VEXU 2022-2023 Spin Up

SKAR Engineering Notebook

Rutgers University - New Brunswick

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Team Introduction

Who we are

SKAR (Scarlet Knights at Rutgers) is a team from Rutgers University - New Brunswick, that is competing in the university division of the VEX Robotics Competition. The name SKAR is derived from the first letters of Scarlet Knight at Rutgers. SKAR operates under the Rutgers University's Institute of Electrical and Electronics Engineering student organization, which primarily focuses on helping students develop professional skills for industry. Last season in the Tipping Point, we qualified for the world championship by earning the Design Award at Salisbury University VEXU Winter Tournament where we won Tournament Finalists. During Worlds, SKAR went undefeated in the qualifiers but ultimately fell to WINGU5 in the Semifinals.

Roles on the team

Our team is split up into 2 main subteams. We have a mechanical subteam that is in charge of designing and fabricating the subsystems for 2 robots and then assembling the subsystems together to build the 2 full robots. We have a software team that writes the code required to drive the bot and allow the different subsystems of the robot to function.

Mechanical

The mechanical team primarily focuses on the physical attributes of the robot. This ranges from the electronics such as the motors and sensors to mechanical parts such as the chassis and turret. We are all students from Rutgers University and range from freshman all the way to seniors. The primary tool we used to design was Solidworks to design and we used parts from VEX to design the robot.

Role	Name
Lead	Josh Chung
Lead	Zacharry Soriano
Member	Kyle DeGuzman
Member	Eric Xu
Member	Jouan Yu
Member	Brian Chen

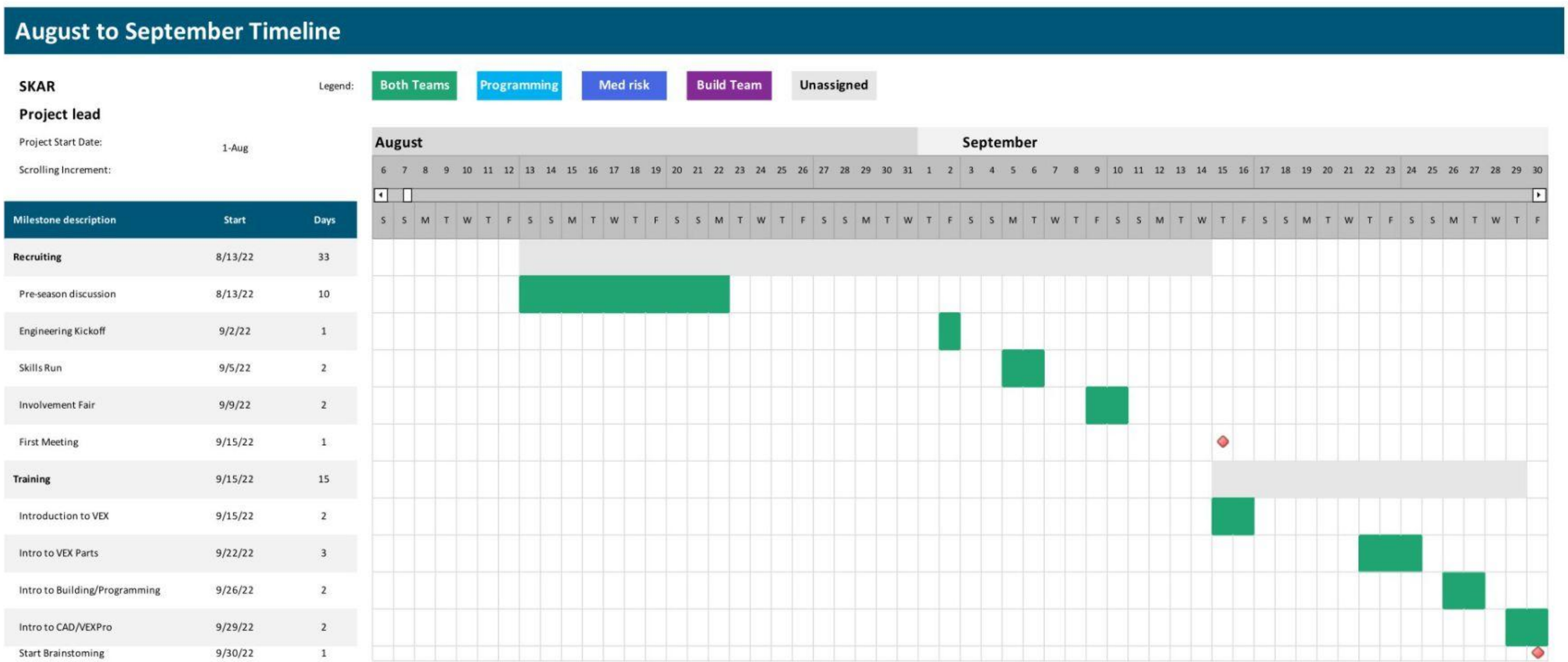
Software

The software team is in charge of programming the robot which includes movement, sensors, and the autonomous period. They ensure that the software is high-quality allowing the robot to work smoothly during the games. The team is composed of three students who are majoring in either Electrical Engineering or Computer Science. They primarily work on the PROS which is a C++ open source development for the VEX parts.

Role	Name
Lead	Jack Lowry
Lead	Jinam Modasiya
Member	Dylan T
Member	Sasha Gupta

Timelines

The timelines are broken down into 2 month increments. The timeline below is the predicted time where we should finish each section. We started planning events out from August, and we wanted to finish the robots by 1/31. Last year, we went through two iterations of the robot before our final design and so this year,



October - November

SKAR

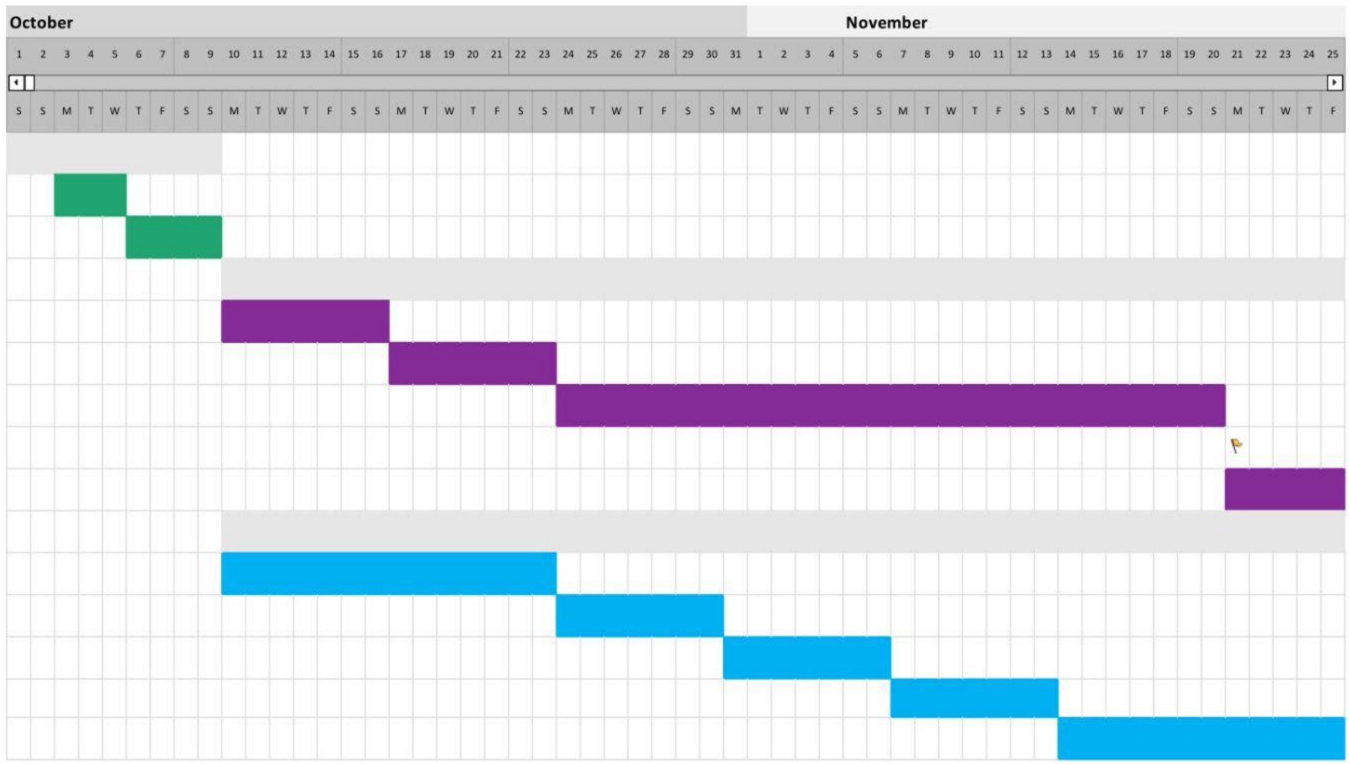
Project lead

Legend: Both Teams | Programming | Build Team | Unassigned

Project Start Date: 10/1/22

Scrolling Increment: None

Milestone description	Start	Days
Brainstorming	10/1/22	9
Ideas	10/3/22	3
Research	10/6/22	4
The First Build Prototype	10/10/22	47
CAD/Planning	10/10/22	7
Chassis	10/17/22	7
Launcher	10/24/22	28
Launcher Test	11/21/22	1
Intake	11/21/22	7
Programming	10/10/22	47
VEXPro Training	10/10/22	14
Movement Coding	10/24/22	7
Odometry	10/31/22	7
Launcher Plan	11/7/22	7
First Iteriation	11/14/22	14



December to January Timeline

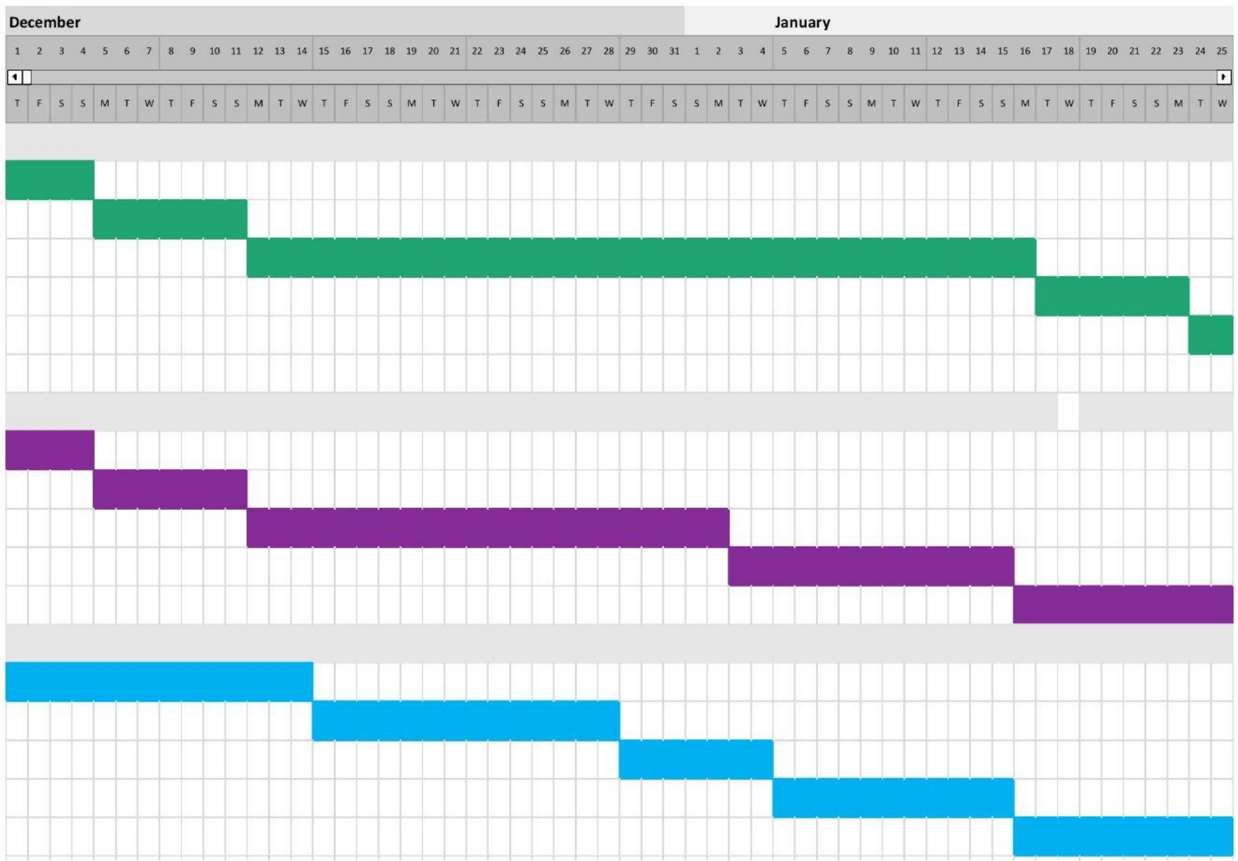
SKAR

Project lead

Legend: Both Teams | Programming | Design Team | Unassigned

Project Start Date:	12/1/22
Scrolling Increment:	

Milestone description	Start	Days
Second Iteration	12/1/22	62
Evaluate the previous design	12/1/22	4
Map out improvements	12/5/22	7
Redesign	12/12/22	36
Re-Test	1/17/23	7
Reevaluate	1/24/23	7
First Competition	1/31/23	1
Second Design Prototype	12/1/22	62
Evaluate Old Design	12/1/22	4
Redesign based on previous results	12/5/22	7
Improve launcher	12/12/22	22
Improve intake	1/3/23	13
Retest and Reevaluate	1/16/23	15
Programming	12/1/22	61
Data Collection	12/1/22	14
Data Analysis	12/15/22	14
Model Selection	12/29/22	7
Implementation	1/5/23	11
Autonomous Period	1/16/23	15



Spin Up (2022 - 2023)

