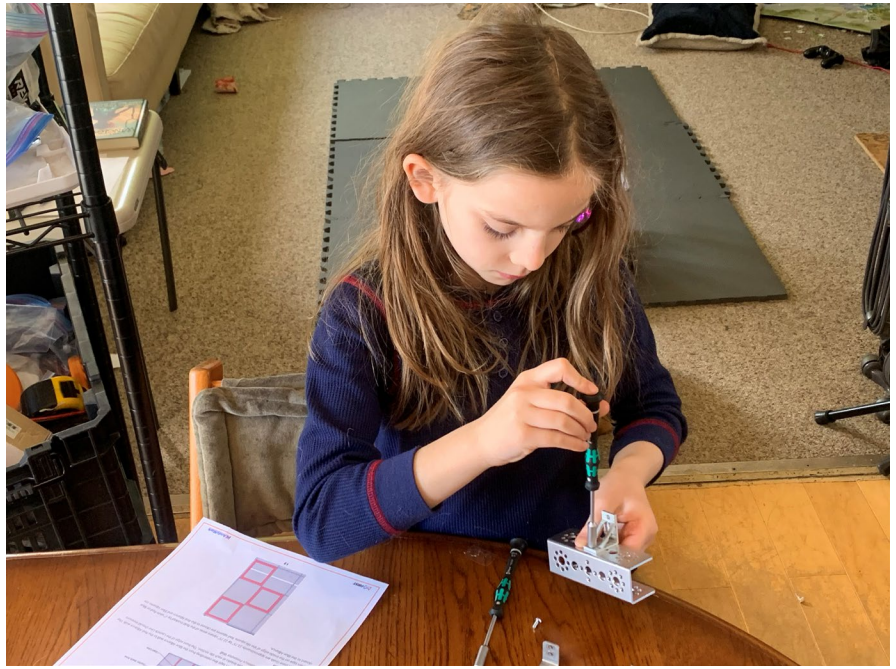
Autonomous System-Chassis

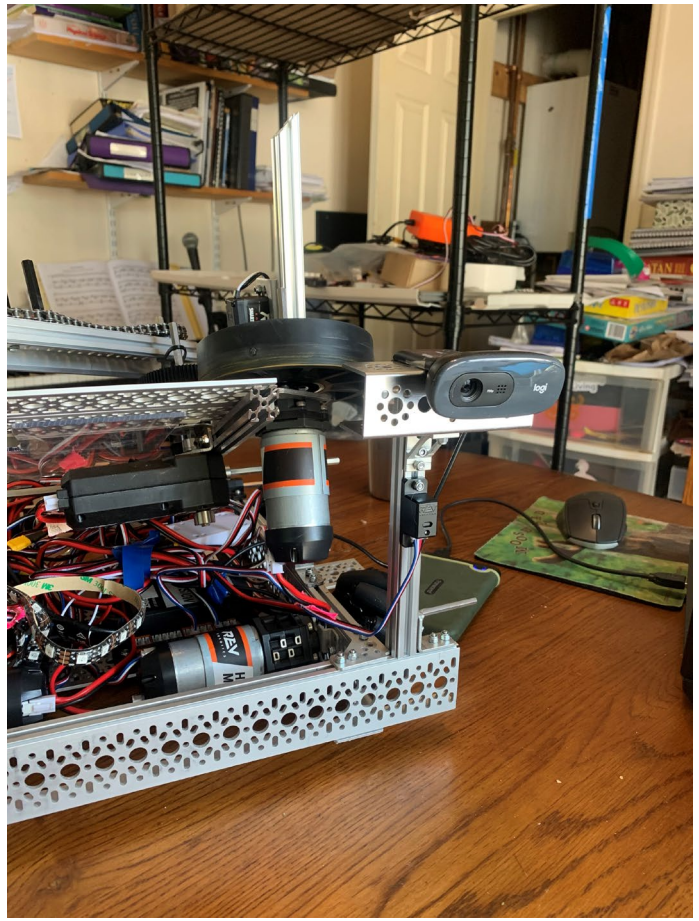
- Holonomic chassis-(4) ultraplanetary motors connected to REV mecanum wheels and geared using 5:4 for a 20:1 gear reduction, which is similar to advanced robot kits.
- REV mecanum wheels were selected because they made better connection with planetary motor axles and better bearings.
- PID algorithm allows robot to drive a specific heading using the IMU
- Robot can drive forward/backward, rotate right left and strafe right/left
- C channel design inspired by the TileRunner platform from AndyMark and the mecanum demo from REV

