Robotics Engineering Notebook

team name: When Robots Fly

team number: 1618 A

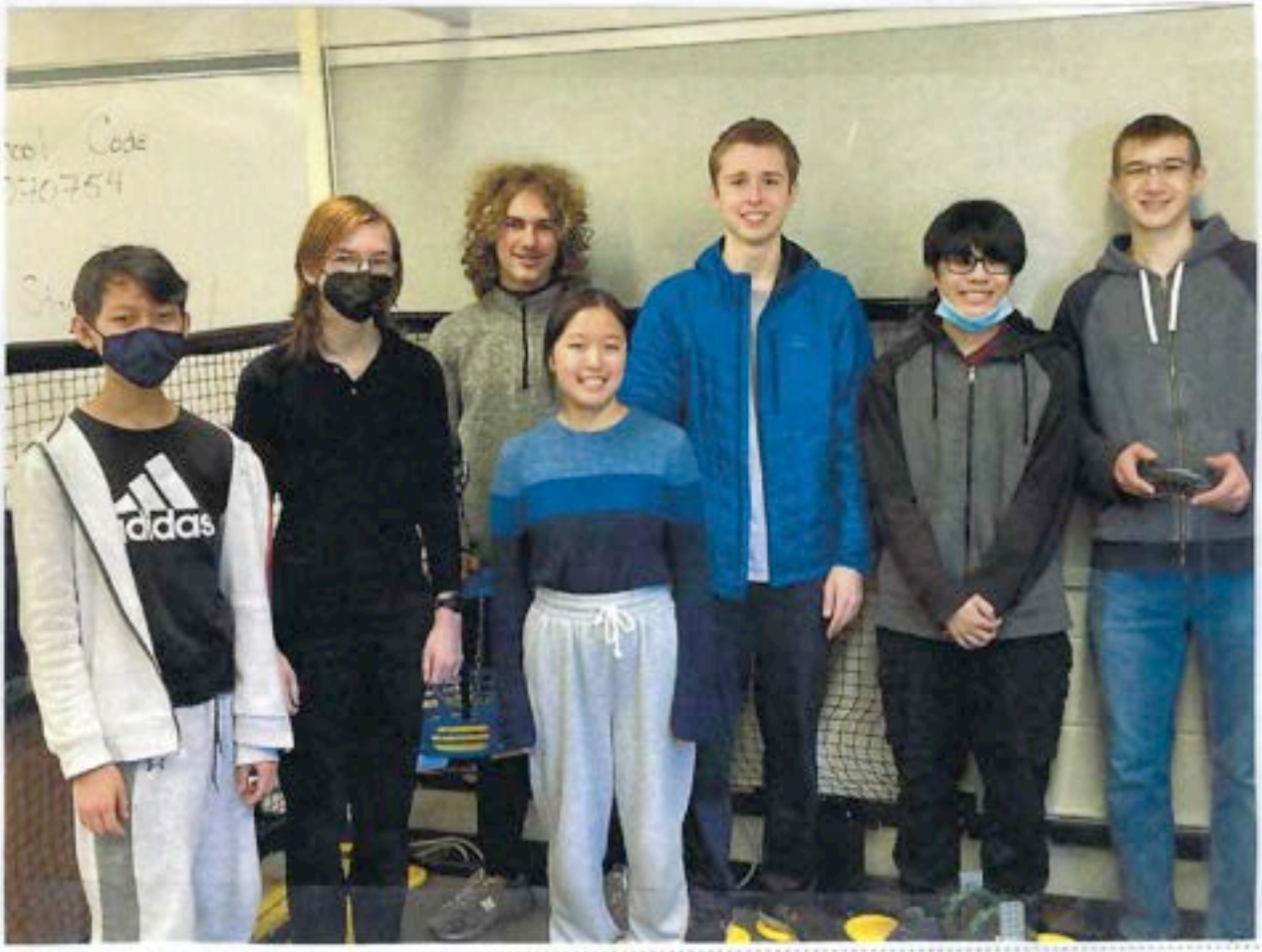
season: "Spin Up"

start date: 9/6/22

end date:

book number: 1 of:

Team Photo



Team Profile

We are 1618A, the robotics team at E.O Smith High School, located in Storrs, CT. Our team is currently made up of students from all grades 9-12. We have an open door policy during robotics meetings - anyone who's interested can come by to see what we're up to and help out if they wish. We also have a permanent group of members who show up to almost every meeting. These people make up our team: Sam, who mostly builds and designs; Riley, who mostly programs; Todd, who mostly designs and builds; Rain, who builds; Ian, who builds and drives; Sungjin, who builds; Anayi, who designs; Shaun, who builds; and Lucy, who designs and records in the engineering notebook. Each meeting brings different challenges and opportunities, so we're all very flexible in our roles and help each other out on what needs to get done.

My Projects

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1	Brainstorming and organization (Robot design #1)	9/12/22
2	Brainstorming Robot designs #2 + #3	9/12/22
3	Brainstorming Robot Designs #4	9/12/22
4	Point priorities and Festival preparation	9/13/22
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22-26	Code 1	12/12/22

My Projects

page	project	date

9/12/22 Today we watched the official video on the rules of this year's competition, as well as reviewed the rules book. Then we had all members start brainstorming and designing initial ideas for our robot. We also had to set up our field, making sure all the pieces come together so that we will be able to use the field in the future to test our robot with.

Our town is having a local festival soon, and our team has a stall there to introduce our robots team to our community. We do this every year to hopefully inspire new people to have the same love for robotics that we do.

Design #1

This robot prioritizes scoring disks, it can grab discs and move them up a conveyor belt to score, with a motor at the top to launch the disk. -LL

project Brainstorming and organization Robot Design #1 designed by: Rain Zhang witnessed by: [signature] date: 9/12/22

9/12/22 (continued)

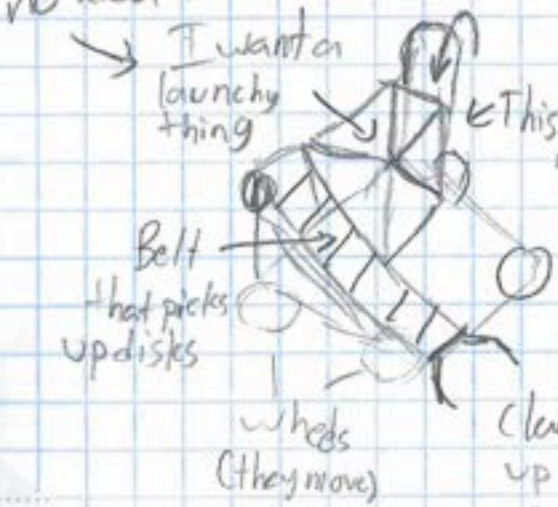
Design #2

Anayi

This is another conveyor belt design. From the video she saw that disks need to be carried from point A to point B, and thought the best way to do that was through a conveyor belt design. -LL

Design #3

This design also prioritizes scoring disks, with a claw to flip disks onto the conveyor belt, which may be tall enough to have the disks fall over the edge and into the goal. There would also be a structure on the side that would spin rollers. -LL



shaun

project Brainstorming Robot Designs #2 + #3 designed by: Anayi, Shaun witnessed by: Kayla

date: 9/12/22

9/12/22 Continued

Design #4

Todd's design includes a conveyor belt that would have a fly wheel at the top to launch disks into the goal.

Todd

There would also be a chain on the side to be extended in the last 10 seconds to get points for area covered. The arm in the front would turn the rollers.

After examing the roller part of the field, however, the roller proved much more difficult to turn than previously anticipated. The arm component will have to be carefully thought out. - LL

project Brainstorming Robot Designs #4 designed by: Todd Buch witnessed by: [signature]

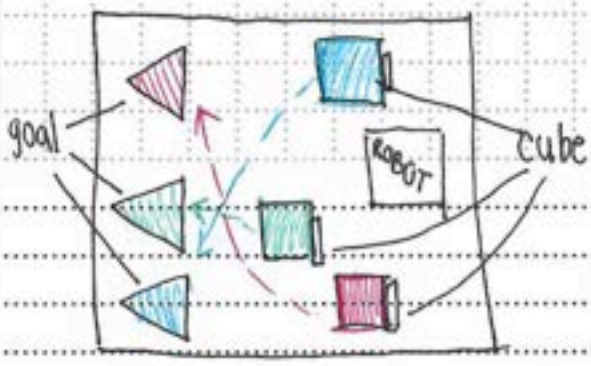
date: 9/12/22

9/13/22 Today we rewatched the official competition video. Then we created a spreadsheet to organize everyone's roles and brainstormed different ways to score points as well as estimated about how many points we thought we'd be able to score. We also spoke about our priorities and thought of possible strategies. We continued building the field and discussed the upcoming festival, deciding to introduce our robot by engaging our audience with a maze. We started work on the maze, planning and building its layout. - MS

ways to score points	Points per unit	※ units	Max Points	Realistic units	Realistic Points	Priority
scoring disks in basket	5	60	300	8	40	1
roller	10	4	40	2	20	3
area at end	3	36	108	7	21	2

We finished building a simple claw bot that we will let passerbys at the festival drive through a maze. There are always a lot of kids from the local elementary and middle schools who will hopefully take an interest in robotics, and our booth there might encourage that.