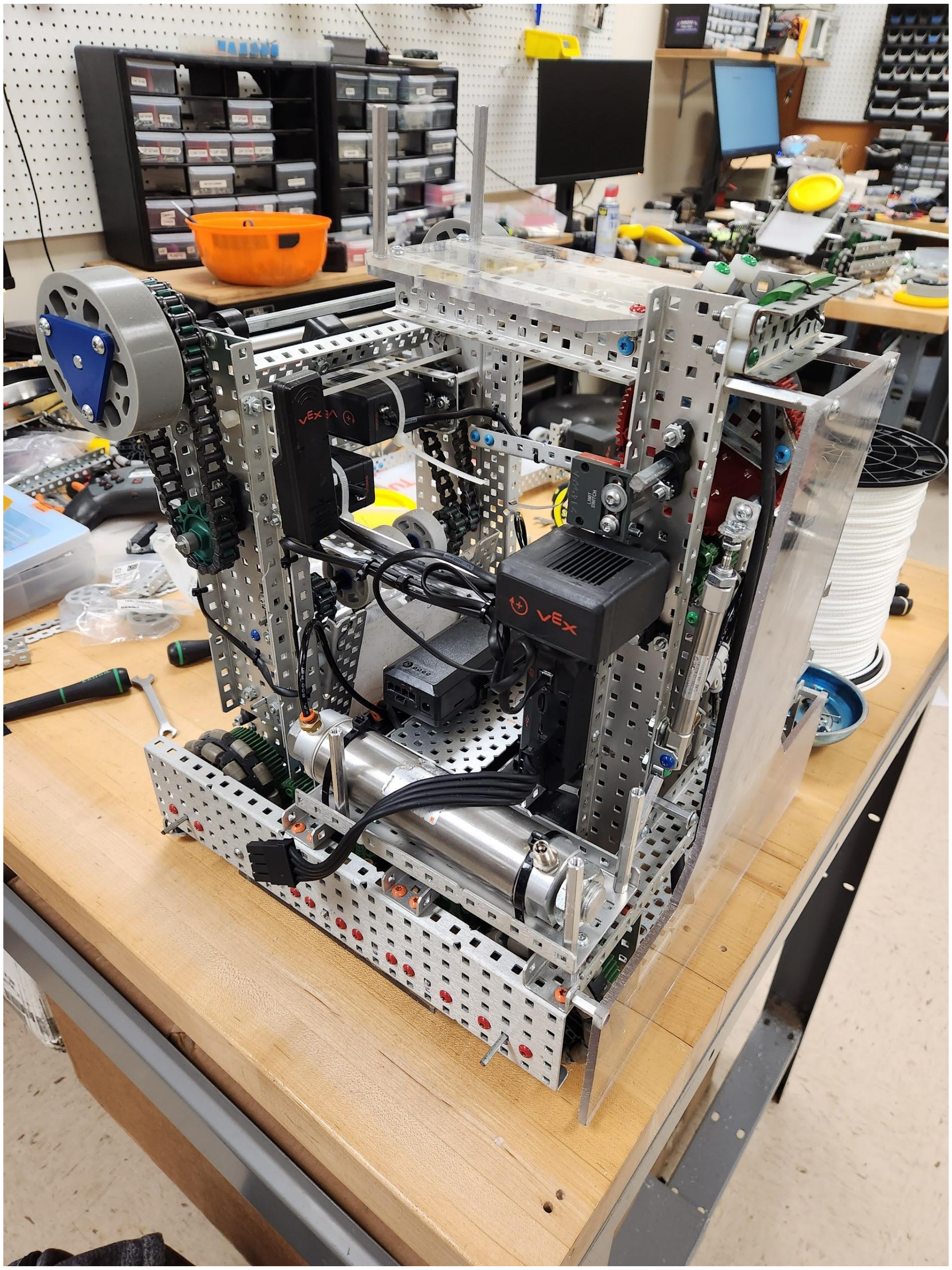
Point Breakdown

Methodology	Value	Quantity
Disc in High Goal	5	60
Disc in Low Area	1	(60)
Rollers	10	4
Covered Area (Per Tile)	3	36
Autonomous Win	10	1

Game Analysis

The game this year, Spin Up, is about creating a robot to launch discs into a goal and then controlling the greatest number of tiles. In the first few glances of Spin Up, there's more emphasis on accuracy compared to last year's Tipping Point.   Given the breakdown of the point system this year in Table 1, due to the high quantity of discs, the most important feature on the robot this year will be the launching system as there's a whopping 300 points available from discs. The second most important feature is the zone control at the end of the game. The total amount of points to be obtained from covering the entire field at the end of game racks up to about 108 points.

Mechanical Design

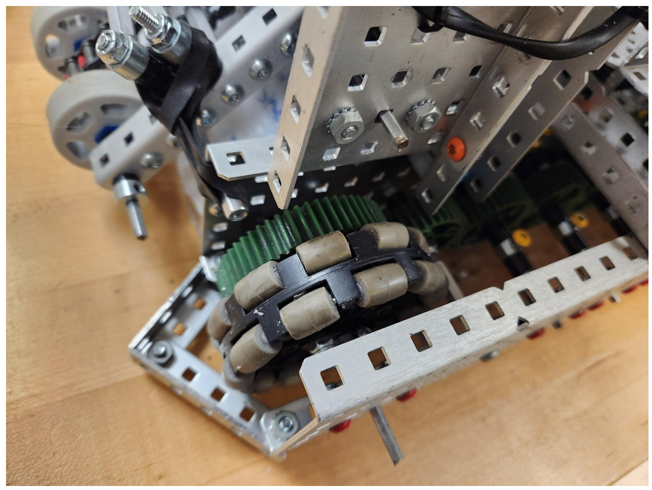


15” Mechanical Design

Chassis

The foundation of the entire robot is the chassis. We wanted our chassis to be sturdy, and still maintain adequate speed and mobility. In order to retain these traits, these are the main specifications we used for our chassis:

Drivetrain



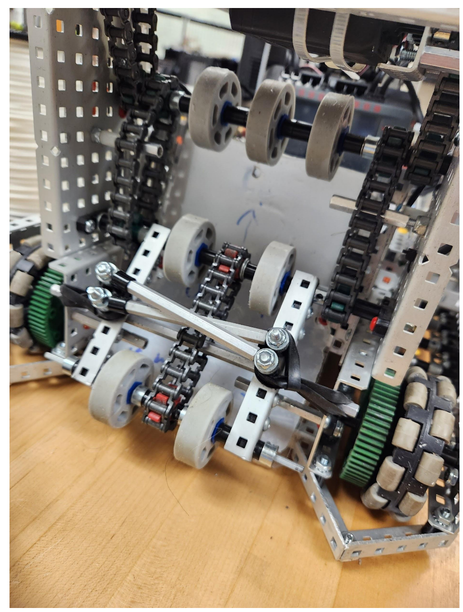
- ➔ a total of 8 motors for the drive
  - ◆ 4 motors on each side geared together
  - ◆ gear ratio of 3:5
  - ◆ 600 rpm
- ➔ tank drive
  - ◆ 3.25” omni wheels, 4 on each side
- ➔ 5-wide aluminum
  - ◆ allows for the wheels to move freely without hindering movement
- ➔ Front Triangle
  - ◆ Allows the the disc to not get stuck

Intake

The intake system is responsible for the accumulation of the discs in our robot. There are several avenues we could have taken for the design of the intake system. Based on our members’ experience from previous years, we decided that one of our main priorities with the intake system would be to ensure flexibility and leave some room for error while accumulating discs. In order to alleviate this concern, these were the parameters with which we built our intake system:

- ➔ consists of 4 wheels, not just 2
- ➔ has the ability to bend slightly
- ➔ we opted to use rollers instead of flaps
    - ◆ rollers provide better grip
- ➔ rather than having a linear ramp, we opted to create a J shaped ramp
    - ◆ ramp significantly bends upward
    - ◆ allows for less obstruction of discs
    - ◆ more compact, leaving room for additional features
- ➔ bottom of the glass just barely touches the field
- ➔ cross bracing the entire structure for firmness

These features essentially enables our robot's intake system to be extremely versatile, allowing for discs in several different orientations and locations to be able to enter the robot. Not only does this allow for more room for error, but this design also removes a lot of variation in how the disc moves once it enters the intake system. The J shaped ramp and the compact nature of the system ensures that the discs only move vertically in one dimension, taking away any further issues one could encounter with the discs.

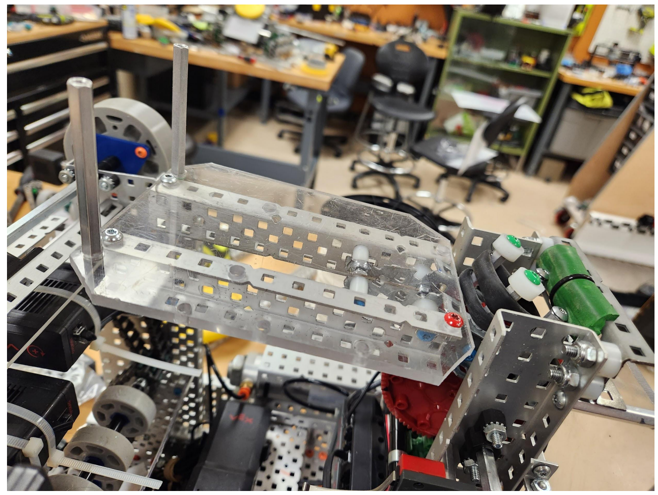


Catapult

For the small robot, the launching system uses a catapult to fling discs. Within the area of the catapult, there's enough space for 3 discs. The launcher utilizes 2 red motors to wind up the catapult and once it hits the empty spot of the slip gear, it launches the all three discs at once. The catapult has a compact design which is perfect for the 15" robot as there's not much area to work and thus allows for more mechanisms on the robot. Features on the catapult include:

- ➔ Glass platform to launch on
    - ◆ Allows for all three disc to align when intaking and shoot in a straight line
- ➔ Stopper perpendicular to the catapult.
    - ◆ Testing indicates that a 90 degree angle had the best consistency scoring
- ➔ Uses rubber banding to initiate spring potential energy

- 2 red motors and a slip gear
  - The powering mechanism behind the launch
  - 2 motors allows for a smaller chance of overheating
- Pneumatics on the side of the launcher
- Used specifically for the autonomous period. A one time use mechanism to launch the disc from a further distance.



The main benefit of this design is the consistency. While the catapult doesn't launch as fast as the other types of shooters, with this setup, we are able to consistently score 3 discs from 3 tiles or closer. In the results sections, we will demonstrate the consistency and the different iterations the catapult went through.

Roller Mechanism

The roller mechanism we created is slightly longer than the length of the entire roller. While the roller is about 13.15" in length, that's the gap between the two rollers on top. This ensures easier defensive play as the robot can block other teams from accessing the roller. It's also easier for the driver to control as well because he/she could come in from either side of the robot and change the color of the roller. The roller is also chained together with the intake system so when the intake is collecting, the roller spins as well. The benefits behind this idea is that it takes up less space and less ports on the robot as we don't need additional motors to power the rollers.

End Game Mechanism

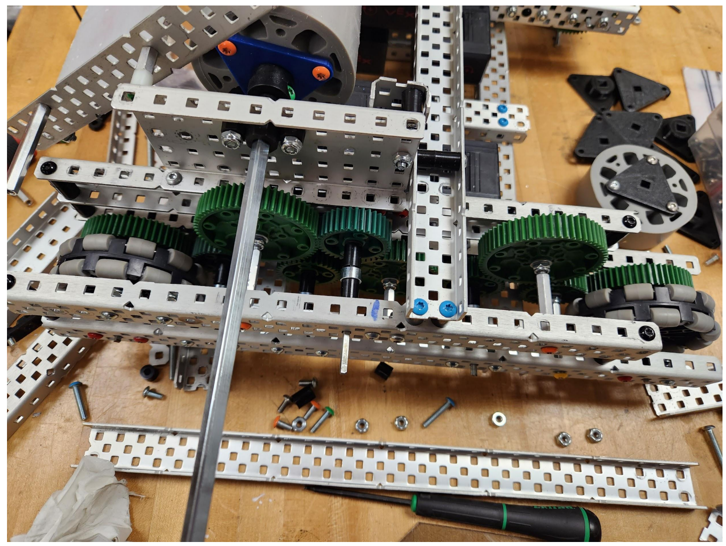
- 5-string launch

18” Mechanical Design

Chassis

Drivetrain

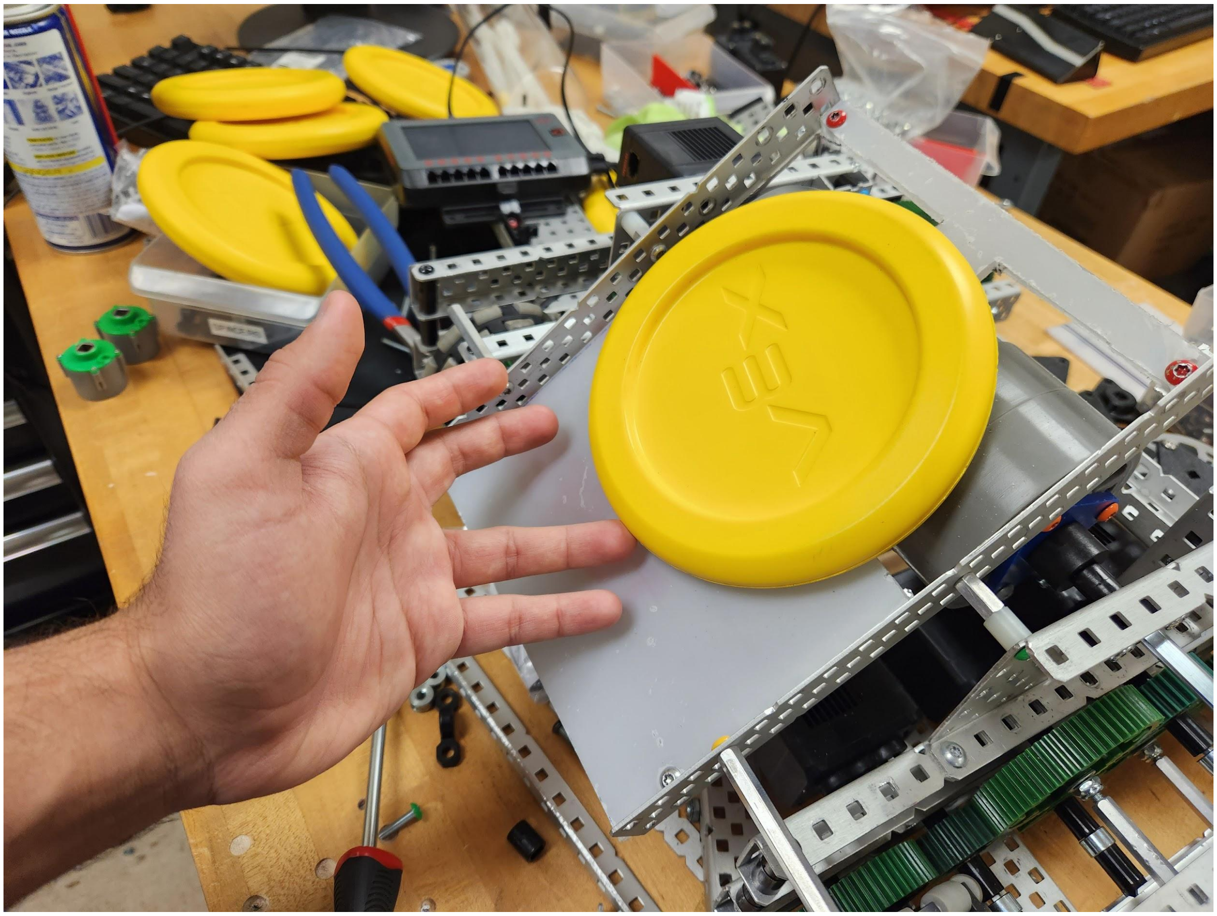
- The drivetrain is made almost entirely out of VEX parts.
    - VEX Motors
    - VEX Gears
    - VEX Aluminum C-Channel
    - VEX Axle
    - VEX Omni Wheels



Intake

We decided to use surgical tubing in our intake system because we needed a way to put discs from the robot into the flywheel. In order to make this happen, here’s what we used:

- 600 rpm motors
    - 2 motors
    - 1.625 inches flywheel
- we custom designed and 3d printed/fabricated our adapters



How did we decide the disc path?