Luke making final build of robot chassis

Autonomous-Object Detection and Navigation

- Web camera designed and mounted by FLL 3958





Wobble Goal Release

- Wobble goal gets hung on the robot using a servo

Shooter

- Shooter uses a 4” compliant wheel from AndyMark. This was new for us. We focused on the 60 duraometer material after experimenting with the 40 and 20.
- Shooter wheel uses ultraplanetary motor without any gears-3.7:1 gear ratio.
- Shooter uses motion bracket to squeeze donut into shooter wheel
- Initial angle is about 30 degrees (protractor)
- Initial velocity appears to be around 8.4 m/s (tracker pro)
- Consistently shoots 5.334 meters (tape measure)

- Inspiration for this shooter was from pitching machines and the the Bulldogs 30 hour video https://www.youtube.com/watch?v=j5b6PV39Toc

Autonomous Demonstratoin Videos

https://youtu.be/wyfsl74T_t0 Run 3 from Virtual Competition

TeleOp Performance (4-12) points

- Robot uses intake system to collect donuts from the floor
- Robot uses conveyor system to move donuts to the shooter
- Shooter can hit the middle target 100% of the time when the robot is positioned near the launch line
- Robot can drive forward/backward, rotate right/left and strafe right/left
- Robot can shoot 1-2 donuts per teleOp session