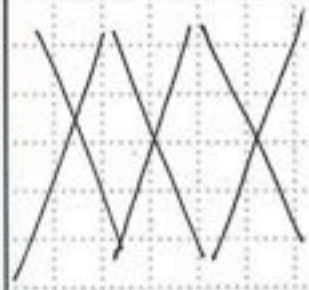
The game design will be a field using cubes of 3 different colors that will need to be moved into 3 goals. -LL

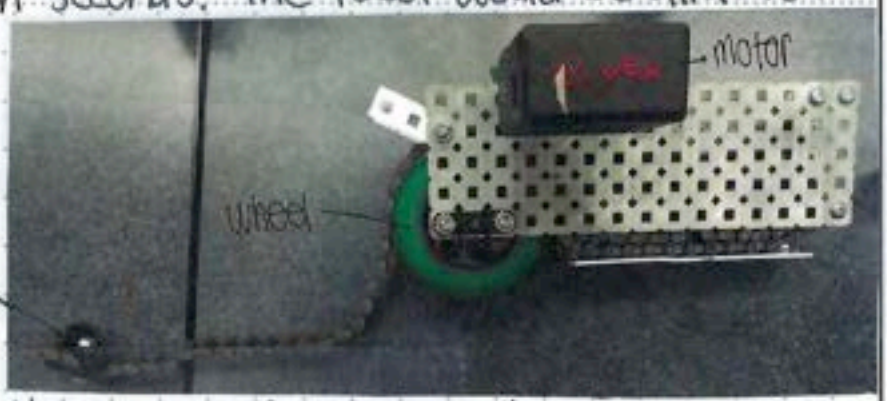


project Point Priorities and Festival preparation designed by: Miriam Shamshoh witnessed by: Riley

date: 9/13/22

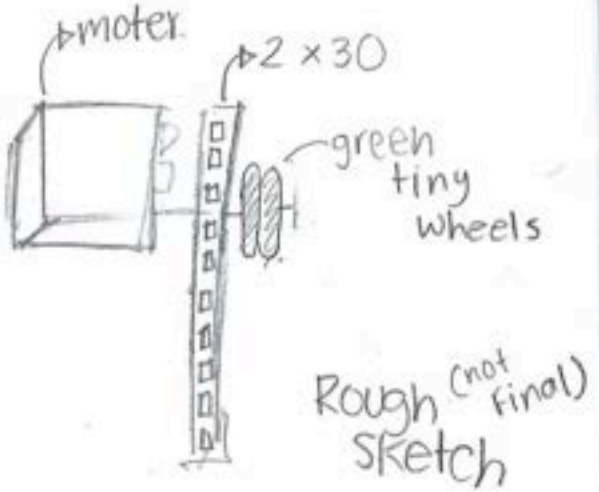
~~9/19/22~~ 9/19/22 we come up with an idea to eject a chain as a way to increase our robot's area at the last ten seconds. The robot would be attached to one end. -LL





9/26/22 We experimented with a design for a roller, to change the roller color. Our team has split into separate groups to design 1. scoring disks, 2. expanding to cover more area, and 3. changing the roller color. Our first design was to attach some mesh to a 4X13 piece of metal, hoping that the mesh would create enough friction to move the roller, which is a bit difficult to move.

Another design is to attach a motor and 2.75" diameter smooth wheels to a long bar of metal and use the wheels to turn the roller. We attempted to use an 84 tooth gear, but it required too much precision and was unreliable even when we manually held the design to try and turn the roller. -LL



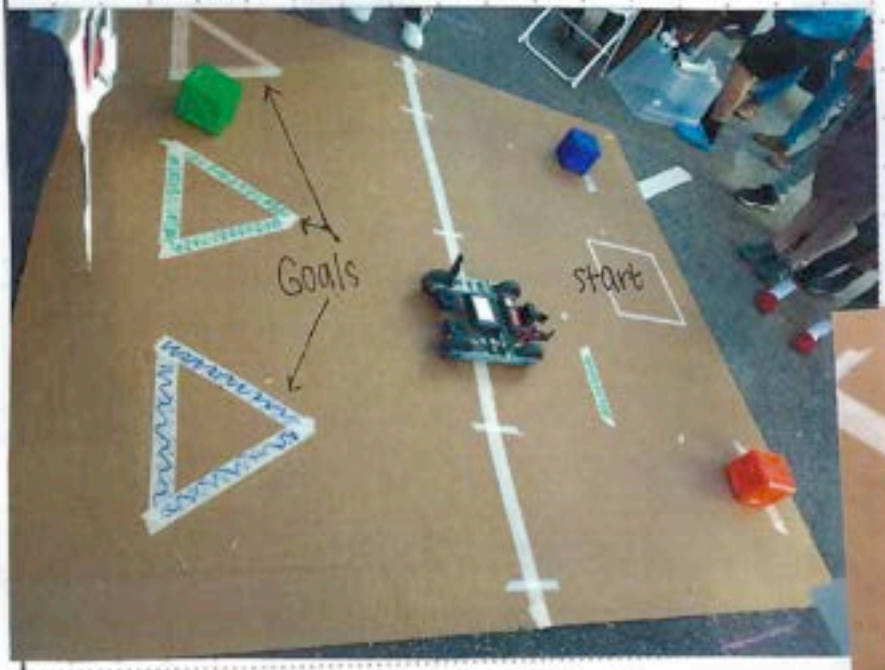
Rough (not final) sketch

project Roller designs designed by: witnessed by:

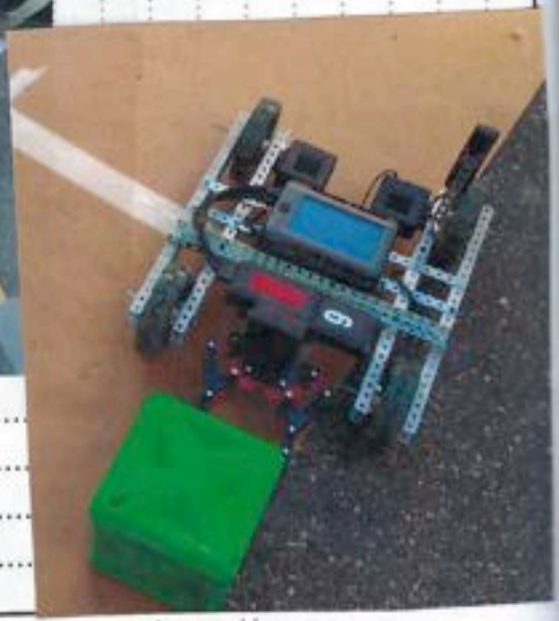
date: 9/26/22

9/26/22 Our experience at the community festival was a success. We set up a cardboard field with 3 different colored cubes and 3 goals. We invited people to drive a claw bot we put together for the festival. We had people of all ages attempt our challenge, from 4 years old to 54. It was an amazing experience being able to share our love of robotics with our community. We met quite a few middle schoolers who were eager and interested in robotics, which makes us hopeful that there will continue to be people who will want to participate in the future.

Next up we have another event to prepare for, a small school club festival. We're planning to do the same thing for this festival as we did with our community. It's important to us that we do outreach and spread our interest in robotics with other people. Hopefully we'll be able to foster a stronger connection between our robotics team and school. -LL



People were really invested in completing the challenge, whether it took 30 sec or 7 minutes! -LL

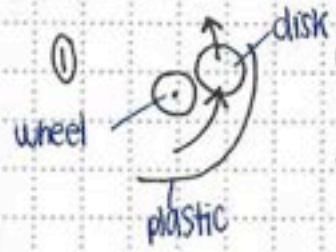


Even a simple claw bot is able to inspire awe and interest as some people drive a robot for the first time. -LL

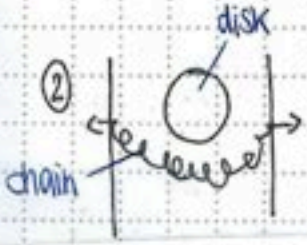
project Festival Reflection designed by: Lucy Liu witnessed by:

date:

9/27/22 we have 2 ideas for a disk launcher.