- we have a funnel design with guard rails in front of wheels to help funnel discs into the intake without jamming the wheels
- combined use of intake motors to spin the wheels of the roller wheels

Turret

What is it?

A flywheel that can rotate 360 degrees to track the goal regardless of range and position on the field.

How it works:

Initially, a disc enters the magazine through the intake system while the magazine is in the down position. With the aid of the elevator, using a rack and pinion system, the magazine goes up. This elevator uses a 200 rpm motor that has enough torque to move all the mass. As the magazine goes upward, the disc reaches the flywheel, which is supported by the gantry. The gantry rests on a stack of 5 ball bearings. We use a flex wheel to spin a gantry that is on ball bearings, bearings meant to reduce friction.

How did we create our design:

Elevator: one of the restrictions that we needed to monitor for the elevator was volume. Keeping this in mind we tried to make the footprint as small as possible. In terms of gears, we used 36 tooth gears because they provided us with sufficient linear travel per revolution and they were small enough to fit our elevator system. Along with that we also used rack gears which were modified from original VEX parts to allow for fasteners to fit inside the holes.

Magazine: it was a custom design to have the angle of the magazine exit match the angle at which we are planning on shooting the discs. There were 2 major designs we considered for our magazine:

1. simple connection to pneumatic system which would displace the discs around 2 inches but this was insufficient for disc to reach flywheel
2. magazine uses pneumatics with series of extra members to displace the disc more than 2 inches, making the displacement sufficient to reach the flywheel
    a. this method gave us more horizontal space to work with compared to the little vertical space we got from design 1

Gantry: our gantry needed to be able to rotate freely with minimal friction so we decided to use a stack of ball bearings as the tires/tracks for the gantry

- this helped us minimize the friction between the gantry and gantry support

Gantry support:

- it is essentially a giant plate with a hole in the middle to allow discs to pass
- acts as a support structure for the gantry
- provides crucial mounting points for VEX components on the robot

Flywheel: this one is fairly simple: a wheel that spins at 3600 rpm, in order to achieve this speed we designed a custom internal gearbox that would allow us to push the speed up to 3600 pms

Manufacturing

- 3D Printing
- fabricating

Elevator

We 3D printed parts sliding on 2 linear rails on each side of the robot. In order to utilize a rack and pinion system, we had to scale the elevator and go up and down. We did so using a single 200 rpm motor.

- **Conflict 1:** if the linear rails are not aligned correctly, the motor will cause a rotational moment and jam the entire elevator
    - **Solution:** create a bracket so the linear rails are aligned correctly

Magazine

We wanted to create a magazine that can hold up to 3 discs. In order to do that, we 3d printed a storage space that can hold up to 3 discs and used a pneumatic system to actuate the discs into the flywheel. As expected, we did run into a few conflicts, and here is how we solved them:

- **Problem** 1: pneumatic system on its own was not enough to push disc up into the flywheel
    - **Solution** 1.1: add rubber bands to increase the range to which the disc can move to
        - Result 1.1: rubber bands increased displacement by half inch, still not enough
    - **Solution** 1.2: change initial position of disc to rest further up on magazine using a simple block
        - Result 1.2: in conjunction with rubber bands and the block, the magazine can actuate the disc into the flywheel

- **Problem** 2: friction between disc and 3d printed part of the magazine was high
    - **Solution** 2: put a polycarb piece in between the disc and 3d printed part to reduce the friction

- **Problem** 3: as a result of using rubber bands on pneumatic, it increases minimum psi necessary to effectively actuate them, because there is an added force acting against pneumatic

    - **Solution** 3: add more pneumatic tanks to add more pressure, negating the force created by the rubber bands

- **Problem 4: magazine roof**
    - the roof of magazine was initially flat which caused the disc to get lodged, not allowing the disc to go into the magazine
        - solution: ***curve*** the roof to allow for more space, negating the risk of the disc getting lodged

Gantry

We wanted to create a gantry in order to support the flywheel, which can remain
frictionless while rotating about an axis. We custom designed it to fit our robot's specifications and then 3d printed the part. It's job is to essentially help feeding discs into the magazine.

After watching a few FTC bots, we came to the conclusion that using bearing stacks with 2 ball bearings would be a good way to reduce friction as much as possible. The bearing stack acts as a wheel set to allow the gantry to rotate with little friction.

Manufacturing the gantry was more difficult than we had originally anticipated. Here are some conflicts we ran into with the 3d printer and a few solutions:

- proper leveling on the 3d printer
- giant deformities forming on the plate of the 3d printer
- plastic getting stuck on the tip of the nozzle
- complex geometries lead to print failures
- supports being an issue
    - change of software from pruSA TO cura
- ramp is at static angle of 45 degrees

Flywheel

- Custom machined part used to launch the discs
- 3600 rpm spin rate

So, as expected, a motor spinning at 3600 tends to heat up quickly. There's no real solution we could come up with for cooling purposes so this is what we decided to do:

- **solution 1**: quick swap the motor,
    - create multiple motors of same spec and swap them out between matches

Although not the most creative or intuitive solution, it works and it is simple.

Roller Mechanism

Our original plan was to have a single axle with 1 C channel.

- decided to upgrade to cover more space, hopefully leading to more points
- **built** a base with 5 independent c channels
- connected with c channels and screws, axles

- each independent c channel is built with 1 axle, spacer on end, screw on top to allow for seamless launch of string

- for piston: one singular piston, attached to c channel,
    - pops out and launches all 5 independent catapults
- **problem 1**: launching all 5 catapults together, connecting everything together
    - **solution 1**: adding pneumatic piston that allows for all 5 launching at the same time with one single action

So why did we use pneumatics?
Well we already had pneumatic tanks installed so no additional parts needed to be added. A pneumatic piston is also more efficient and consistent, making it an all round winner.

End Game Mechanism

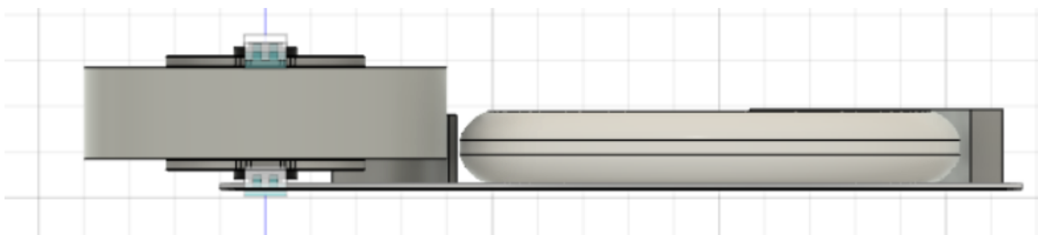
- **5 string launch**

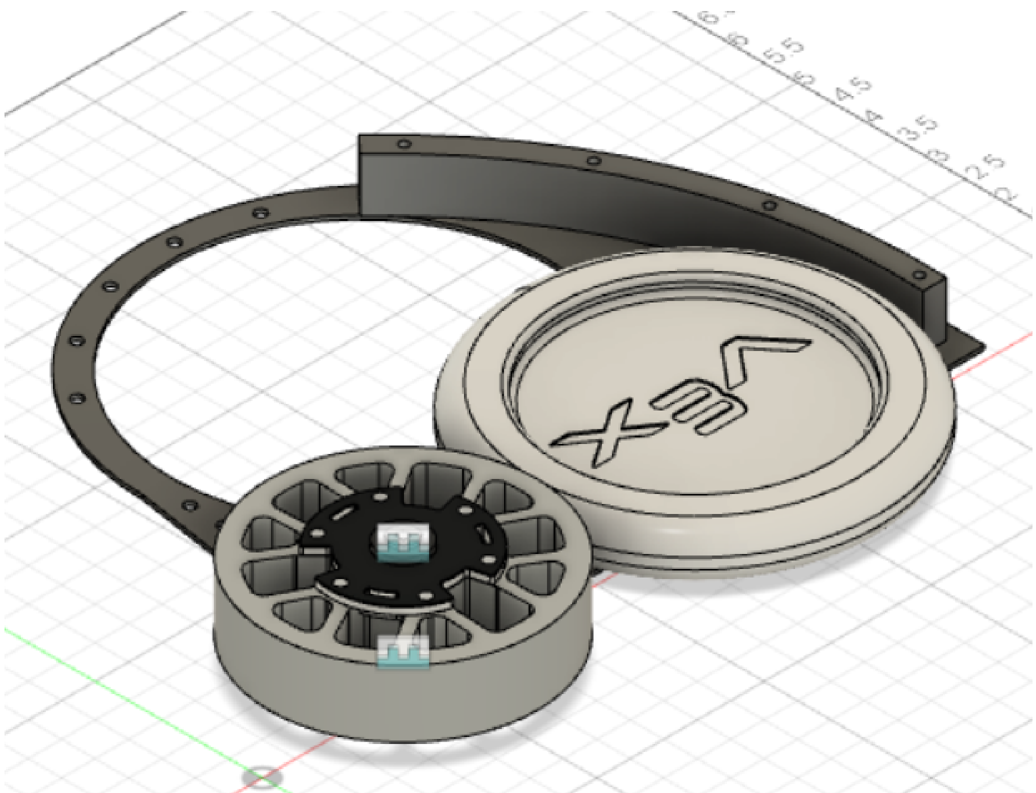
Launcher Tracker

10/31 initial concepts

- V0.0: single flywheel adjuster
- V0.1: 2 flywheel adjusters
  - Realizing math for this will not work out for the angles we want to hit and the RPM needed to be generate and should switch to a turret

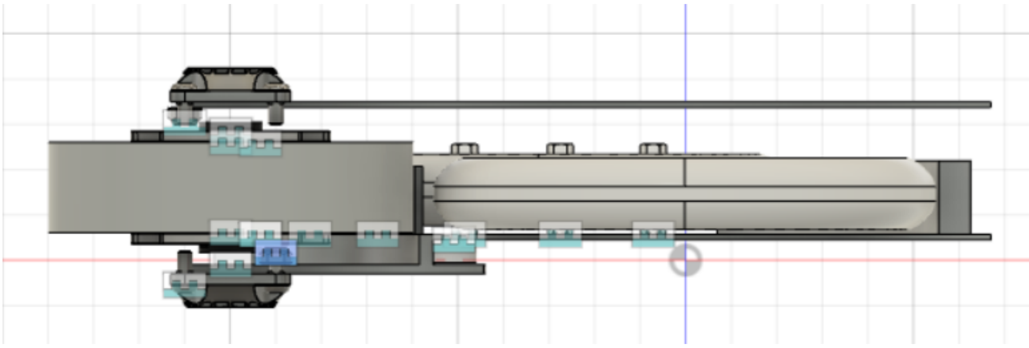
- V1.0: Baseplate completely flat discs barely interacted with the flywheel

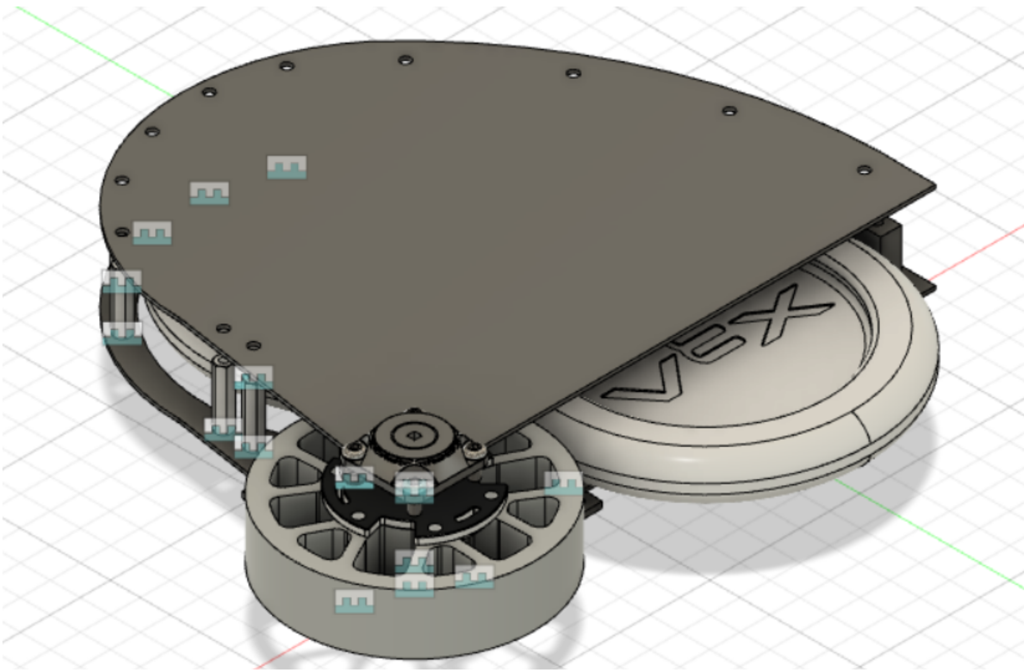




11/27 started the launcher assembly

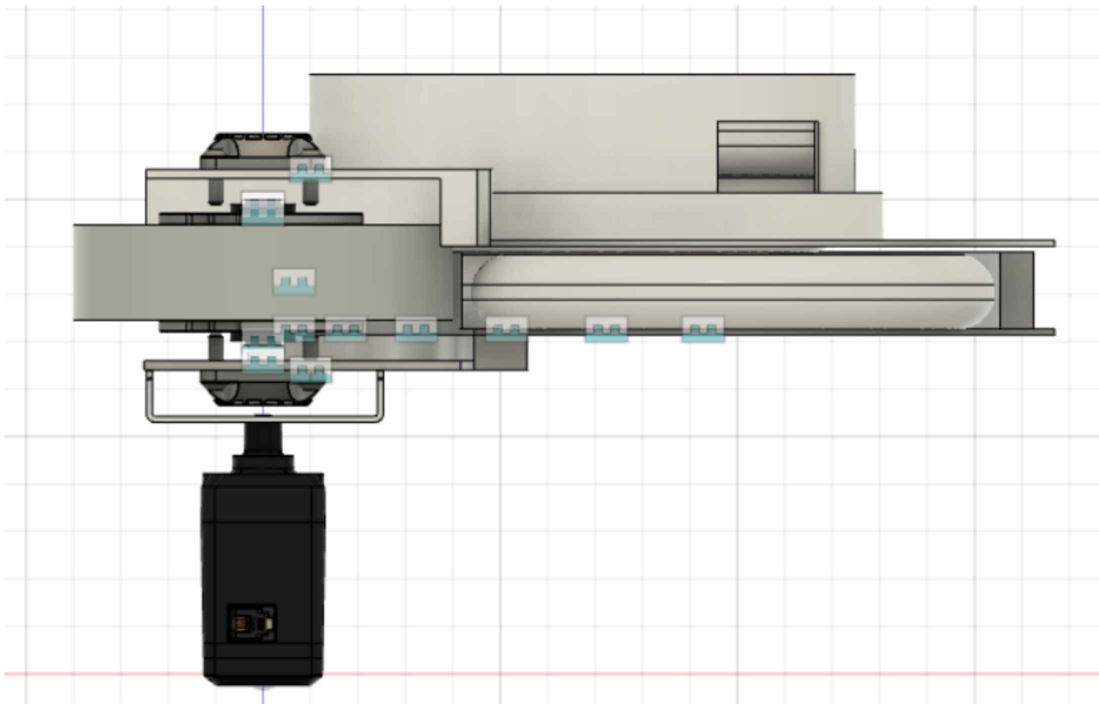
- V1.1: Dip in the baseplate, flat cover plate