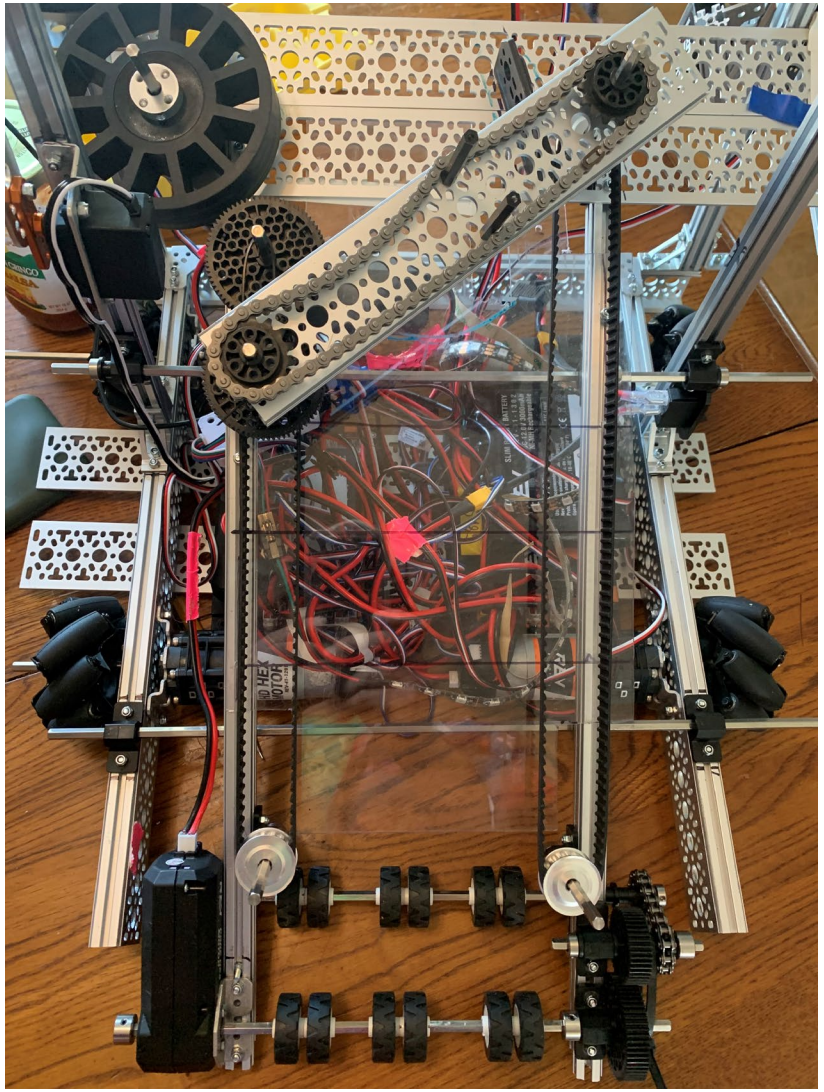
TeleOp-intake system

https://youtu.be/QgaSjTJzMNA

- Robot uses wheel intake system powered by a medium motor
- Medium motor was select because it fit into the frame better and it was powerful enough to make the system work
- The medium motor is connected to the first axle. The first axle is connected to a dummy axle with spur gears. The spur gear connection is held together using zip ties. The gear connection changes the direction of motion.
- The dummy axle is connected to the third axle with a chain and very small sprocket. This causes the third axle to rotate opposite of the first axle.
- This system was inspired by a REV tutorial
- https://docs.revrobotics.com/kickoff-concepts/ultimate-goal-2020-2021/intake

teleOp conveyor

- Conveyor system and intake system are very similar.
- Conveyor is also powered by a medium motor because it fits easily on the underside of the floor
- Floor of the conveyor was cut from lexan using a jig saw with a plastic cutting blade. This was new for our team. We had previously used a plastic cutter, which did not work well for us.
- Power is moved from the motor to an axle, which is connected to another axle about 10” away, using a timing belt with a pulley. The timing belt and pulley are new for our team. We had great difficulty getting the parts because they were backordered through REV so we moved to ServoCity.
- The first axle is connected to a dummy axle with spur gears. The two axles are held together with a zip tie. The spur gear connection changes the direction of motion.
- The dummy axle is connected to the third axle with a chain and sprocket with a long chain. The spacing is maintained using a C channel. The system This causes the third axle to rotate opposite of the first axle.
- The third axle is connected to another axle with a timing belt and pulley system. These belts are spaced so that the tension from the donut holds them in place.
- This system was inspired by a REV tutorial system.
- https://youtu.be/aWmIiIyM9sc



Kenny making final build of conveyor/lifter system

TeleOp Mapping

gamepad1

gamepad2

teleOp-LED Array

- Team added an LED controller and programmable strip to robot this year
- Code sends signal to LED array to help robot operator understand how robot is behaving without having to look at the phone

End Game-Lifter/Gripper (15 Points)

- Powered by ultraplanetary motor 5:1,5:1,5:1 for a total of 125:1
- This gearing allows motor to hold its position when not powered directly (long standing problem for lifters)
- Control uses encoders to operate robot arm for more consistency
- Once arm is in place, robot strafes into position
- Servo closes on wobble goal and holds it in position against back support
- Arm rotates into higher position in order to drive and clear wall
- Servo release goal and robot arm drops wobble goal