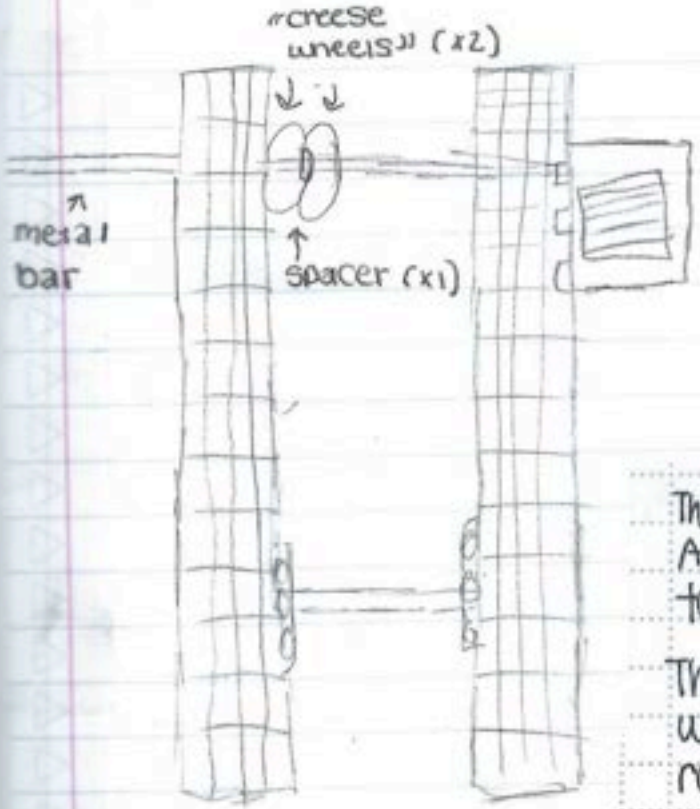


Riley is working on a design with a curved piece of plastic on the outside, and a wheel in the middle that will spin to launch the disk. -LL



Todd's design is to have a chain pull tight to launch a disk. -LL

ROLLER prototype



Rain
Kalyani
Shaun
Anayi

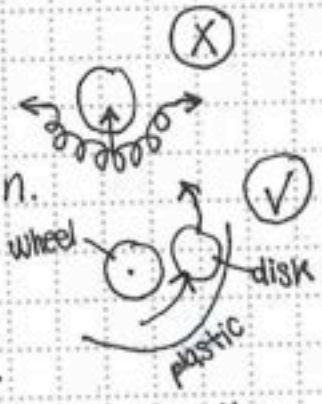
The roller design was revised. A gear and 2 wheels were removed to focus on power, not speed.

This design was tested, but did not work since when attached to the robot, the design was above the roller itself; no contact between roller and wheels. -LL

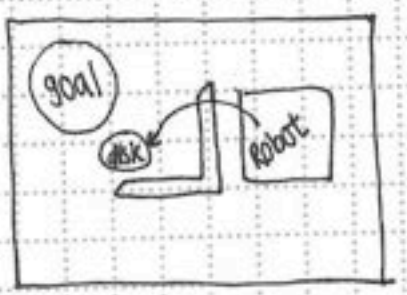
project Disk launcher designs + Roller prototype designed by: Riley, Todd, Rain, Kalyani, Shaun, Anayi witnessed by: Lucy Liu date: 9/27/22

10/3/22 We built the base today, making its dimensions as large as possible considering our robot can score more points for the number of tiles it can cover at the end. It's dimensions are 18 x 18 inches. -LL

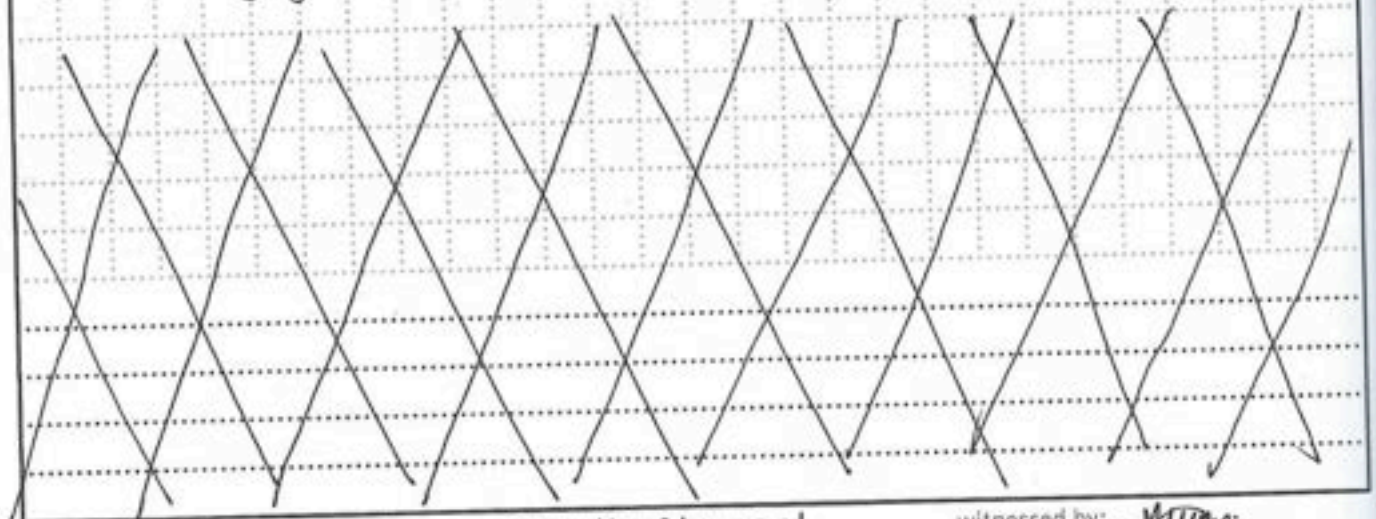
We are no longer considering the flinger design as it doesn't seem to be very effective or efficient. Instead, we'll focus on the curved design.



We tested out the curved launcher design, but the wheel didn't spin fast enough to launch the disk far enough, to where we wanted it to be. To solve this problem, we will try to increase the gear ratio by attaching a 64 tooth gear and a 36 tooth gear to get our wheel to spin with greater speed. -LL



10/4/22 We tried out a pneumatic disk launcher. It worked, however only managing to score into the goal at an extremely close distance. There was also not enough pressure to be able to shoot many goals. -LL



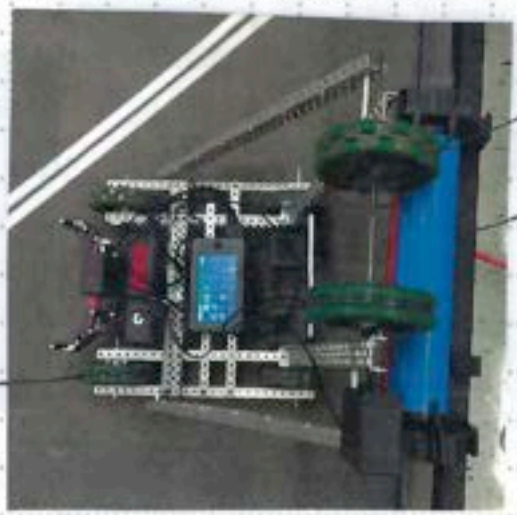
project Curved Launcher design designed by: Riley, Todd witnessed by: [signature]

date: 10/4/22

10/10/22 We've created an effective and working roller turner. It can turn the roller precisely and fast. The only concern is its size and how it'll fit on the robot and the launcher, but we'll need to finish the launcher and then re-evaluate. -LL

Side view

TOP view



We replaced the smooth green wheels with omni wheels to increase the reach and friction to be able to turn the roller more efficiently. The roller turner was also put at a tilt and wheels were positioned above the roller to better able turn it, as putting the wheels directly in front of the roller proved to have more difficulty when testing it. -LL

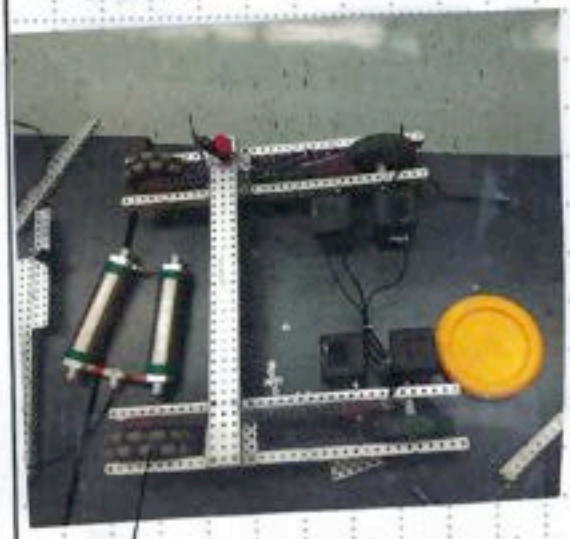
project Roller improvements designed by: Kalyani witnessed by: Lucy Li

date: 10/10/22

10/17/22 we've decided to use 4 mecanum wheels on our base. This will ~~else~~ allow for better positioning as our robot will be able to move sideways. Better positioning is essential when trying to shoot disks into the goals. Riley is working on coding the wheels. -LL