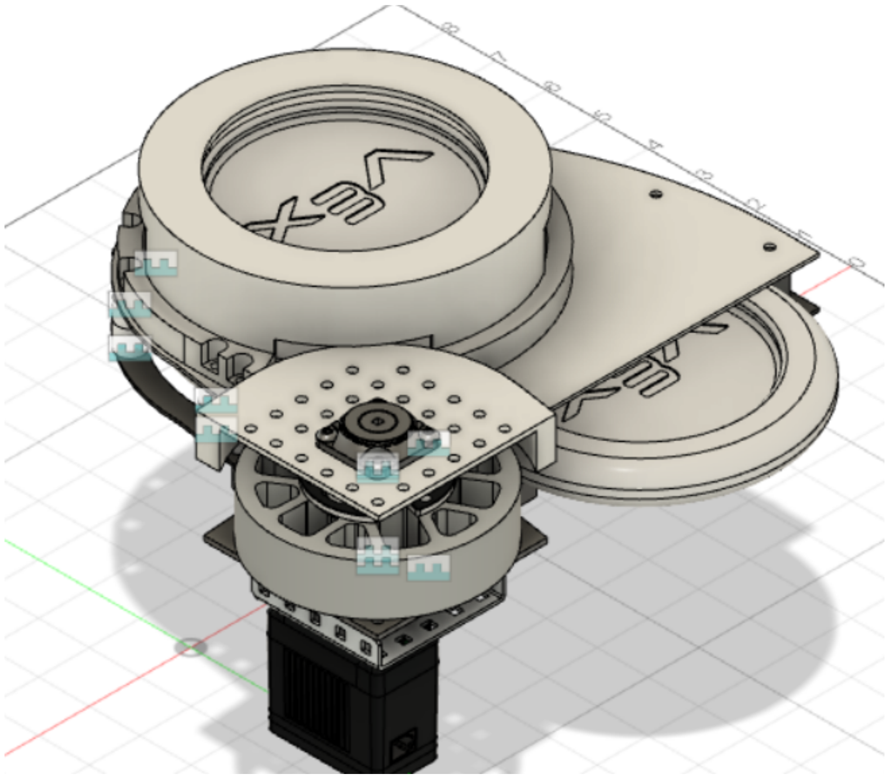




12/1 - 12/2 finishing launcher assembly

- V1.2: Added an extension on top so multiple discs could be stored allowing for rapid-fire capabilities





V1.3: realizing the gantry doesn’t have enough space to fit discs the way we wanted it to and needed to scrap the entire thing

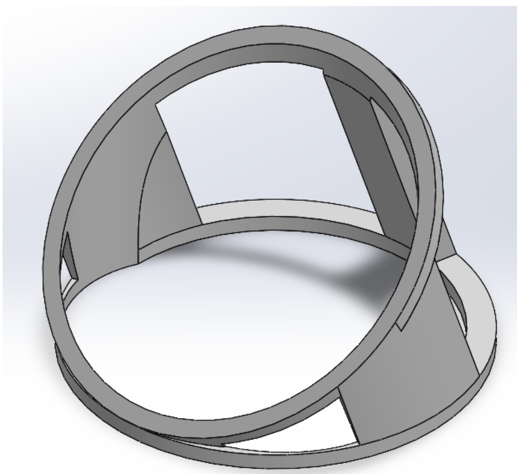
Turret Tracker

12/2 began turret assembly

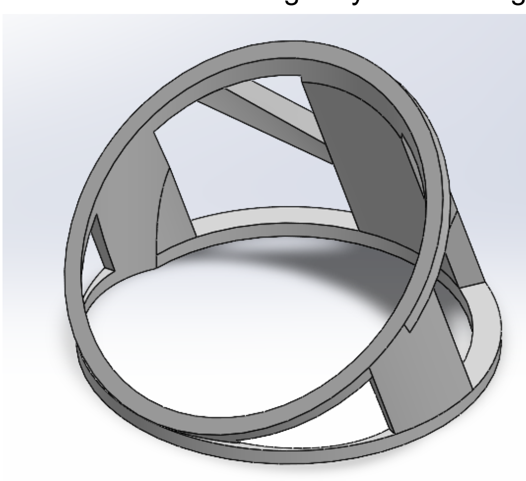
12/3

Trying to get multiple discs to angle solving problem presented in
https://www.youtube.com/watch?v=2A8ReL7fW34

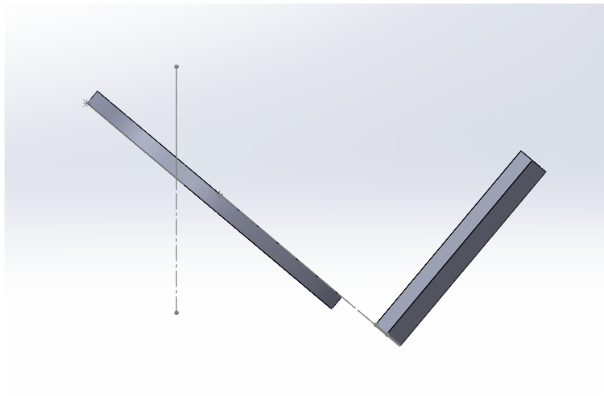
V1.0: no wall for discs gantry has arc angles of (20 front, 45 sides, 60 back)

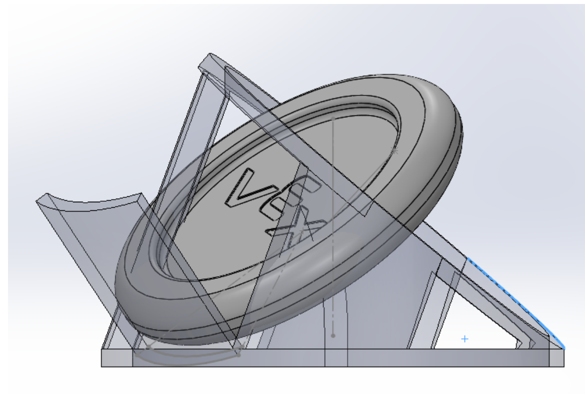


V1.1 no wall for discs gantry has arc angles of (45 front, 30 sides, 60 back) now with arms



V1.2 static wall for discs to stack on then gets pushed up to launcher (simplest) not enough space to accommodate

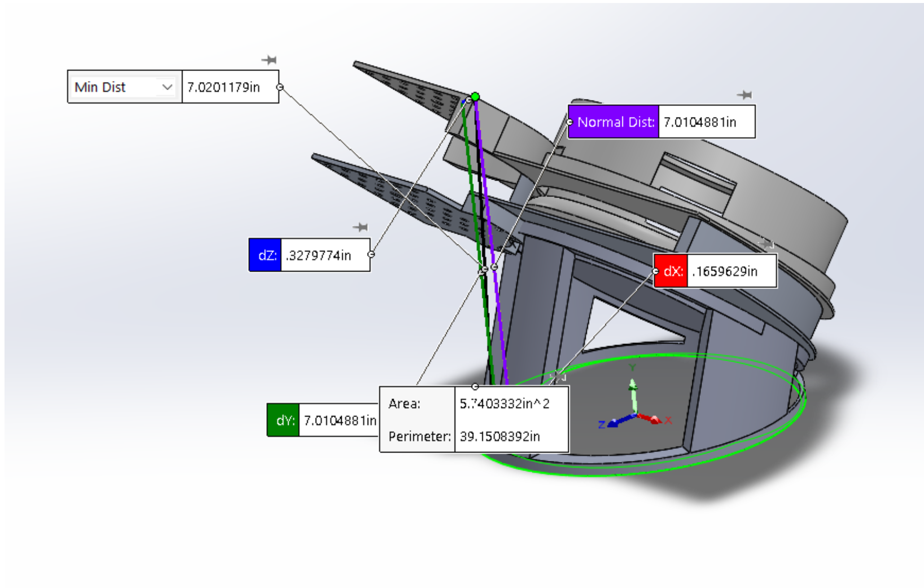




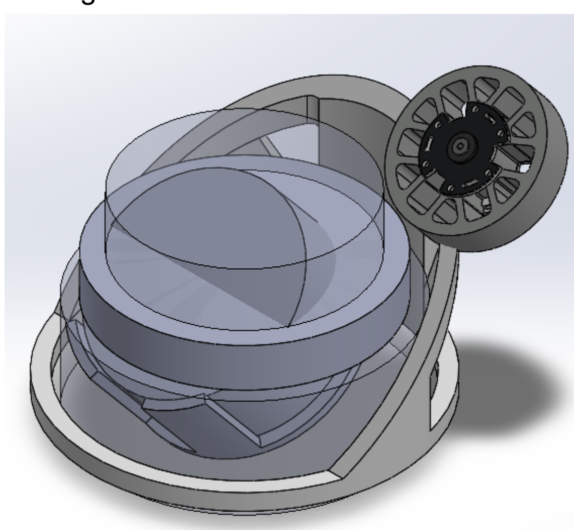
Problem:
Turret could be adjusting and discs won't be able to come up because they need to be in a specific position

Solution

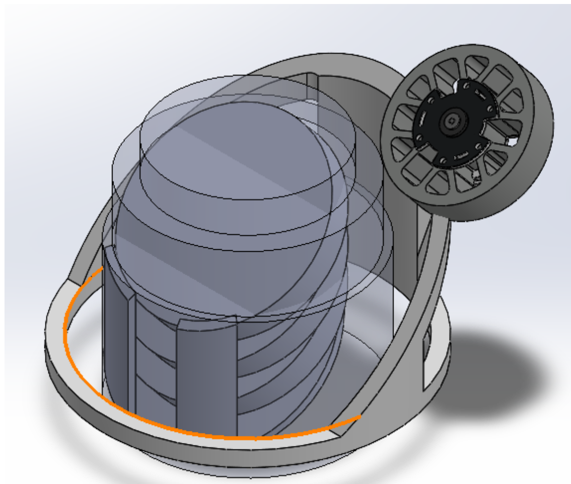
- Make base plate hole bigger and increase distance between base plate and cover
    - https://www.youtube.com/watch?v=bXSdIjpz4x4
- Make the extrusion go straight up rather than normal to the plane
- Cut out the back of the launcher
    - Lifter and launcher could mesh together incorrectly so not possible
- Disc flat when coming up when inside the gantry increases the angle somehow
    - Mechanically more complex
    - Will probably increase footprint of assembly more than other one



V2.0: massive hole to allow for elevator to move freely inside and not hit the gantry now trying to determine how to assemble the flywheel, the transparent cylinder represents a volume where nothing can be mounted or else the elevator will hit it on the way to its max height



V2.1: cut down the height of the gantry (was too big before) changed the extrusion on the elevator to be straight up to decrease unmountable volume space was (254.93in^3 > 234.76in^3) saving volume by 7.8%



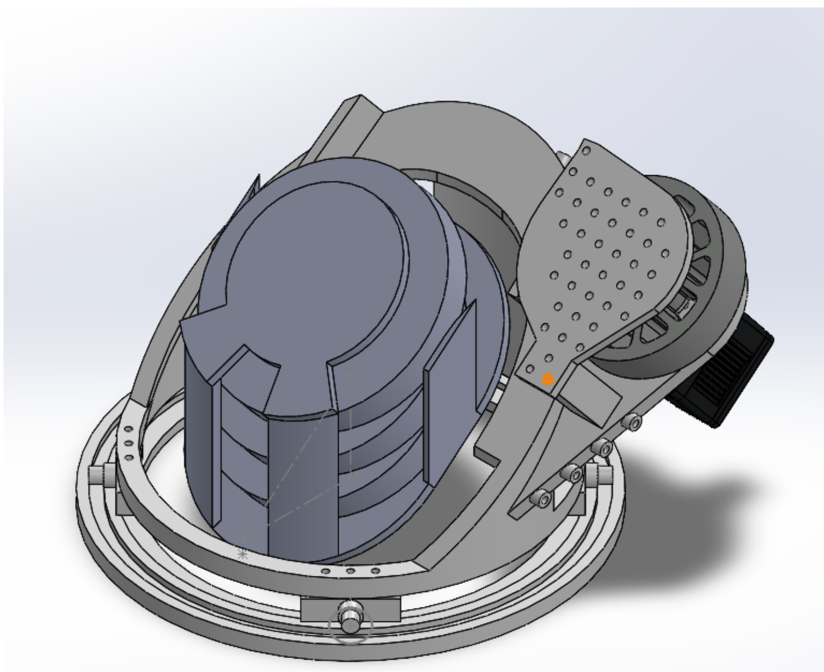
Concerned that indexing the discs will be a problem not be as consistent
Things to look into:

- Where to put the flywheel
  - Horizontally
    - Max diameter tangent or a little intersecting the path of the disc
  - Vertically
    - Where do we want the disc to last touch off
      - Flywheel should accelerate, then we should adjust the angle via a flapper where at least half the disc is off the gantry
      - Also bringing the flywheel closer to the axis of rotation decrease bending/torque
      - Also bringing it closer would decrease the amount needed to push the disc
- Making the whole gantry radially smaller