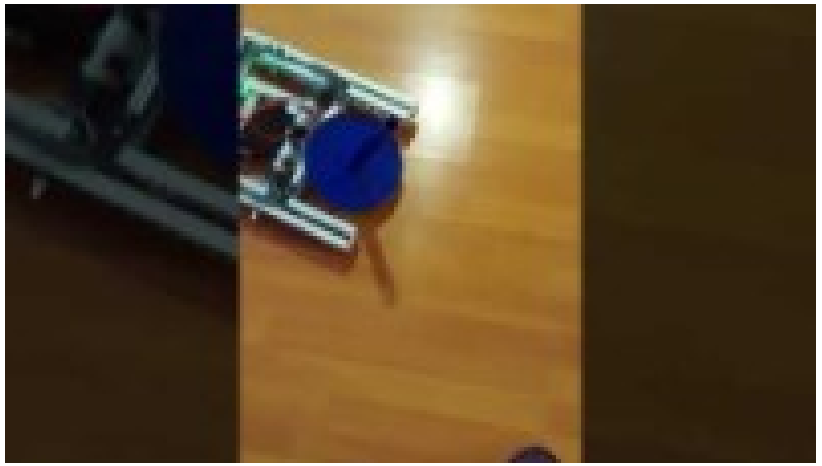
https://youtu.be/SikZNj8_wNQ

Andrew making final
Build of lifter/gripper

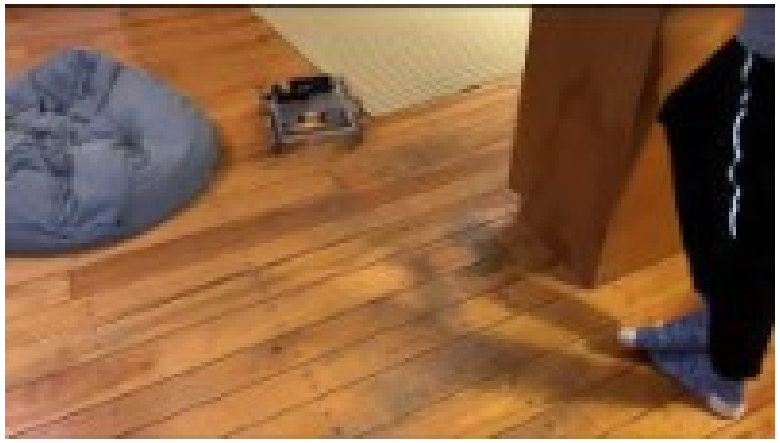
Out-Reach

- Supported (2) new rookie teams 18753(all islands) and 18641(all girls)
- Found grants to cover all costs
- Tested and delivered rookie prototype robots
- Re-used conceptual tutorial videos from last year
- Made new videos specific to this year

18641- End Game Wobble Demo
https://youtu.be/UEn9gdFLC68



18751 https://youtu.be/nUuN7O9Moi0



Out-Reach and Legacy

- From our old engineering notebooks, we determined that it takes roughly 20 hours to develop a working sub-system
- We identified key sub-systems
  - Chassis and control systems
  - Collector
  - Lifter
  - Shooter/sorter
  - autonomous navigation with encoders, distance sensor, imu
  - Robot vision with Vuforia and tensor flow
- We developed specific expectations and provided support to move team members from one level to the next

- Rookie Team
  - Chassis and control systems
- JV
  - Rookie team + lifter or collector
- Varsity (1)
  - JV team + lifter, collector, shooter
- Varsity (2)
  - Varsity (1) + autonomous navigation and computer vision

Demonstrating Our Model (year 2)

- We are at varsity (2). Our robot scored 47-78 points in the competition
- 16295 was an all-girls rookie team last year and they returned this year and added a lifter. They scored 20 points by lifting the wobble goal into the drop zine.
- We mentored two rookie teams, including another all-girls team and a team from the islands. Each team scored 5 points by pushing the wobble onto the starting line.