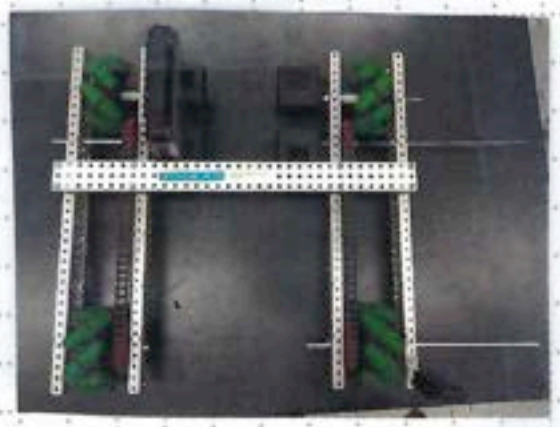
10/18/22 Today we attached the mecanum wheels to our base. It took much longer than expected since the wheels are new and we needed to insert axels through them. -LL

BEFORE

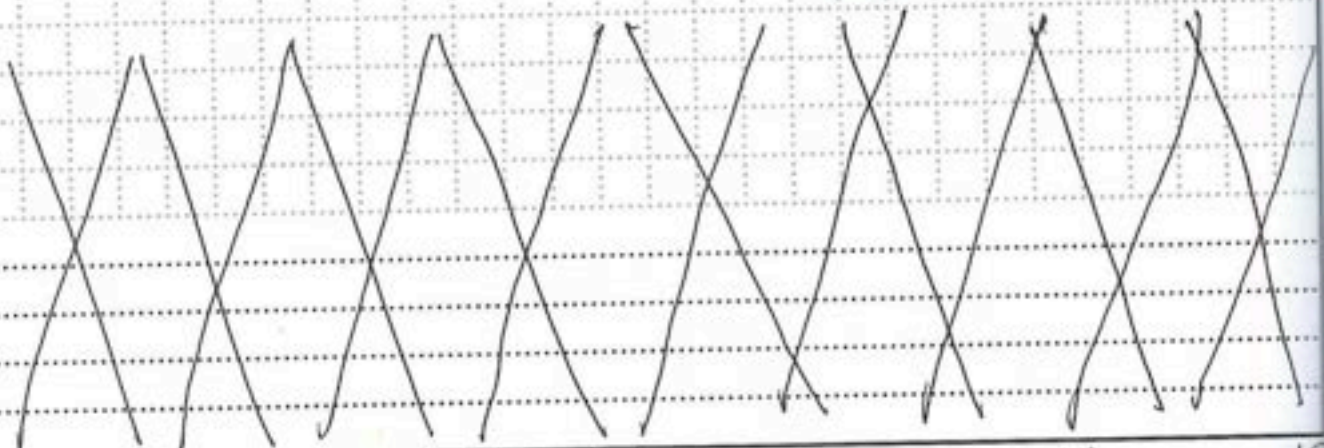


omni wheels

AFTER (mecanum wheels)



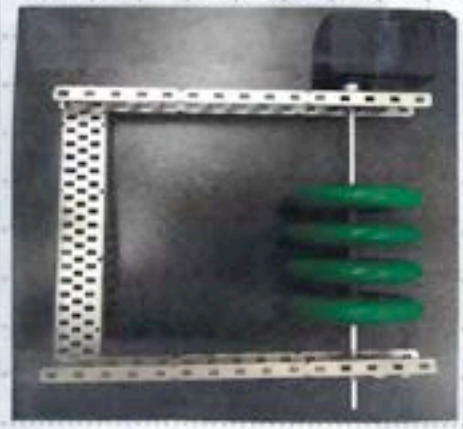
Front view ↓



project Mecanum wheels designed by: Riley witnessed by: Lucy Liu

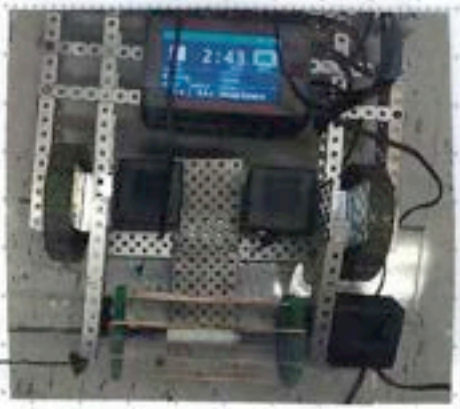
date: 10/18/22

10/25/22 We worked more on testing and constructing disk pickup/intakes today. Sungjin had a design with 4 smooth wheels connected through by a long axle with a motor attached on the end. Rain had a design where he had 2 24 tooth gears with 4 rubber bands pulled about 6 inches apart. Rain's design relies on the friction between the disk and rubber bands, while Sungjin's design relies on the friction between the wheels and disk. -LL



Sungjin's design

Rain's design



10/31/22 Todd worked on the launcher, and was able to make the launcher launch the disk fast enough to make it into the goal. Rain also continued working on his disk intake design and added a curved metal section for the disks to move up. However, after testing his design, he discovered that the disks would get stuck and couldn't be moved up. -LL

TOP VIEW

gears connected by chain

rubberbands

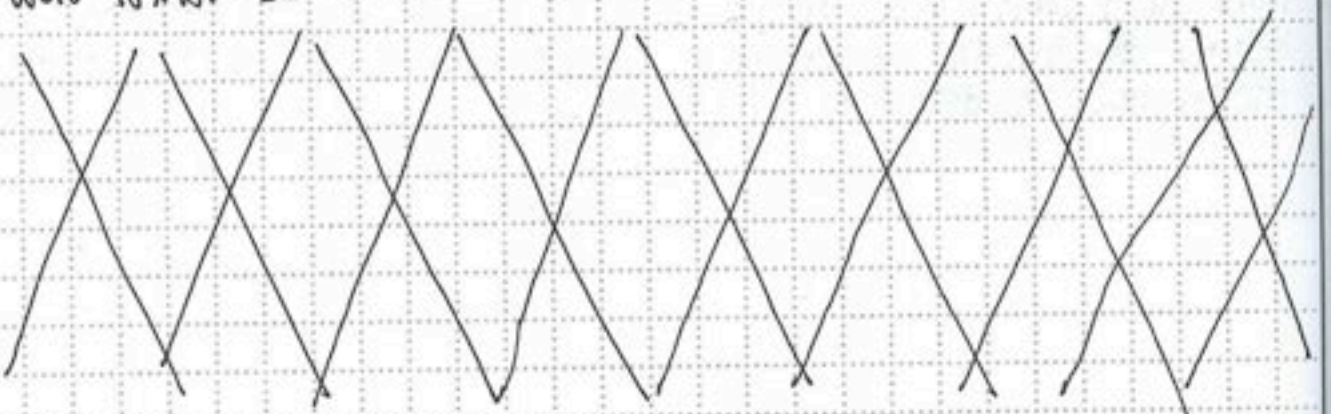
motor

SIDE VIEW

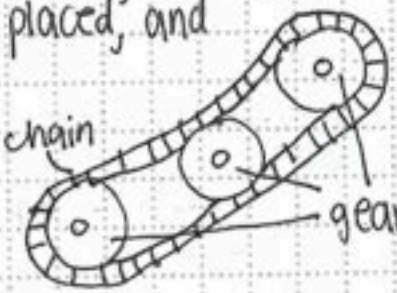
project disk intake designed by: Rain witnessed by: Lucy, Lil

date: 10/31/22

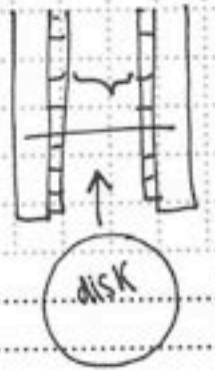
11/1 Rain decided to detatch part of the disk intake to bend the end of the curved metal ramp to allow for disks to be picked up. Riley worked on modifying the base to make sure the dimensions were 18 x 18. -LL