V2.2: Cut down the height of the gantry even more, added all the support necessary, added the magazine actuator, added the gantry rollers, improved where the flywheel should be placed horizontally after printing and testing V2.1. Between the wall and the center of the flywheel should be 7.431”

12/9-12/12

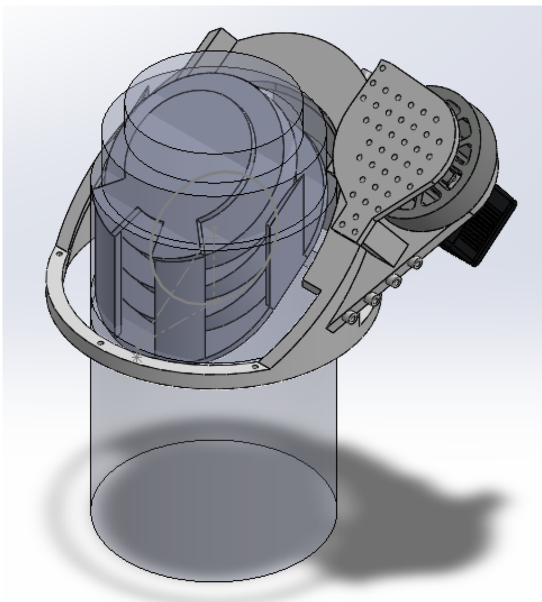
- Added base plate for the flywheel attached 7 8-32 screws around the plate's perimeter through the gantry mount
- Added a top plate for rigidity
- Added walls and a roof to the magazine
- Added a track with approximate locations of where ball bearings will mount to
    - Need to ensure a motor can actually rotate the gantry or whatever
- Added guides on the gantry mount for disc to follow
- Things to look at
    - Foot print of the track is a bit big
    - Still need to make holes to allow for vex parts to mount to



12/15-12/26

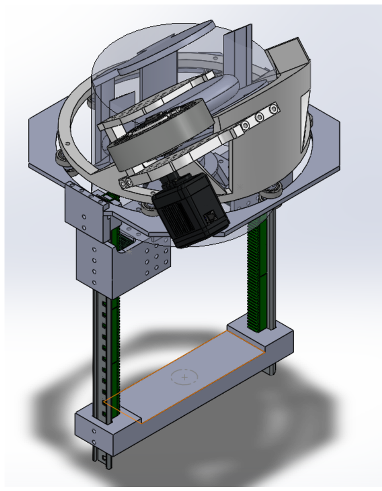
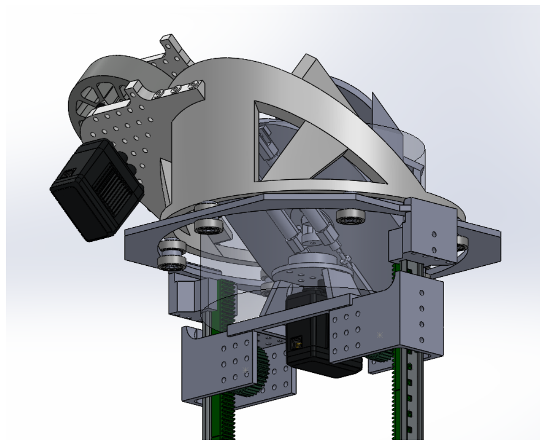
- Finals :)

12/26



- Dimensions Mag Loaded (mag in line with gantry)
  - Height: 8.26”
  - Max Diameter: ~13”
- Dimensions Mag Loading (mag in bottom volume)
  - Height: 15”
  - Max Diameter: ~13”
    - Dimensions of loading area (can mesh with bot)
      - Height: 7.5”
      - Max Diameter:6.9”
- Bearings are now stacks rather than in bending see 12/8 meeting notes
- First prints are starting for the gantry mount, base plate, and cover plate.
-
- Things to consider
  - Filling in support
  - Filling in how the gantry will rotate
  - Filling in how the magazine will rotate
  - Condensing the size of the gantry to allow for more things

V2.2 12/27 - 01/05

- **Filled in mostly how the turret will be supported**
- **Generated how the gantry will rotate**
    - The gantry will use a series of bearing stacks to support the weight of the gantry and minimize friction using ball bearings functioning as a wheel
- **Generated how we will actuate discs**
    - Using pneumatics because the hardware is the lightest and most compact which allows us to fit under the magazine and still be light enough to lift without drastically impacting speed
    - In addition to using pneumatics there will be additional rubber bands to help accelerate the discs if pneumatics are not enough
    - We can also use a series of valves to decrease the velocity of the pneumatics of it proves to be too much
    - A actuator as seen in the video (https://www.youtube.com/watch?v=bXSdIjpz4x4) was considered however the space surrounding the magazine is limited and the size of motors is massive
- **Further shortened the height of the gantry**
    - Before it was too tall so shortened it so we can fit better into the 18” height limit
- **Things to consider**
    - Height is around 17.5” which is cutting it close so reducing the height might be necessary again
    - More support will probably need to be filled in at the back of the turret
    - Testing to ensure that the pneumatics can be actuated to real game conditions and not lose power before time is finished

V2.3 1/5-1/15

- Cut down the height more to 16.75”
- Added more support to the front and back

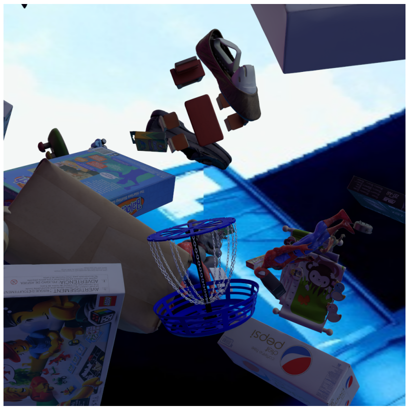
Software Design

External Sensors

For software design this year, we identified that keeping track of and shooting discs at the goals would be a difficult and time consuming operation if performed by the drivers. Thus, we sought to automate the process, especially given our plans for our 360 degree turret design, for which automatic tracking would be vital for a successful implementation. Given that VEXU allows us to explore the use of different types of external sensors, we explored multiple different methods of tracking the mobile goals. Ultimately, we decided upon using an external OAK-D stereo camera. This camera provides both RGB and depth information at a suitable resolution and framerate for real-time detection. It's most attractive feature is the addition of Robotics Vision Core System on a Chip, which allows us to run any modern neural network based architecture directly on the device. This opens up a plethora of possibilities for incorporating modern deep learning techniques for our goal detection and tracking. Before we chose an approach, we had to first tackle the problem of data acquisition

Data Acquisition

The main drawback of using learning algorithms is the prerequisite of a large dataset for training on. We deemed the idea of gathering real data that would provide enough variance for training to be infeasible, given we don't have access to a wide range of environments for taking pictures of the goals. Instead, we looked towards the modern approach of synthetic data generation. Using a software published by Nvidia called NVISII, we exported a CAD model of the goals alongside a selection of objects from the Google Scanned Object dataset, and created 10000 randomly generated scenes of the goal and various objects with randomized poses, and backgrounds.

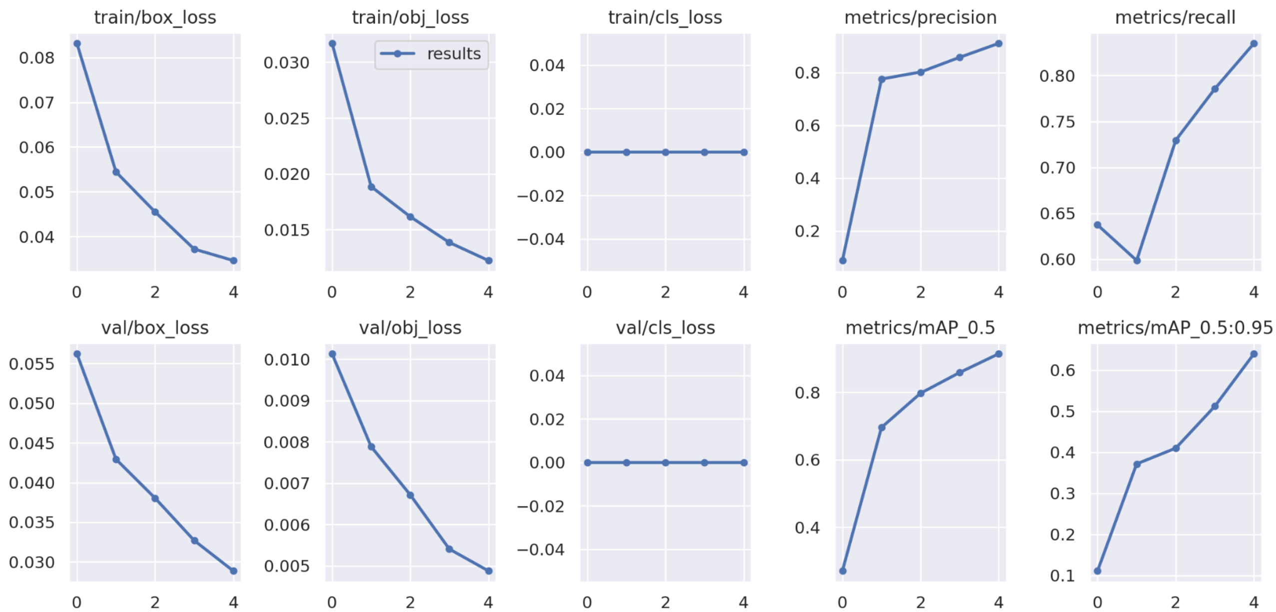





These images randomize the size and place of the goal, and can include partial or full occlusion of the mobile goal. The Environments are more difficult than we would be using during a typical VEX match, but our goal was to train an algorithm that would successfully identify the goal with very high accuracy. If a detector succeeds on this dataset, it will most likely work well in the real world (this is confirmed through our later experiments.

Model Selection

After reading many modern academic papers for object detection, we decided to use the well known YOLOnet architecture for our purpose. The network is optimized to run on any number of different hardware architectures, and is incredibly easy to finetune and export to our Robotics Vision Core on the OAK-D. The model is trained by providing images, and the bounding box of the object in the image. Using the output of our synthetic data generation, we trained YOLOv5 on our data for 5 epochs. Achieving a precision of 89%. This is exceptional performance on a difficult dataset, and we found that this performance transfers well to the real world.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results
train/cls_loss
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metrics/recall
val/box_loss
val/obj_loss
val/cls_loss
metrics/mAP_0.5
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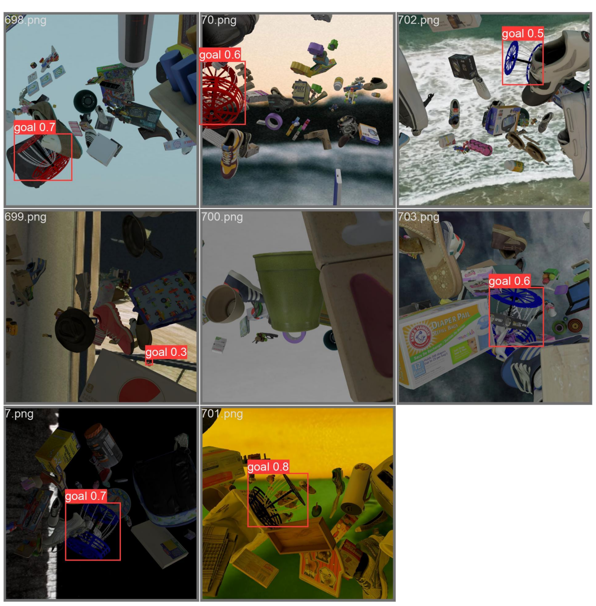
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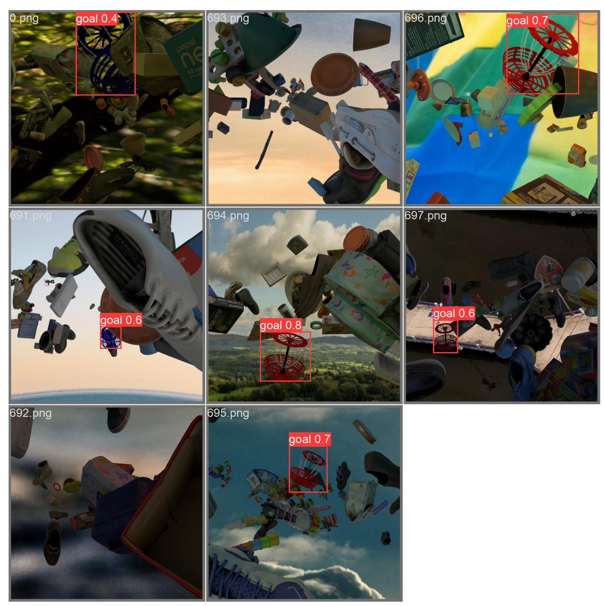
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On-Robot Implementation

To incorporate this system onto the robot, we attached the OAK-D to a Raspberry 4 which can run the intermediate software to start and begin listening to the camera. On average, the camera runs about 30 fps, which means we can extract the location of the goal about 30 times a second. The raspberry pi then communicates this data over Serial to the VEX V5 Brain. Our current implementation for this data is for autonomous and a macro during driver control, which automatically lines up the robot with the goal before shooting. Our future plans for this system will be mounting the camera on the 360 degree turret, and using it to always keep the robot aligned with the goal, so it is ready to shoot at any moment.

Meeting Notes

Summer

05/08/22 Pre-Semester Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	05/08	Document Creation

Parties Involved

Name	Team Role	Report Role
Jack Lowry	Co-lead	Editor
Brian Chen	Build Team	Editor
Kyle Deguzman	Build Team	Editor
Josh Chung	Co-lead	Editor
Zach Soriano	Build Team	Document Owner

Purpose

The primary goal of this meeting is to review the Spin Up game release and start breaking down the game into smaller components so that we could brainstorm ideas to implement on the robot.