New Videos-Bracket Assembly Tutorial

https://youtu.be/ZAHqZFTkYdM

Rookie Robot Operation Tutorial

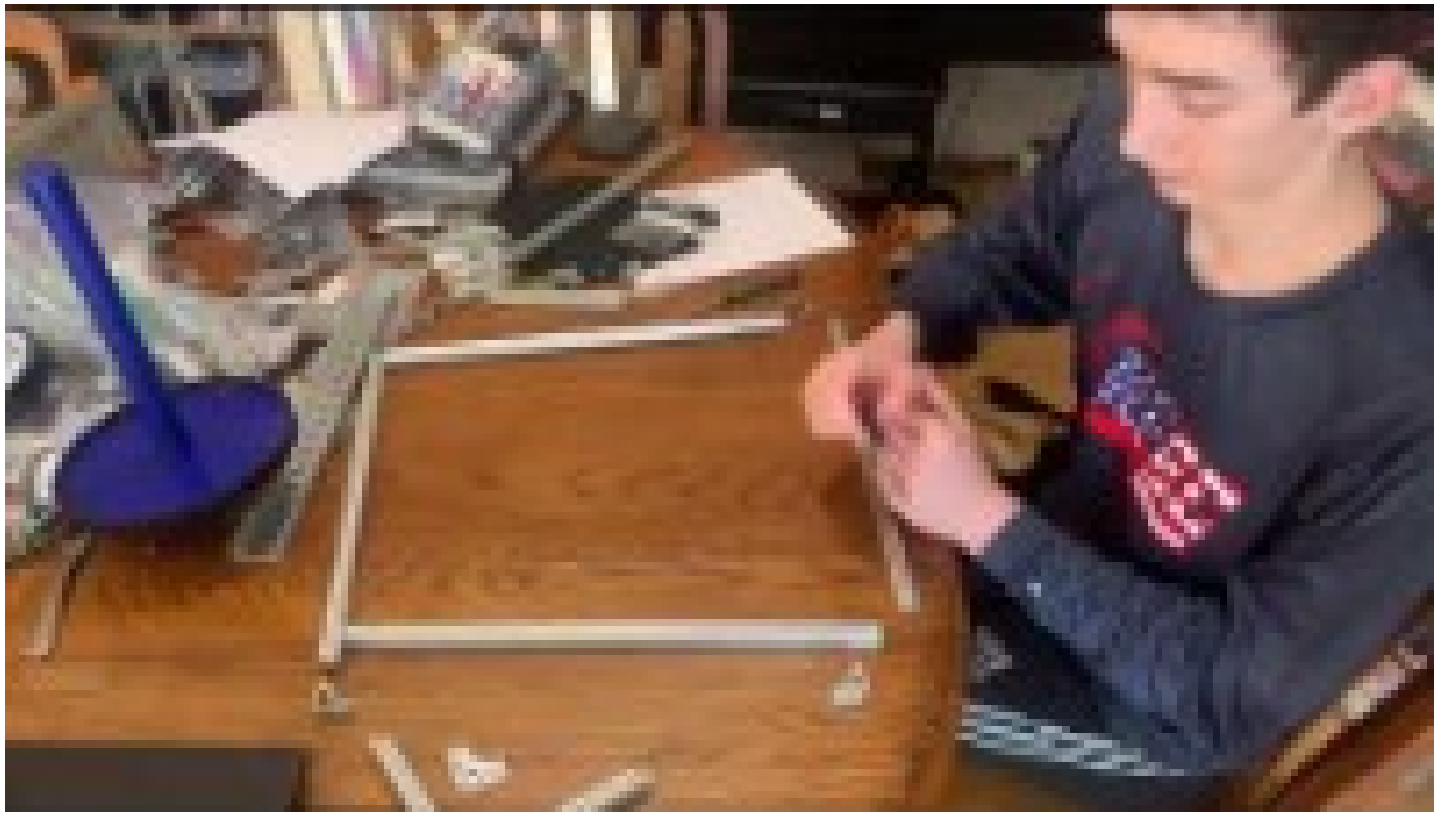
- https://youtu.be/EOfIdiymGJU

Rookie Robot Programming Tutorial

- https://youtu.be/Mz92gxIldEk

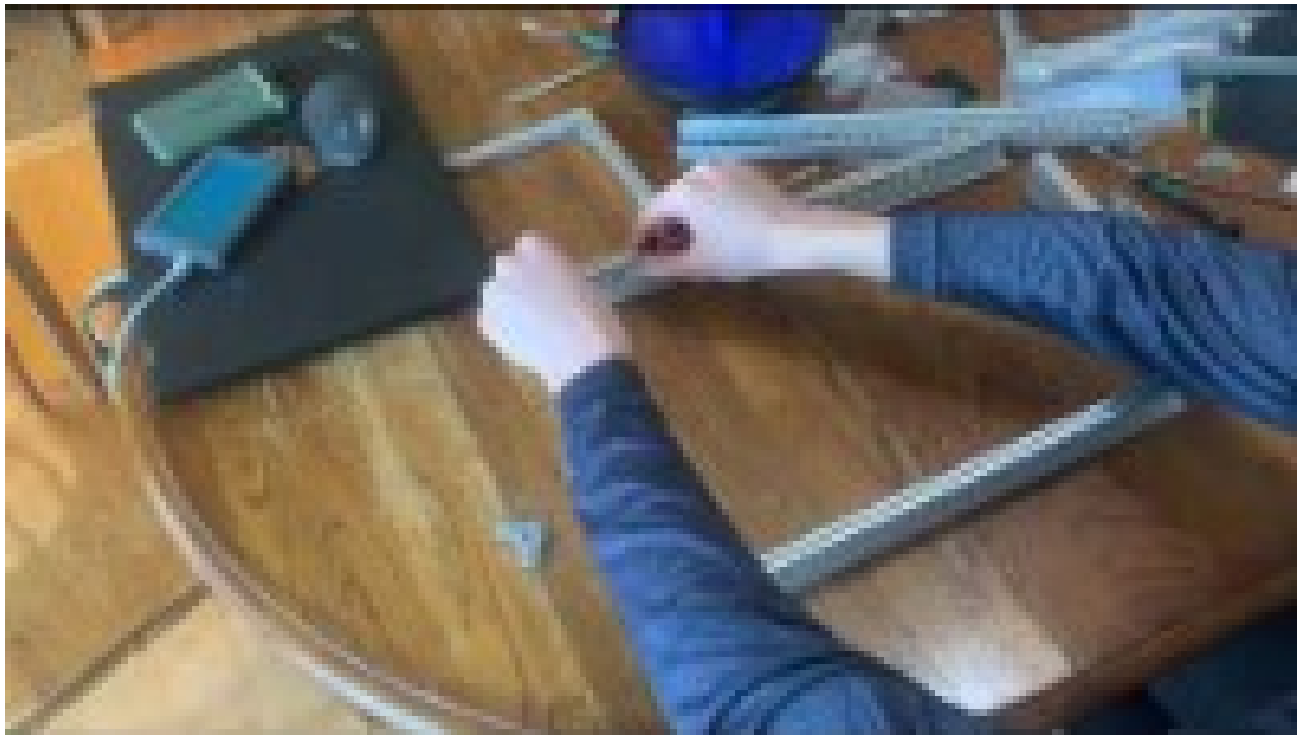
15 mm extrusion frame

https://youtu.be/fLVKIcdGym4



C Channel Frame

- https://youtu.be/86kGiE2FH6o

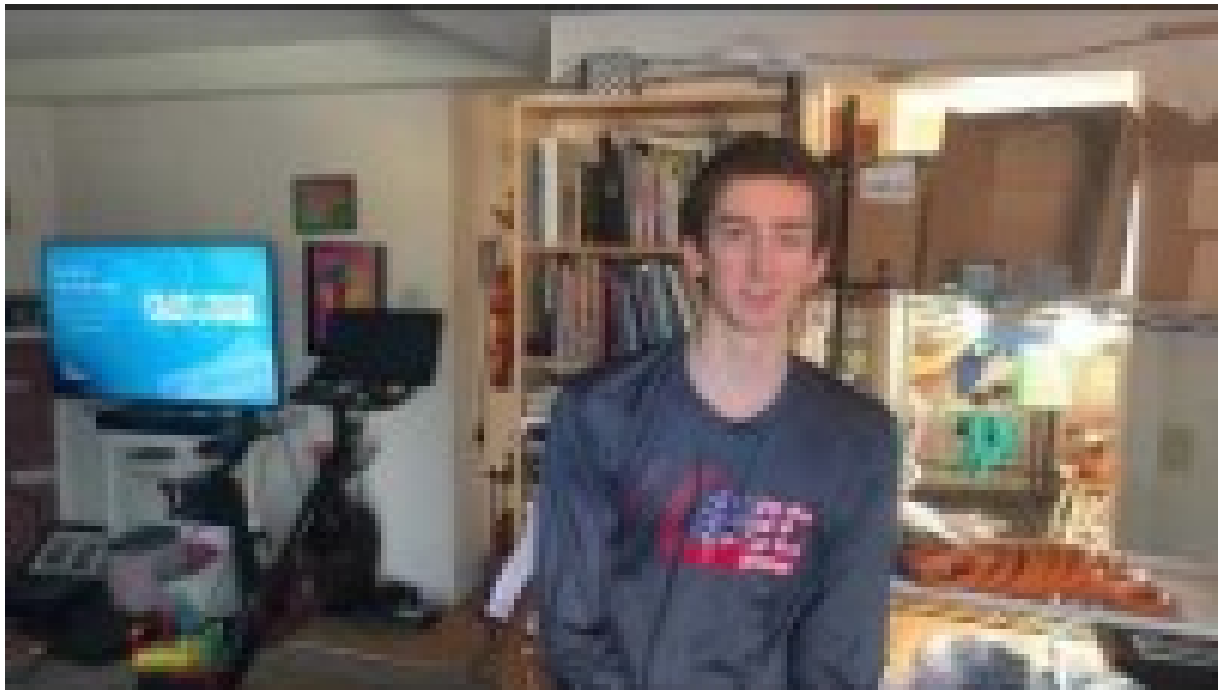


Wheel Tutorial

- https://youtu.be/zFBtZg7xYGU

Wobble Goal Tutorial

https://youtu.be/zFBtZg7xYGU



Out-Reach-JV Team 16295

- Found grants to cover all costs
- Provided material support
- Provided tool support (miter saw for cutting aluminum)
- Provided in-person tutorial (Andrew to Kayla)

Sponsors and Grants

- REV Robotics
- *FIRST* STEM Equity Community Innovation Grant
- Vermont Academy of Science and Technology (VAST) HOST grant