11/7 Rain attempted to connect the 3 gears together using a chain, but it wasn't working since the gears were not evenly placed, and the chain was too loose. we shortened the chain and it worked! Unfortunately, when we tested our design, we realized that the rubber bands did not create enough friction to pull the disk up. -LL



Shaun and Rain decided to try a new design, using tread chains to support the disk instead of rubber bands. But after only a few minutes we suddenly thought of the problem of how we'd get the disk into the tread chain system. -LL



The disk would not be able to enter, since the spacing inside/between them had to be exact to the disk. -LL

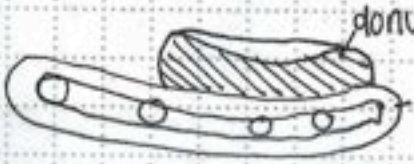
side view →

Top view →

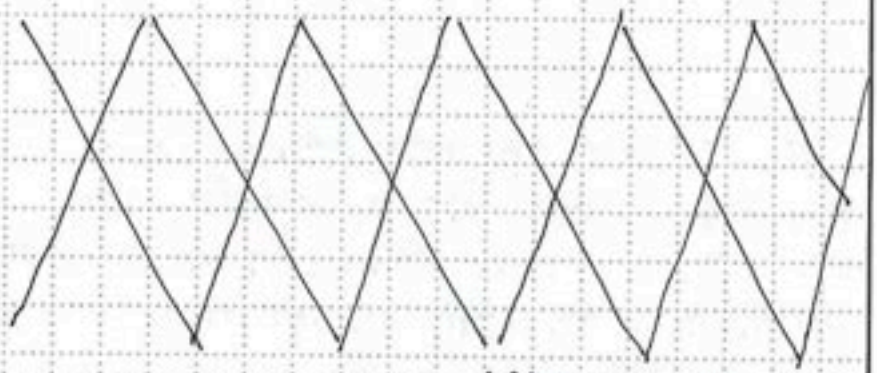
project Disk intake designed by: Rain + Shaun witnessed by: Lucy Liu

date: 11/7/22

11/7 (continued) I suddenly thought of a water ride of a donut moved along a path in a river by a conveyor belt. I suggested we instead place a conveyor belt in the middle of our metal structure. -LL



←Tread chain design, requires a little too much precision in terms of getting disks in the correct position in between. -LL

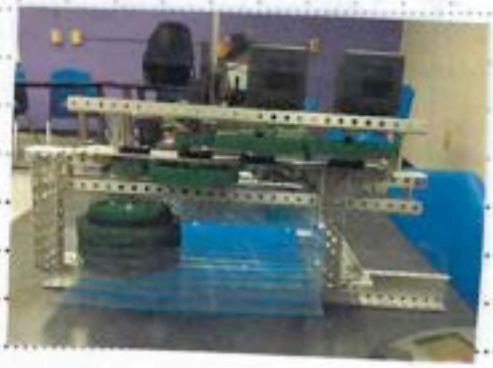


11/8 We worked more on our disk launcher design, increasing the gear ratio to increase the speed in order to launch the disks far enough. We calculated the speed at which the fly wheel spins. -LL

$$600\ \text{rpm} \cdot \underbrace{\left(\frac{84}{36}\right)^2}_{\text{gear ratio}} = \boxed{1900\ \text{rpm}} = 31.7\ \text{rot/s}$$

BEFORE

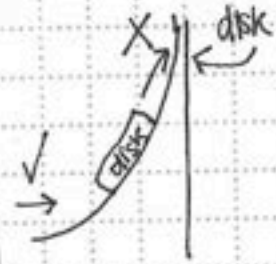
AFTER



project Disk Intake designed by: Rain + Shaun + Sungjin witnessed by: Lucy Liu date: 11/7/22

11/14 We encountered a problem with our disk launcher. One of the motors kept overheating, and the wheel was not getting up to speed, when it had previously been fine. We suspect that it's a problem with the overheating motor as the other motor is fine. We tested using a different motor, and it worked fine, however we need a turbo motor to replace the faulty turbo motor, which we don't have. -LL We also changed some of the gear locations to make sure the 2 motors are more evenly stressed. -LL

11/15 To solve the motor problem, we're switching the gearbox from the faulty motor into a working motor.
We noticed a new problem in the disk intake design as well. The dimensions at the bottom are wide enough to allow the disk to pass in, but the width at the top was blocking the disk from leaving. We adjusted our design to widen so that we can accomodate the disk size. -LL



our current design.
The top needs to be widened.

Riley started working on controls for the fly wheel as Ian attached a new working motor back onto the disk launcher. -LL

project Disk Launcher motor problem

designed by: Ian + Riley

witnessed by:

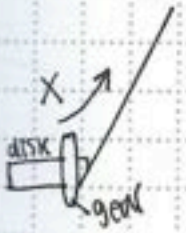
date: 11/5/22

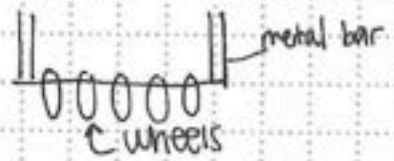
11/21 Unfortunately, even after attempting to fix the gear ratio, our launcher still cannot launch the disk effectively. Our design is already so bulky that increasing the disk ratio again wouldn't be worthwhile. With only 7 meetings left until ~~over~~ our tournament, we need to change our launcher design.

We will have 2 wheels on either side of the disk and one gear ratio.

We are also trying to figure out how to get the disks into our intake. Once they're inside, our design can smoothly transport them up, however it's getting them inside that's giving us some difficulty. We tried simply putting a thin bar with 2 gears on either side at the bottom, but the angle the gears make with the slope is too steep.

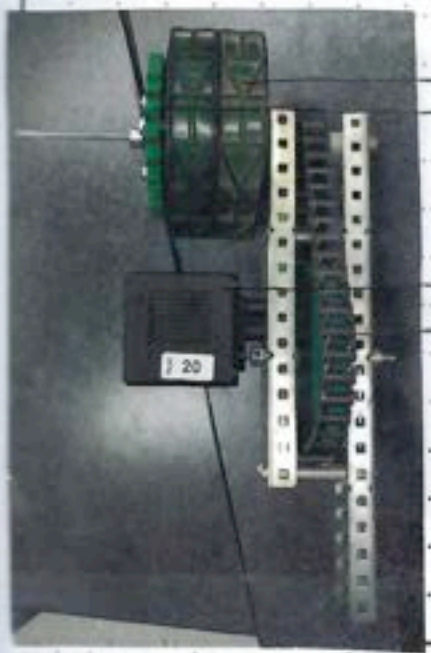
To make the disk entry more flexible, we plan on adding



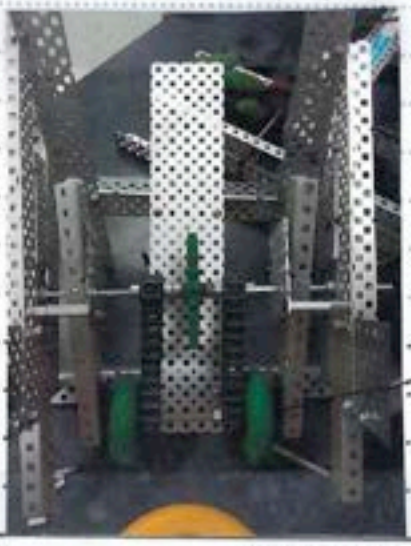


to the bottom that will be able to move slightly up and down to allow easier entry. -LL

1/2 of Launcher↓



Disk intake↓



project Disk Launcher Redesign designed by: Riley witnessed by: Lyay Liu

date: 11/21/22

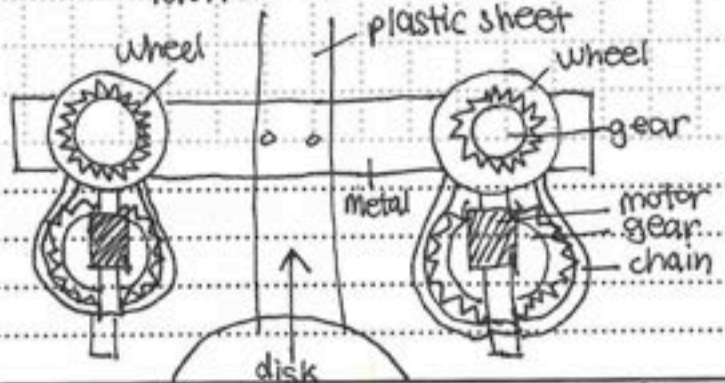
11/22 We modified our roller design to have it fit on the side of our robot, since previously it would have taken up the entire front or back of the robot and we want to conserve space to fit the intake and launcher. The design is now simpler, 2 metal bars on either side of 2 omni-wheels used to spin the roller. We tested this design and were successful.