Major parts to consider

- Drivetrain
- Intake system
- Shooter/launcher (5pts in the basket | 1pt on the ground | 60 rings total) (Primary)
- Aiming, maybe use computer vision here?
- Roller Controller (10pts | 4 rollers total) (Secondary)
- Area Controller (3pts per tile) (Tertiary)

Similar Games

VEX Turning Point

Shooting Object: Balls
First look ideal mechanisms: Linear Puncher / Flywheel / catapult

FRC Ultimate Ascent
Shooting Object: Rings
First look ideal mechanisms: flywheel

FTC Ultimate goal
Shooting Object: Disks
First look ideal mechanisms: Flywheel / catapult

Caveat
- Possession limit: 3
- Preload : 2
- No horizontal expansion limit for end game (last 10s)
- Vertical Expansion limit of 24”

Other things to look at
- Ratchets - to prevent motor overheating
- Manufacturing
    - Additive Manufacturing materials, stats, costs
    - Considering using CNC for parts

Coding
- Curve generator

Design Goals
Accomplish the task in as little steps as possible

Fall

8/13 Organizational Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	8/13	Document Creation

Parties Involved

Name	Team Role	Report Role
Jack Lowry	Co-lead	Editor
Brian Chen	Build Team	Editor
Kyle Deguzman	Build Team	Editor
Josh Chung	Co-lead	Editor
Zach Soriano	Build Team	Document Owner

Purpose

The primary goal of this meeting is to discuss the logistics for this upcoming season focusing specifically on creating a timeline, recruiting, brainstorming, and finding competitions.

The secondary goal of this meeting is generating content to teach new members, document organization within a drive, and finding templates so our documentation is simpler and easier to read.

The reason we are taking the liberty to implement these steps is because we have learned from our previous experiences that proper planning, organization, and communication makes the life of everyone involved much simpler. We want to plan in advance so that we can be prepared early on to recruit students and help them get involved in the club fairly quickly. One of the common themes we noticed every semester was that several people would show up in the beginning of the semester but due to our lack of planning and ways to get members involved, many would quit very quickly. We are hoping that if we can enable members to start contributing to the robots independently fairly quickly, we will be able to retain more members.

Primary Goal Notes

Organization:

Schedule:

- Introduced a Gantt Chart with deadlines for checkpoints
    - **Checkpoints**
        - Recruiting

                - Brainstorming
                - Designing
                - Prototyping
                - First Competition

- Meeting times:
    - Discuss the optimal time to meet when the school year starts
        - Using the Table 1: Group Availability Chart, the conclusion was to schedule the weekly meetings on Monday and Thursday from 8-10.

Teams Breakdown

- If feasible, we would like to bring back two teams this year
    - SKAR will consist of more experienced members
    - RUSK will be more focused on learning and teaching the new members mechanical design and programming skills
    - The first team will still be guiding the second team but not extensively building to ensure the newer members actually gain skills necessary for their progression in the club
    - Both teams will be competing in VEX competitions

Recruiting

We want to make the recruitment process more active rather than only passive. In order to accomplish an active recruitment process, these are a few ways in which we are planning to expand our recruitment:

- Involvement Fair: Rutgers Club Showcase
    - Takes place on (9/5 & 9/6)
    - Bring bots from VEX to showcase what we built last year
    - Answer any questions people may have, introduce them to the overall IEEE club
    - Invite people to join the discord s
- IEEE Division Breakdown
    - Introduce the robotics division to new incoming members of IEEE
- (Continuous) Classroom Advertising
    - Ask members from IEEE to help promote VEX through small talks in classrooms
    - Maybe speak to Professors and take our robots to classrooms to demonstrate and get people interested in VEX
- Student Activity Center **Secondary Goal Notes**
-
- skills runs

- Set-up a miniature skills tournament similar to the ones that are run at proper VEX tournaments
  - Each person gets 2 attempts to get a score as high as possible
- Introduce last year's game to new students and overall show them what VEX is comprised of
  - Physically driving the robots makes VEX a lot more interesting and enjoyable

Secondary Goal Notes

VEX teaching

- Vex teaching week
- first 2 meetings will be designated towards teaching design process (CAD) and how to test designs
- For the first few weeks (September-Oct) focus on teaching new members about VEX competition overall and teach them what this year's game is comprised of
  - In order to accomplish these tasks, we will have to create content we can use to teach
    - Slides
    - CAD
    - Example videos
    - Game release
    - Proper VEX games from this year
    - Previous VEX games

Potential space for the club:

The primary IEEE lab that we as VEX operate in is shared by a few more sub-organizations that are also part of the IEEE. Due to the nature of robotics and engineering as a whole, the lab often lacks space and is prone to cluttering. Furthermore, we also want a space we can set up a field in to test our robots. Here are potential places we could set up the field in:

- The computer lab upstairs
  - This is what we were able to use last season and it was extremely useful, so hopefully we are able to have access to it again
- Look into a the studio for Extracurricular activities
  - See if we can move into here because it is a newer facility, which could potentially be very appealing to new members

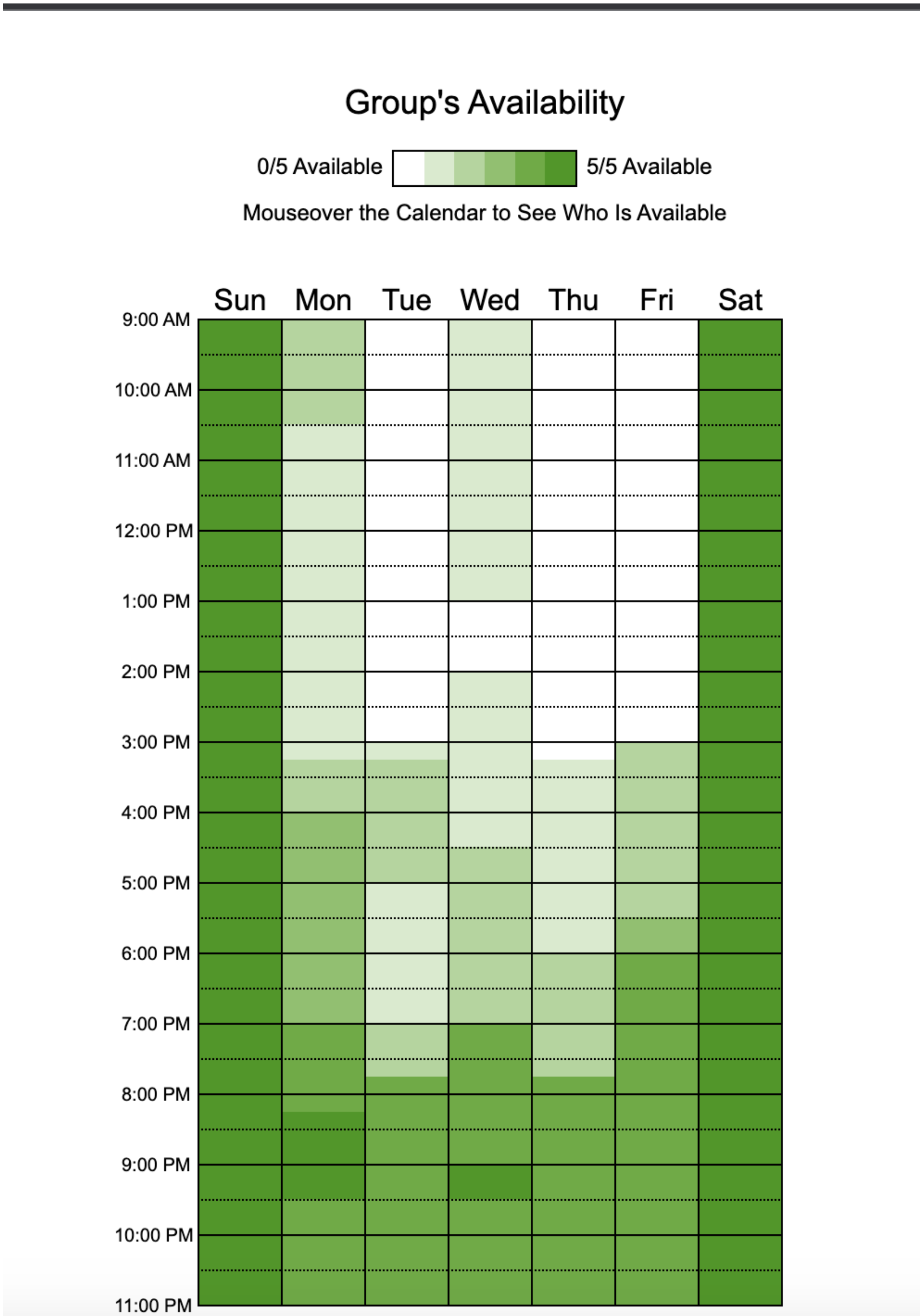
Goals for next meeting

VEX

- Start the Gantt Chart for the Preseason/ September
  - Recruiting
  - Teaching content
  - Research and Development of specific mechanisms and their performance stats
- Define what content we will be teaching

- Update progress on alternative lab locations
- Update progress on securing skills run locations in Busch for recruiting

Table 1: Group Availability Chart



8/22 Organizational Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	8/22	Document Creation

Parties Involved

Name	Team Role	Report Role
Jack Lowry	Co-lead	Editor
Brian Chen	Build Team	Editor
Kyle Deguzman	Build Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Team	Document Owner

Purpose

The primary goal of this meeting is to add more detail to the plan for this upcoming season focusing specifically on creating a rough draft on what recruiting and the first meeting will look like. This is an extremely important discussion since it pertains to how many people will contribute to the team during the season and possibly for the next few years. The first meeting will dictate the amount of people who will be in the club. Within this meeting, we layed out the foundation of the structure of our meetings and our brainstorming for recruiting new members into this club.

The secondary goal of this meeting is to touch base on some of the topics we discussed in the previous meeting regarding space, and some early organization on bot designs that need to be sorted before we get into the thick of teaching.

We are doing this so as to ensure that we have a significant turnout but to also ensure that we can retain as many members as possible.

Primary Goal Notes

Brainstorming:

- How did our current members become a part of IEEE:
    - participated in VEX during high school
    - word of mouth
    - Involvement fair
    - Student center skills runs

Teaching Content Plan:

- **Intro Presentation (first meeting of the semester)**
    - Introduce ourselves and the purpose of the VEX team
    - What are the benefits of becoming members of the VEX team?
        - Immediate access to designing and prototyping
        - Learning content from upper level courses such as CAD, Simulation, 3D Printing, and coding
            - No prior experience needed
                - The first few meetings will be training the new members of the club
        - Travel to different competitions around the nation
            - Last year, the club went to New York, West Virginia, Maryland, and Texas
        - Developing soft skills
            - Working with a team
            - Learning effective ways to communicate your ideas
    - Start showing off previous bots and games
        - Show videos of the games we participated in last year
        - Show reveals that other teams have done for spin up
        - Previous bots
            - Take down the bots from the rack and point out all the mechanisms that previous games utilized
            - Describe how they work and what made them successful
    - How do new people get involved
        - Show up to meetings
        - Timeline and projects
            - Assign different parts of the robot to members to design
                - Ex: one member gets to work on the flywheel and the other gets to work on the chassis
            - Have an objective for each meeting and try to hit the objective

Student center skills runs (after involvement fair days before first general meeting)

In order to attract students, we would like to showcase the game from last year. We plan on creating a miniature skills tournament within the student center as a way to introduce people to the game.

- Multiple sessions as students who can't come to the first one will have the option to come to the ones following.
- The format will be similar to how a skills tournament is ran in VEX
    - The field is set up the same way as it was in Tipping Point
    - We used our big robot from last year as the competitor
    - Created a time sheet for sign up. Each person gets a 2 minute run.

Secondary Goal Notes

Notebook:

- Highlighst the design process not about the specific mechanisms
- Set up a format to structure individual meetings

Early Semester Plans:

- Unlike last year, we will not dismantle the bots and keep the bots for basic programming
  - Allows for newer programmers to get use to VEX code.
- Create an odometry bot with a x - drive chassis

Space for the club:

- The computer lab upstairs
  - Lab is indeed available for use in Spring 2023
- Look into the studio for Extracurricular activities
  - Recently, Rutgers built a new building for Formula Racing, see if there's a time slot that we can use in that building
  - However, the space is already occupied by different engineering clubs so we will stick with our primary lab and the computer lab upstairs in the same building

Goals for next meeting

- Finish the Gantt Chart for the Preseason/ September
- Obtain permission from both the student center and the club lead to initiate the plan
- Finish the presentation for our first meeting
- Set-up and clean the lab
- Update progress on securing skills run locations in Busch for recruiting

8/26 Organizational Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	8/26	Document Creation

Parties Involved

Name	Team Role	Report Role
Jack Lowry	Co-lead	Editor
Josh Chung	Co-lead	Editor
Zach Soriano	Build Team	Document Owner

Purpose

The primary goal of this meeting is to give a quick update to everyone else on what we've been working on and where we could use more hands

We are doing this to ensure we are properly planning and communicating. We would also like to be extremely prepared when it comes to recruiting season in early September so as to get the best people for this team and prepare enough for the potential members so they stay engaged.

Primary Goal Notes

Recruiting:

- Engineering Kickoff
    - The Engineering Kickoff at Rutgers University showcases the different clubs and extracurricular activities that are at Rutgers to new incoming freshmen
    - Plan what to show to them
        - Bring robots from VEXU and IGVC to
    - We need to have meeting dates before then
    - Waiting on when other divisions are having their dates
    - Bringing VEXU Bots and IGVC Bots actively recruiting
- BSC Skills Run Recruiting Tournament
    - Found an employee at BSC to set up specifics of the event
        - Drafted a doc that has the dimensions of field and bots to inform this contact

    - Additional Rules of the Tournament
        - Each person can only sign up once
        - Limit each person to 2 tries. However, if they scan the QR code for the first general meeting, they can get another try.
        - In order to get more people to compete, there's an incentive for a top 3 finish.

Schedule:

- Meeting Date
    - Either Monday/Thursday or Wednesday/Thursday
    - Start on the week of 9/11/22
- Gantt Chart is completed

Teaching Content:

- Intro to VEX Presentation is nearly completed
    - Need pictures where there are blue blocks
    - Need programming content
- Building presentations
    - Reference "(8/22-10/22) Early Season Gantt Chart"
    - Finish presentations by those dates

Goals for next meeting

VEX

- Finish teaching content for the first meeting
- Update progress on securing skills run locations in Busch for recruiting

9/7 Organizational Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	9/7/22	Document Creation

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to give a quick update to everyone else on what we've been working on and where we could use more hands. We also wanted to completely solidify a meeting time so we could inform E-board.

The secondary goal was to inform each other of what basic designs seem promising so that we could look into more depth and determine whether or not we should continue with them in the design process.

We are doing this to ensure we are properly planning and communicating. We would also like to be extremely prepared when it comes to recruiting season in early September so as to get the best people for this team and prepare enough for the potential members so they stay engaged.

Primary Goal Notes

Meeting Times:

As the club starts in a week, the meeting time was finalized to be on Monday and Thursday from 8 pm -10 pm.
https://www.when2meet.com/?16553670-5sAey

Budget:

- Currently, there's no set amount on budget
    - We reached out to Harini (Treasurer) to get an idea but there was no response
- In the meantime we started our own spreadsheet to be more prepared for when we get more details for budget

    - We estimate that the budget should be around $1423. The items that are currently needed are listed below in a spreadsheet.

Part Name	Part Cost	Quantity Requested	Total Cost	Website	Total Cost:
High Strength Shaft Ball Bearing (11-Pack)	$39.99	4	$159.96	https://www.vexrobotics.com/276-8402.html	$1,423.10
Inertial Sensor	$49.99	4	$199.96	https://www.vexrobotics.com/276-4855.html	
Optical Sensor	$45.99	4	$183.96	https://www.vexrobotics.com/276-7043.html	
V5 Flywheel Weight (2-pack)	$19.99	4	$79.96	https://www.vexrobotics.com/276-8794.html	
Potentiometer V2 (2-Pack)	$14.49	2	$28.98	https://www.vexrobotics.com/276-7417.html	
HS Lock Bar 7 Hole, 6 pack, for VEX EDR® High Strength Shafts	$11.00	5	$55.00	https://www.robosource.net/custom-more/high-strength-lock-bars/155-hs-lockbar-7-x6	
HS Lock Bar 5 Hole, 6 pack, for VEX EDR® High Strength Shafts	$8.50	6	$51.00	https://www.robosource.net/custom-more/high-strength-lock-bars/154-hs-lockbar-5-x6	
HS Lock Bar 3 Hole, 6 pack, for VEX EDR® High Strength Shafts	$6.50	5	$32.50	https://www.robosource.net/custom-more/high-strength-lock-bars/153-hs-lockbar-3-x6	
1x2x1x35 Aluminum C-Channel (6-pack)	$39.99	10	$399.90	https://www.vexrobotics.com/channel.html	
Spiral Wire Wrap, Medium, 10 ft	$3.99	4	$15.96	https://www.robosource.net/robot-parts/wire-management/97-spiral-wire-wrap-medium-5	
1x1x35 Aluminum Angle (6-pack)	$26.99	8	$215.92	https://www.vexrobotics.com/aluminum-kits.html	
				https://www.wcproducts.xyz/flexwheels	

Structure of our meetings:

Build

- Walk ins - have one person who is more experienced to catch this person up
- Half teach/half design
    - The first half of meetings will be teaching principles of build
    - The second half of meetings will get the new members to design a flywheel with the more experienced members guiding them in this process and answering any questions
        - We want them to design an actual mechanism because it'll allow them to add to the RUSK bot eventually (once they make it out of the presentations)
        - We want members to get experience
        - We don't want members to get lost
        - Experienced members need to be able to read members body language and determine a multitude of things
            - If they know what they're doing
            - How confident are they
            - Where they could be lacking etc

Programming:

- Not quite sure how to approach this but some some basic ideas
    - Walk ins - have one person who is more experienced to catch this person up
    - Split into experience and non experienced
        - Give experienced the VEX basics
        - Give non experienced the coding basics
- If the bot isn't done, work on more advance or intermediate code

Secondary Goal Notes

Basic Bot Designs:

- Turret (change angle or change speed)
- String launchers for endgame
- X drive is too much (turret covers those benefits)
- Multiple direct 3600 rpm motors to prevent overheating (remove the cartridge vex provides
  - https://www.youtube.com/watch?v=9gPDUERmkkc

Room Layout and Field Setup:

- Room Layout / Field Setup
- Move cart closer to the tables
- Make space for the field for programmers to practice with the bots and test flywheel behaviors

9/19 SKAR/RUSK Intro Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	9/19/22	Document Creation

Parties Involved

Name	Team Role	Report Role
Zach Soriano	Build Lead	Document Owner
SKAR / RUSK New Members	Build Members	Editor

Purpose

The primary goal of this meeting was to introduce this season's game and the club to the new members who came to first general meeting of the year. We wanted to give members a general sense of some mechanisms in VEX and highlight what the road lies ahead in terms of building information they will learn.

The secondary goal was to start brainstorming ideas and mechanisms that would work for the robots. We wanted to see what our members had in mind for the new game and what inspired them to come up with these ideas.

Initial Thoughts/Assumptions

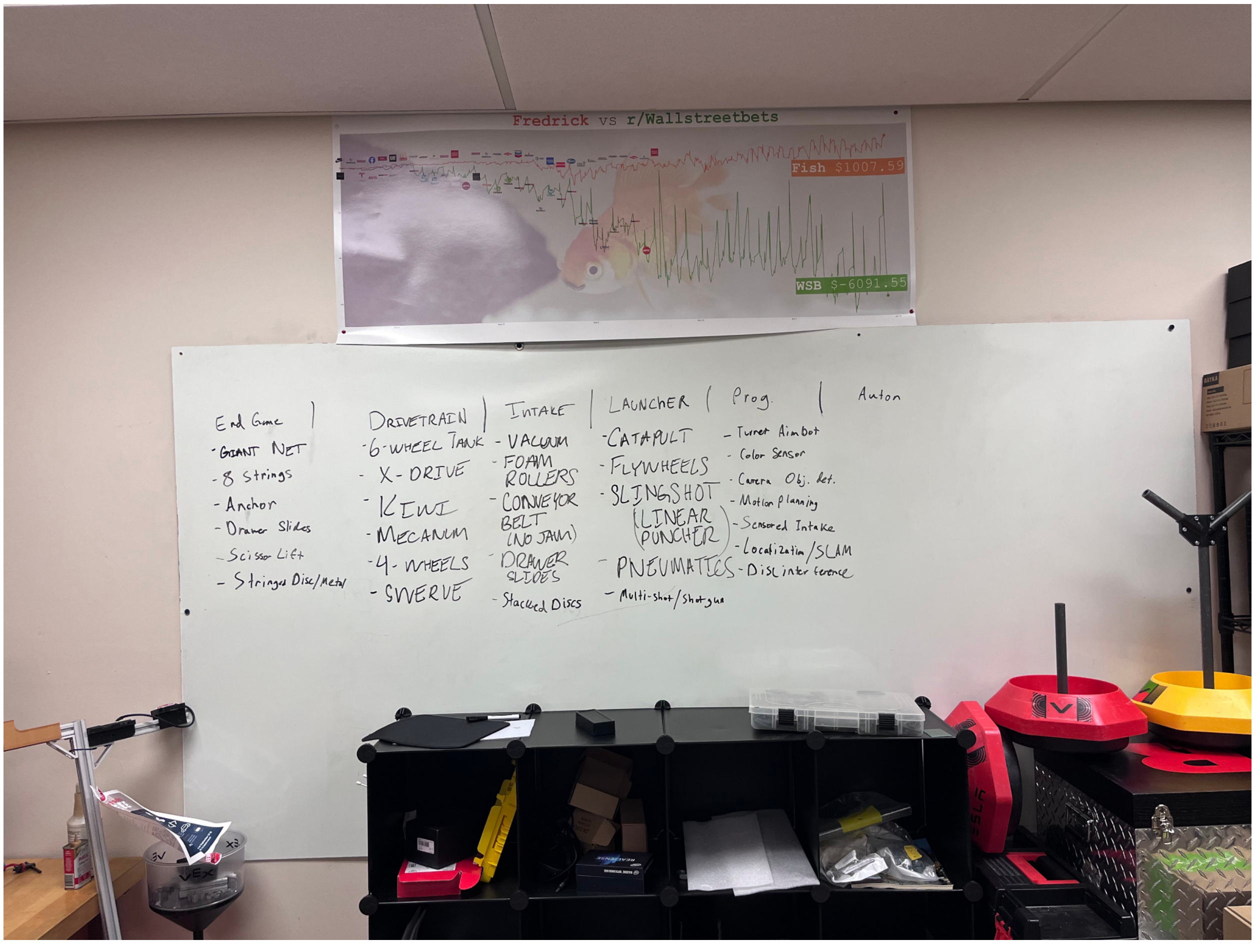
Introduction:

As the first official meeting of the club of the 2022-2023 season, we introduced ourselves to the newer members of the club. We broke down the different subteams of our team, our goals for this season, and the timeline for the club.
(Link to the slides)

Main Objectives of Spin Up:

1.) The main source of getting points is utilizing the disks placed throughout the field and accurately scoring them into our goal as quickly and effectively as possible.
2.) The secondary objective of spin up was to control the four rollers within the corners of the field
3.) The third and final objective was utilizing the no horizontal expansion limit in the endgame to the best of our ability and create a mechanism that can cover as much area as possible but not take up more space than we need

Brainstorming



The following picture above was the result of our first meeting. First, we broke down the different categories that were needed in this year's game which included the drivetrain/chassis, the intake, the launcher, the programming/autonomous period, and the end game. Then, we came up with ideas for each of the different categories. What we wanted to accomplish was to see what kind of ideas everyone had previously heard of ranging from past experiences with Vex to ideas they've seen on television.

Additional notes on Objective 1 in particular

With the intake in particular, there was an additional problem of the orientation of the intake and the shooting system.

1.) Intake and and launch on the same side
  a.) Higher chance of jamming
  b.) You may turn less when launching disks and aiming for the goal
2.) Intake and launch on opposites sides

a.) When it came to Intaking and launching on opposite sides this would result in a lower chance of the disks being able to jam along the way
b.) If there is no way of adjusting the launcher the bot must turn to face the goal which may be drastically different and increase cycle time

Results

New members drew inspiration from any source and tried to think of ways to adjust it for the objectives they found in this season’s game. There weren't a lot of substantial design considerations/ progress made during this meeting but there is a platform in which new ideas can stem. Members also asked what they’re going to learn, and now they expect to learn the parts, mechanisms, and modeling skills to make them very effective members on either SKAR or RUSK

9/22 Launcher Design Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	9/22/22	Document Creation
Zach Soriano	9/22/22	Adding references and designs

Parties Involved

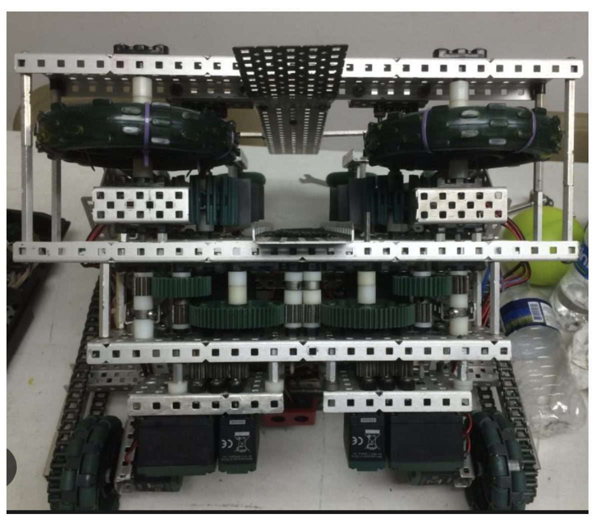
Name	Team Role	Report Role
Josh Chung	Co-Lead	Editor
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

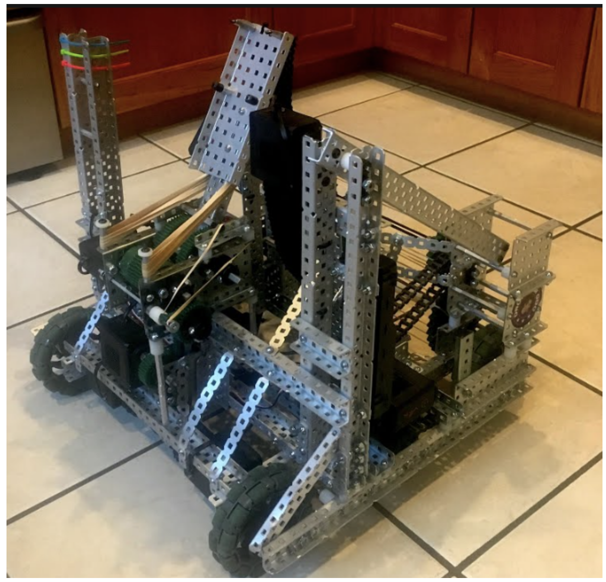
The primary goal of this meeting is to start generating ideas for a launcher design. We're going to research what is currently used in competitions and methods to improve those designs.

The secondary goal of this meeting is to start generating ideas for our own robot's design and choose which option we would like to go ahead with.

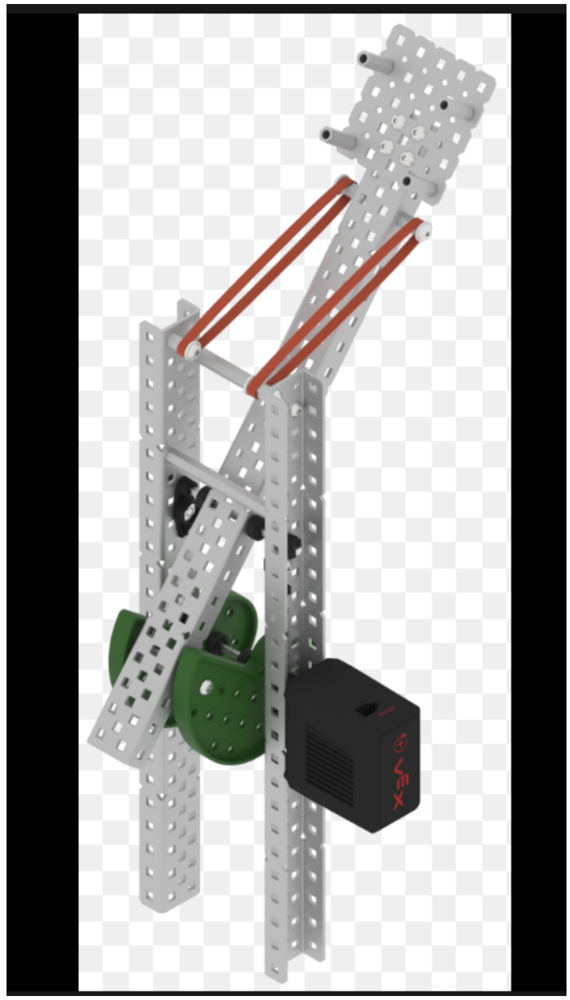
We are doing this to ensure we will be on time for final assembly and testing to improve the bot even further. We would also like to be extremely prepared when it comes to Winter break so as to get the design as possible and so programmers can start getting a sense on what they need to focus on.

Dual Flywheel with Static Ramp	

Research

Design	Reference
Catapult	 [1]
Single Flywheel with Turret	

[1] Kepler's Electronic, "Post-Worlds Catapult Reveal and Explanation", May 17, 2019

Slingshot	

9/23 SKAR Launcher Research

Revision Log

Editor	Date	Revision
Zach Soriano	9/23/22	Document Creation
Zach Soriano	9/23/22	Adding references and designs

Parties Involved

Name	Team Role	Report Role
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to start generating ideas for a launcher design. We're going to research what is currently used in competitions and methods to improve those designs.