Right now our priorities are finishing the disk intake and launcher, then successfully attaching them onto the base. -LL

FRONT VIEW

SIDE VIEW

11/28 we're almost done constructing the launcher. The disk should go in between the 2 wheeled disk wheels and be shot out on the thin plastic sheet. The disk seems to not have enough friction with the wheels to be readily shot out. -LL



project Disk Launcher Redesign designed by: Riley witnessed by:

date: 11/28/22

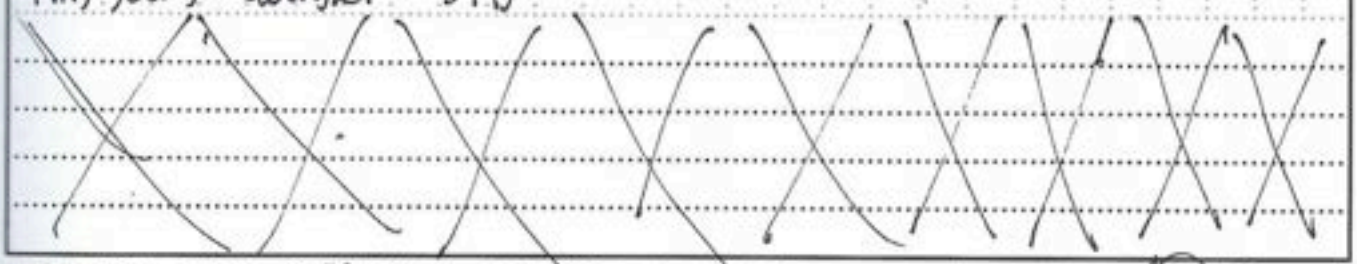
11/29 We added some mesh and rubber bands to the wheels to help the disk be shot out of our launcher.

12/05 We made some changes to the intake today. The main problem with the intake had been that there wasn't enough friction between the disc and the vanguard section of the intake, meaning discs were not getting a significant enough initial push to get them into the intake. If a disc was given a little nudge, the intake could do the rest — we needed more grip at the very beginning.

The solution for this came from something we'd built already: the flywheel. We knew that the launcher had sufficient grip on discs, so we took what we had in the launcher — two wheels, stacked, wrapped in mesh, the mesh being secured with rubber bands — and put it at the vanguard of the intake. We geared this vanguard wheel such that it spins four times as fast as the rest of the intake. This is working very well — the intake can pick up discs fairly easily.

We also gave the launcher its first proper test when it was firing at the goals from ground level, and it performed far better than expected. We were able to score goals from behind the autonomous line and were even able to hit above the goal (this is not due to inaccuracy; we hadn't attatched the launcher and so were holding it ourselves). However, the power was extremely inconsistent with some shots going halfway across the field and some only going a few inches. We added another layer of mesh on top of the first, theorizing that the thicker sections of mesh were responsible for the successful shots. This improved the situation, but not 100%. Tomorrow we will need to investigate this further and increase consistency.

Additionally, we don't currently have a way of connecting the intake and launcher to each other and the robot, and the intake is a bit too big to fit on the robot at the moment. We have three in-school meetings and a six-hour Saturday session to fix these issues and make autonomous. This seems doable. — SPD

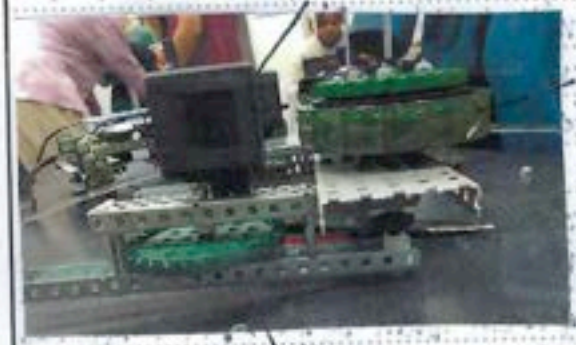


project Disk Intake Modification designed by: Sam P-D witnessed by: [signature]

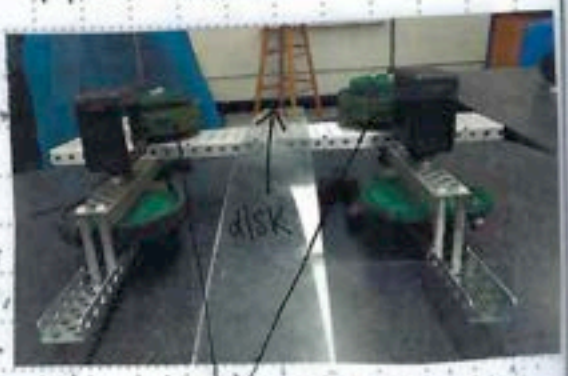
date: 12/5/22

12/05 (continued) Launcher:

side view ↓

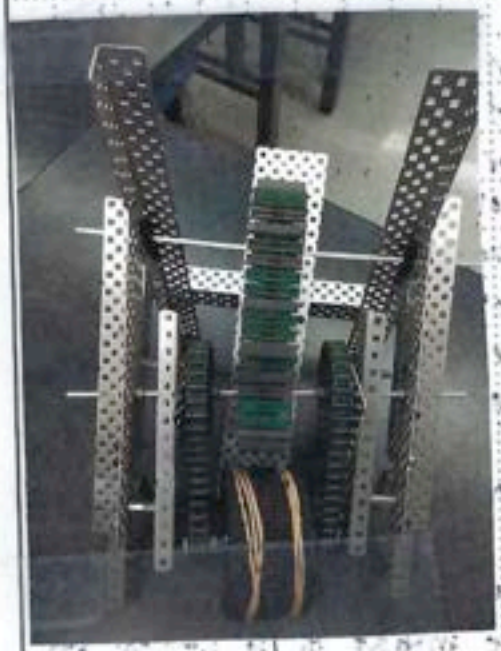


Front view ↓



Front view ↓

INTAKE



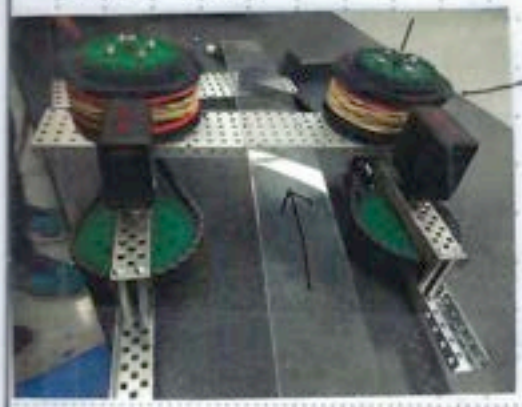
side view ↓

project DISK Intake Modification designed by: Sam P-D witnessed by:

date: 12/05/22

12/6 We added mesh and rubber bands to the wheels of the launcher for increased friction.

Front view



wheel with mesh + rubber band

Side view

We tested the launcher and the disk was able to be launched more effectively and smoothly.

We then examined the disk intake system and discovered the outer metal structure to still be too constrictive, and it didn't fit well on the base. The intake was also not designed with the launcher in mind, so we found it hard to figure out how to attach the 2 separate parts. We decided that instead of trying to attach 2 separate parts onto the robot, we would try to first attach the launcher and intake together and then attach them to the robot.

To do this, we had to remove a lot of the outer metal structure to fit and connect the launcher together. Next meeting we'll try and connect the launcher and intake together and attach it to the robot- LL

simplified ~~not~~ disk intake:

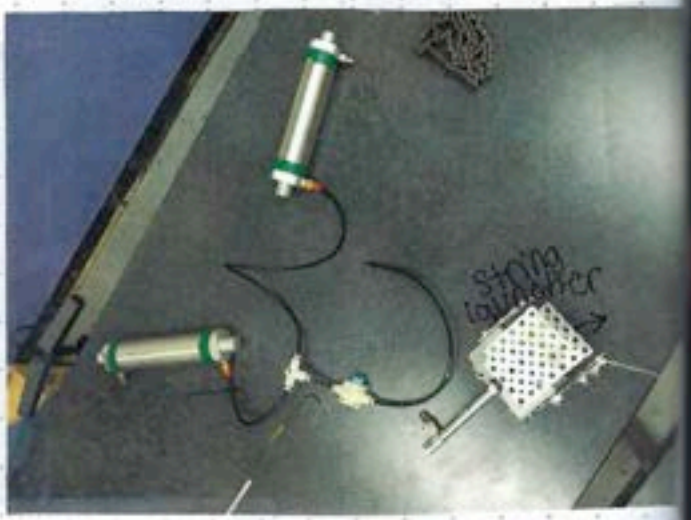
project Disk Intake ~~Redesign~~ Simplification designed by: Sam RD witnessed by: [signature]

date: 12/6/22

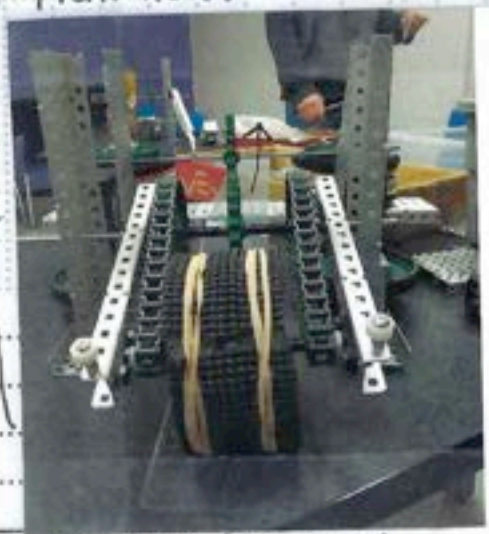
12/10/22 After removing the frame to our intake, we were able to attach it to our intake smoothly. by adding metal guards at the sides of the launcher.
we also worked on an extender design of using pneumatics to launch a string with a weight at the end, so we can get more points from having contact with more floor tiles in the last 10 seconds.
we changed the wheels on the roller to omni wheels + mesh + rubberband for better grip on the roller.
our launcher is angled at about 45° and works great, able to shoot disks from half/ middle of the field. our intake is still having trouble. -LL

Roller turner ↓

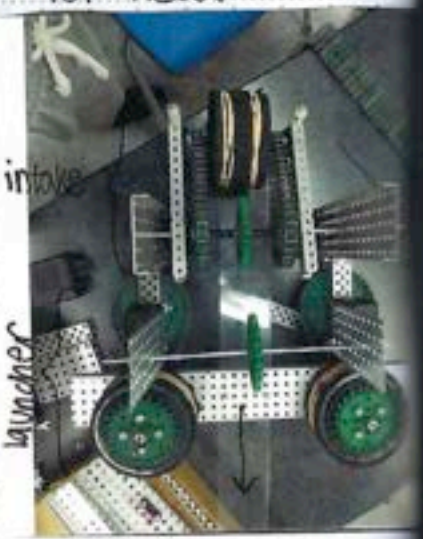
Extender using pneumatics ↓



Front view ↓



TOP view ↓

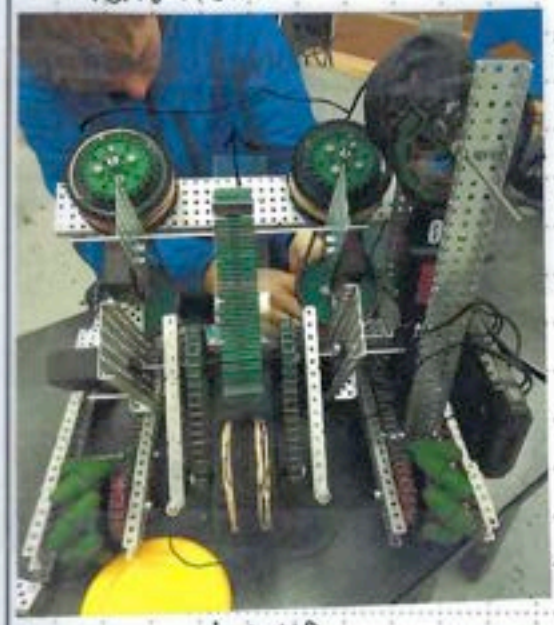


Connecting launcher and intake. The disk should travel along the plastic to the 2 spinning wheels of the launcher. → intake

project Robot construction designed by: Riley, Todd witnessed by:
date: 12/10/22

12/10/22 (continued)
We were able to attach our launcher + intake onto the robot.

Front view ↓

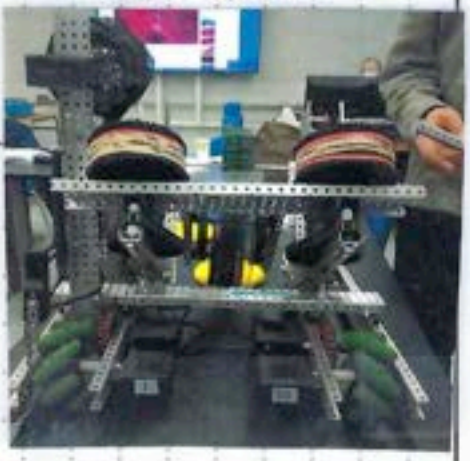


roller
turner

intake

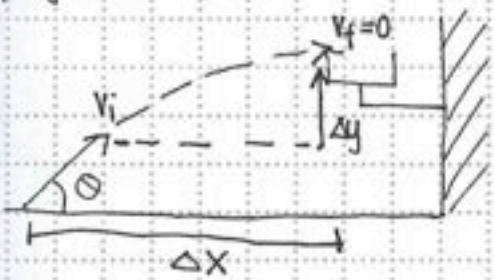
Back view ↓

launcher



Next meeting we're planning to attach the extender and pneumatic system underneath the launcher, as well as try to figure out how to get the intake working smoothly. -LL

12/12/22 To find how fast the flywheel needs to spin given the distance between the robot and the goal, we used a 2D physics projectile equation.



$\theta = 30°$ $\Delta y = 0.45m$

$V_x = \frac{\Delta x}{\Delta t}$ $V_{fy} = V_{iy} + 2a\Delta t$ $V_i = \sqrt{\frac{39.2\,\Delta x}{\cos 30}}$

$0 = V_i \sin\theta + 2a_y \Delta t$

$\Delta X = V_i \cos 30 \Delta t$ $0 = V_i \sin(30) + 2(-9.8)\Delta t$

$\Delta X = \frac{V_i^2 \cos 30}{39.2}$ $\frac{1}{2} V_i = 19.6\,\Delta t$

$\Delta t = V_i / 39.2$

project Robot Construction designed by: Riley, Todd witnessed by: Lucy, Lin

date: 12/10/22

12/12 (continued) Here is our code for the robot so far.

```
// ---- START VEXCODE CONFIGURED DEVICES ----
// Robot Configuration:
// [Name]               [Type]        [Port(s)]
// Drivetrain           drivetrain    1, 2, 9, 10, 20
// Controller1          controller
// Flywheel             motor_group   3, 4
// ---- END VEXCODE CONFIGURED DEVICES ----

#include "vex.h"

using namespace vex;
competition Competition;

//------------------------------------------------------------
// MISC. FUNCTIONS
//------------------------------------------------------------

/**
 * Starts spinning the flywheel given the specified
 * velocity percentage
 *
 * args:      pct (velocity percentage that the motors should spin at)
 * returns:   ---
 */
void startFlywheel(float pct) {
 Flywheel.setVelocity(pct, velocityUnits::pct);
 Flywheel.spinFor(1000, timeUnits::sec);
}
```

project Code 1 designed by: Riley F witnessed by:

date: 12/12/22

12/12 (continued)

```
/**
 * Stops the flywheel. BrakeType should be set to coast to
 * avoid damaging the flywheel motors
 *
 * args:       ---
 * returns:    ---
 */
void stopFlywheel() { Flywheel.stop(brakeType::coast); }

/**
 * Controls when the flywheel is turned on and turned off
 *
 * args:       ---
 * returns:    ---
 */
void flywheelControls() {
 if (Flywheel.isSpinning())
   stopFlywheel();
 else
   startFlywheel(100);
}

/**
 * Moves the roller forward when the up button is pressed
 * Moves the roller backward when the down button is pressed
 *
 * args:       pct (the velocity percentage that the roller will run at)
 * returns:    ---
 */
void moveRoller(float pct) {
 RollerMotor.setVelocity(pct, percentUnits::pct);
 if (Controller1.ButtonUp.pressing())
   RollerMotor.spin(directionType::fwd);
 else if (Controller1.ButtonDown.pressing())
   RollerMotor.spin(directionType::rev);
 else
   RollerMotor.stop(brakeType::coast);
}
```

project Code 1 designed by: Riley F witnessed by: [signature]

date: 12/12/22

12/12/22 (continued)

```
/**
 * Spins the intake when the left bumpers on the controller are pressed
 *
 * args:      pct (the velocity percentage that the intake will run at)
 *            brk (the mode that )
 * returns:   ---
 */
void spinIntake(float pct, brakeType brk) {
 IntakeMotor.setVelocity(pct, percentUnits::pct);
 if (Controller1.ButtonL1.pressing())
   IntakeMotor.spin(directionType::fwd);
 else if (Controller1.ButtonL2.pressing())
   IntakeMotor.spin(directionType::rev);
 else
   IntakeMotor.stop(brk);
}

/**
 * Moves the robot based on input from the controller joysticks
 */
void move() {
 // Get the joystick values
 int forwardBack = -Controller1.Axis3.position(vex::percent);
 int sideways = -Controller1.Axis1.position(vex::percent);
 int turning = Controller1.Axis4.position(vex::percent);

 // Turn the motors accordingly
 rightMotorA.spin(vex::forward, forwardBack - sideways - turning,
vex::percent);
 leftMotorA.spin(vex::forward, forwardBack + sideways + turning,
vex::percent);
 rightMotorB.spin(vex::forward, forwardBack + sideways - turning,
vex::percent);
 leftMotorB.spin(vex::forward, forwardBack - sideways + turning,
vex::percent);
}
```

project Code 1 designed by: Riley F. witnessed by: [signature]

date: 12/12/22

12/12/22 (continued)

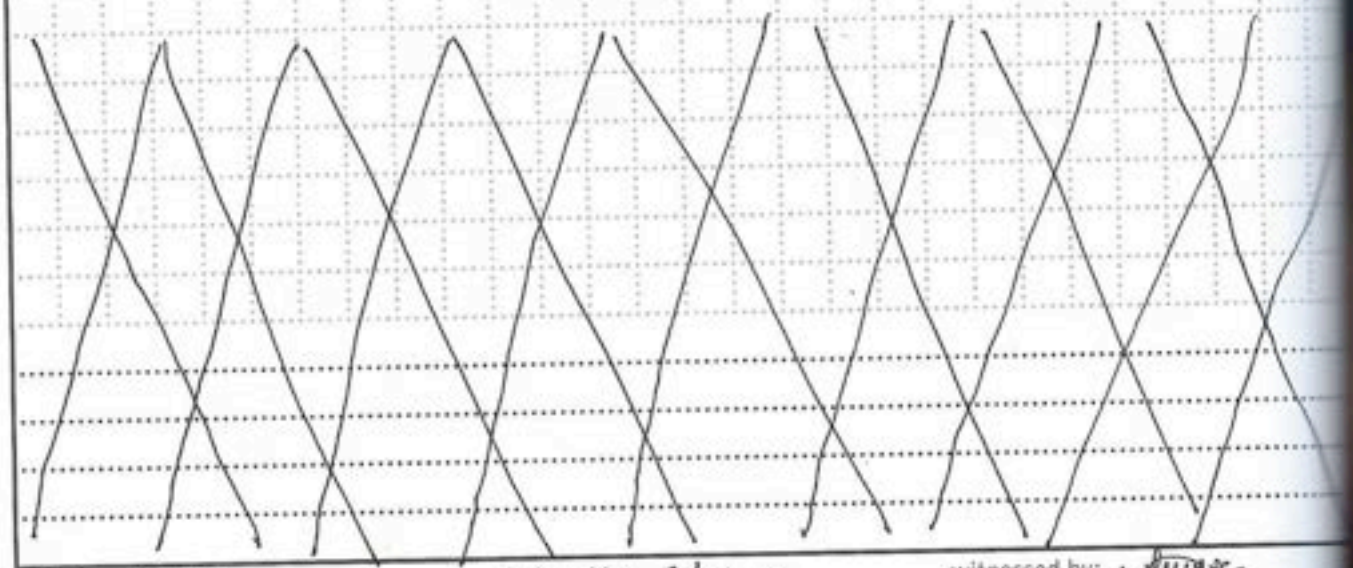
```
/**
 * Activates the piston when the correct controller button is pressed.
 * Piston should not be able to be activated before the 10 second mark.
 * Rumbles the controller and prints time to brain
*/
bool activated = false;
void extendPiston() {
  Controller1.Screen.print(Brain.Timer.value());
  if(Brain.Timer.value() >= 5) {
    if(!activated) {
      Controller1.rumble("...");
      activated = true;
    }
    if(Controller1.ButtonUp.pressing())
      piston.open();
  }
  Controller1.Screen.clearScreen();
}

//*********************************************************
// DRIVER CONTROL FUNCTIONS
//*********************************************************

void user_control() {
Brain.Timer.reset();
 // Start the flywheel at the beginning of the driver control period
startFlywheel(100);

// Main loop
while (true) {
  moveRoller(25);
  spinIntake(40, brakeType::hold);
  Controller1.ButtonA.pressed(flywheelControls);
  extendPiston();
  move();

  vex::task::sleep(1);
}
```

project Code 1 designed by: Riley F. witnessed by: [signature]

date: 12/12/22

12/12/22 (continued)

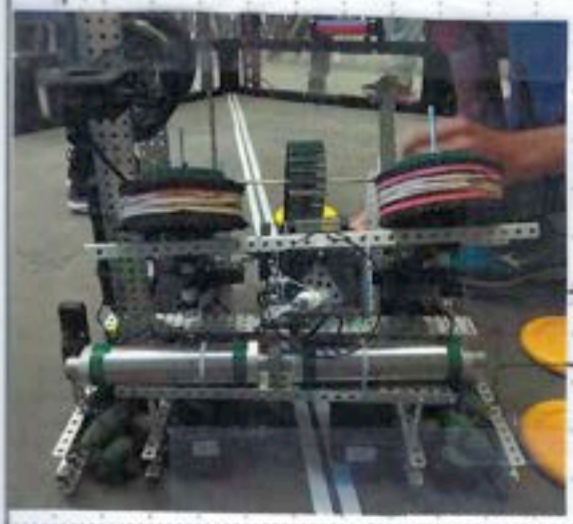
```
//----------------------------------------------------------
// AUTONOMOUS FUNCTIONS
//----------------------------------------------------------

void auto_1() {
 Drivetrain.setDriveVelocity(50, percentUnits::pct);
 Drivetrain.driveFor(directionType::fwd, 10, distanceUnits::in);
}

int autonomous_number = 0;
void auton() {
 printf("<<<AUTO>>>");
 Brain.Screen.print("<<<AUTO>>>");
 Controller1.Screen.print("<<<AUTO>>>");

 if (autonomous_number == 0)
   auto_1();
}

int main() {
 vexcodeInit(); // INITIALIZE OBJECTS: DO NOT TOUCH!!!
 Competition.autonomous(auton);
 Competition.drivercontrol(user_control);
}
```



project Code 1 designed by: Riley F witnessed by:

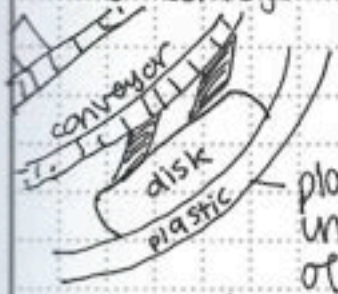
date: 12/12/22

12/13/22

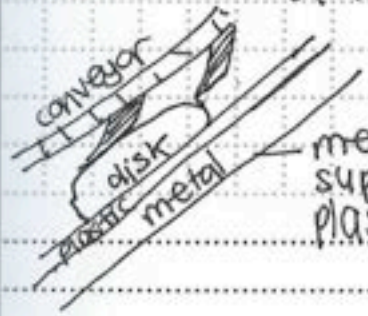


We were able to install the extender under the launcher, with the pneumatic air tanks lying horizontally across the base. String on a metal rod will be able to be launched out and allow our robot to score at least 3 additional tiles, a total of $3 \times 3 + 4 \times 3$ (↑ from robot occupied area) which equals 21 points from tile area. -LL

We noticed for our intake that the gap between the vanguard wheel and the conveyer belt was too big for the disk to be moved up towards the launcher. To fix this, we attempted to use bigger flaps. We were able to intake the disk by driving over it, but it got jammed halfway up the conveyor belt. We noticed that the disk pressed down against the plastic, creating greater difficulty for the disk to be moved. To fix this, we attempted to support the plastic and keep it straight by putting a thin sheet of metal underneath the plastic sheet. The disk no longer gets stuck, but the intake is still very slow. To solve this issue, we attempted to put guides to help the disk stay on track on the conveyor using 1 by pieces of metal as a sort of guard rail. -LL



plastic bending under the force of the disk.



metal to support the plastic.

project Disk Intake Troubleshooting designed by: Ian, Rain, Sam witnessed by: [signature]

date: 12/13/22

12/15/22 we noticed a problem with one of our launchers where one was spinning noticably slowly, slower than the other. we assumed that it was a problem with the motor, but after applying some WD-40 to the connections of the launcher wheel, it starts working fine. -LL

project designed by: witnessed by:

date: 12/15