The secondary goal of this meeting is to start generating ideas for our own robot's design and choose which option we would like to go ahead with.

- Intake
    - Primary
        - Materials:
            - **Surgical tubing**
            - **Zip ties**
            - **Flex wheels**
        - Roller at the bottom
            - Conveyor belt after roller/ramp could work
    - Secondary
        - Funnel
        - Roller on the sides
- Single magazine
- Utilize a crankshaft to push disks up
- Reference:
    - https://www.youtube.com/watch?v=bXSdIjpz4x4

Testing bed

- 3333 rpm, 43 degrees (compound gear ratio)
  - 3ft radius: discs went in, the velocity of the flywheel was sometimes too high and would cause disks to go right through the chains
  - 7ft radius: discs went over at full speed (6” over)
  - 12ft radius: discs short by 6”-12”

Notes

- Half the time discs would skew left and that could be because they are still in contact with metal as they were accelerated by the flywheel

9/26 SKAR Launcher Research

Revision Log

Editor	Date	Revision
Zach Soriano	9/26/22	Document Creation

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

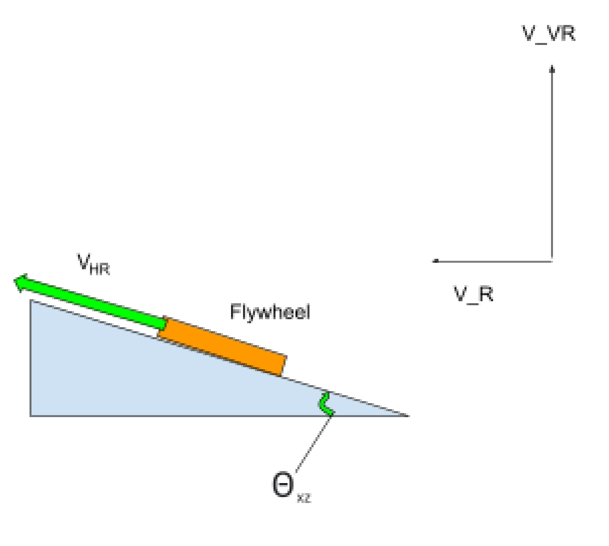
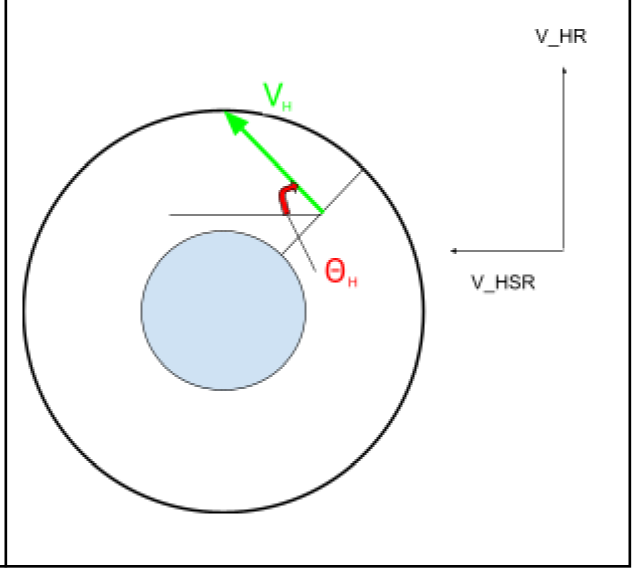
Purpose

The primary goal of this meeting is to start establish the launcher. The first part is to find out the minimum requirements it would take to score the disc into the high goal.

The secondary goal of this meeting is to start spitballing for our own design

We are doing this to ensure we will be on time for final assembly and testing to improve the bot even further. We would also like to be extremely prepared when it comes to Winter break so as to get the design as possible and so programmers can start getting a sense on what they need to focus on.

Initial Thoughts/Assumptions

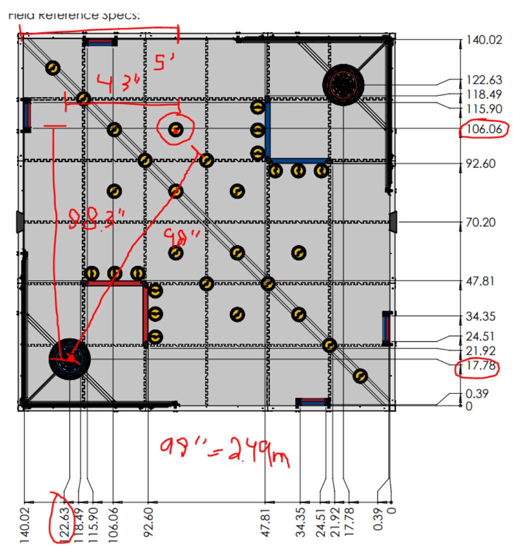
Side View	Top View
	

Dictionary

V_H: Velocity of hood	R = Range
V_HR: Velocity of hood’s range	r = radius of flywheel
V_HSR: Velocity of hood’s sideways range	ω = angular velocity (rad/s)
V_R: Velocity’s range	Θ_H = Angle between normal and horizontal
V_VR: Velocity’s vertical range	Θ_{XZ}= Angle between floor and ramp
VR = Vertical Range	H_G= Height of Goal = 25in = .635m

Kinematics Approach:

$V_H = r\omega$	$V_H = r\omega$
$V_{HR} = V_H sin\Theta_H$	$V_{HR} = V_H sin\Theta_H$
$V_R = V_{HR} cos\Theta_{XZ}$	$V_{VR} = V_{HR} sin\Theta_{XZ}$

$V_R = V_H sin\Theta_H cos\Theta_{XZ}$ $V_R = r\omega * sin\Theta_H cos\Theta_{XZ}$	$V_{VR} = V_H sin\Theta_H sin\Theta_{XZ}$ $V_{VR} = r\omega * sin\Theta_H sin\Theta_{XZ}$
$V = dX/dt$ $\int V dt = X$ $\int V_R = \int (r\omega * sin\Theta_H cos\Theta_{XZ})dt$ $X_R = (r\omega * sin\Theta_H cos\Theta_{XZ})t + C$ $t = (r\omega * sin\Theta_H cos\Theta_{XZ})/X_R$	
	$\Delta Z = 1/2(-g)(t^2) + V_0 t$ $\Delta Z = 1/2(-g)(((r\omega * sin\Theta_H cos\Theta_{XZ})/X_R)^2)$ $+ r\omega * sin\Theta_H sin\Theta_{XZ} * ((r\omega * sin\Theta_H cos\Theta_{XZ})/X_R)$ $r = 4in/2 = .0508m$ $g = -9.81m/s^2$ $\omega = 3600rpm = 377rad/s$ $\Theta_{XZ} = 40°$ $X_R = 98.2in = 2.49m$ $\Delta Z = -0.0809 + 2.18m = 2.02$ (Assuming $sin\Theta_H = 90°$) $\Delta Z = -0.1618 + 2.18m = 1.94m$ (Assuming $sin\Theta_H = 45°$) $\Delta Z = -0.692 + 2.18m = 1.41m$

	(Assuming $sin\Theta_H = 20°$) $\Delta Z = -2.04 + 2.09m = 0.05m$ (Assuming $sin\Theta_H = 11.5°$)
Notes: This was using basic kinematics so it is probably very far off from reality This means that there is no air resistance Air resistance plays a crucial role in projectile motion because the faster you go the more your air resistance increases in all directions of movement, as a result, it is necessary to model these equations with these considerations in mind	

- Using kinematics to get a basic idea of how a flywheel with 2 adjustable hoods would work
  - Trying to get a sense of what RPM we would need to spin at in a world with no air resistance to get hit the goal at a set distance
  - If the rpm is absurd then the idea is physically impossible especially since this doesn't take into consideration air resistance
  - https://www.geogebra.org/m/rYmNxYMY
- https://en.wikipedia.org/wiki/Projectile_motion
- We did a derivation for projectile motion considering the effects of air resistance so we will just verify these results
- We also made a basic Solidworks assembly modeling showing off the angles that were mentioned in 9/23 and how utilizing just a hood in order to launch disks in a direction different from intake is practically impossible
- References we looked at when trying to derive the kinematics equations
  - https://www.engineeringtoolbox.com/drag-coefficient-d_627.html
  - https://dynref.engr.illinois.edu/afp.html#afp-fd
  - https://reader.elsevier.com/reader/sd/pii/S187770581000281X?token=CFAB4CDD3682482890B58F81224BF792210E8DB07721CF9E8FDCF96848D27ECB5889556C1306499DC169D1D97A007A49&originRegion=us-east-1&originCreation=20221005073323
  - https://web.mit.edu/womens-ult/www/smite/frisbee_physics.pdf
  - https://digitalcommons.usf.edu/cgi/viewcontent.cgi?article=4817&context=ujmm

09/27 SKAR Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	9/27/22	Document Creation

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to start generating ideas for a launcher design. We're going to research what is currently used in competitions and methods to improve those designs.

The secondary goal of this meeting is to start generating ideas for our own robot's design and choose which option we would like to go ahead with.

- Kyle sends a video to look at and it's a team utilizing a big gear on a series of roller bearings with a motor to adjust the angle making a complete turret
- This solves the problem of having to have a flywheel at a crazy RPM to get awkward angles
- Utilizing a hood in conjunction with this new idea could minimize the effects of defense that a bot could encounter on the field
- We also started building the chassis for the robot.
    - We went for a

10/05 SKAR Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	10/05/22	Document Creation
Zach Soriano	10/05/22	Adding references and designs

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to start generating ideas for a launcher design. We're going to research what is currently used in competitions and methods to improve those designs.

The secondary goal of this meeting is to start generating ideas for our own robot's design and choose which option we would like to go ahead with.

- With the new idea in mind I've started to think about how we would move the disks from a general intake to a initial storage then use a magazine loader (pneumatics and some slots) to move disks to the actual turret
- The initial storage is to store disks being collected as others are being launched
    - I'm assuming there will be a hole for disks to move through into the actual magazine that won't always be lined up so this is to store disks somewhere until the turret can line up
    - The idea that the hole might not always line up is something to address to increase efficiency but for now it'll have to do

Results

Conclusion

10/10 SKAR Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	10/05/22	Document Creation
Zach Soriano	10/05/22	Adding references and designs

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to start generating ideas for a launcher design. We're going to research what is currently used in competitions and methods to improve those designs.

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- With the new idea in mind I've started to think about how we would move the disks from a general intake to a initial storage then use a magazine loader (pneumatics and some slots) to move disks to the actual turret
- The initial storage is to store disks being collected as others are being launched
    - I'm assuming there will be a hole for disks to move through into the actual magazine that won't always be lined up so this is to store disks somewhere until the turret can line up
    - The idea that the hole might not always line up is something to address to increase efficiency but for now it'll have to do

11/10 SKAR Launcher Testing

Revision Log

Editor	Date	Revision
Zach Soriano	11/10/22	Document Creation
Zach Soriano	11/10/22	Adding references and designs

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to test the launcher that we currently have to see how consistent we can make it.

- 2 motors at 3600 rpm direct
    - Tested accuracy at different ranges
        - Drifted right
            - Could be because there was still track after the disc was launched
            - Evident at longer ranges
            - 30% successful
    - Tested different speeds to test precision at a set distance
        - Distance was "right in front of goal"
            - Low speeds about 60% were successful which could be a result of how discs were pushed in
    - Added a bay with an arm to make inserting discs more consistent
    - Changed the spacing so that the flex wheel would deform less
- Catapult regular rubber bands
    - 90% success rate when distance is right in front of goal
        - 0% at minimum auto distance
    - Using a torsional spring and a motor to change distance you can vary the force produced by the spring which can increase or decrease range
        - Axle is bending significantly, look into it

Winter

12/8 SKAR Design Meeting

Revision Log

Editor	Date	Revision
Zach Soriano	12/08/22	Document Creation
Zach Soriano	12/08/22	Adding references and designs

Parties Involved

Name	Team Role	Report Role
Jinam Modasiya	SKAR Programming Team	Editor
Josh Chung	Co-Lead	Editor
Zach Soriano	Build Lead	Document Owner
Kyle Deguzman	SKAR Build Team	Editor
Brian Chen	SKAR Build Team	Editor

Purpose

The primary goal of this meeting is to start generating ideas for a gantry and a flywheel.

Brief Design Process on each part

Gantry

Gantry Goals

1.) Low friction
2.) Spin fast if needed
3.) Allow magazine to pass through it
4.) Strong enough to mount things to

Gantry stresses

1.) Weight of the gantry and launcher

Gantry Ideation:

1.) blocks that has an axis extrusion perpendicular to the outward face

a.) Pro:
b.) Con: bending, bigger radially

2.) Blocks that have an axis extrusion perpendicular to the inward face
    a.) Pro: radially the same
    b.) Con: bending, could hit magazine
3.) Gantry sits on top of wheels like a shopping card
    a.) Ball wheels or something similar
    b.) Pro: radially same, no bending
    c.) Con: have to buy more stuff and we can't right now
4.) Stack of bearings like in that one video (8:00)
    a.) https://www.youtube.com/watch?v=bXSdIjpz4x4
        i.) Pro: radially same, no bending, roller bearings will act like tires
        ii.) Con: Slow, complicated to make

Flywheel

Flywheel goals

1.) Launch discs consistently
2.) Launch discs at long range
3.) Minimize the drops in speed after launching a disc

Flywheel stresses

1.) Axle stresses (will need quarter inch)
2.) Vibrations

Flywheel ideation

1.) Literally a spinning wheel
    a.) Test: flexibility of wheels, coefficients of friction (harder to do), How much wheel is in contact with the disc
    b.) Increase coefficient of friction via antislip on the wall or increase the normal force exerted on the disc as a result of the wheel flexing (should help discs be stable during flight)
        i.) http://people.csail.mit.edu/jrennie/discgolf/physics.pdf
    c.) Launching discs at long range will depend on angle of attack (10-11 degrees for most range but minimal lift)
        i.) https://digitalcommons.usf.edu/cgi/viewcontent.cgi?article=4817&context=ujmm

Flywheel path

Flywheel path Goals

1.) Low friction
2.) Minimal in area
3.) Just enough space for the discs to accelerate

Flywheel path Stresses

1.) Radially
2.) Disc to floor

Flywheel path Ideation

1.) X_degree arc around a flywheel
    a.) Pro: Constant contact with discs
        i.) Fake Pro: according to https://www.youtube.com/watch?v=QOpM9RcoB6E spinning gives gyroscopic stability
        ii.) Not a result of the path but a result of the disc acting like a tire against a wall
    b.) Con: bigger, harder to manufacture
2.) Straight path
    a.) Pro: smaller, simpler
    b.) Con: flywheel only in contact with the disc for a second which may not be enough to get it up to max/desired velocity

The End