







## **5839B's Notebook**

# Table of Contents

## Entries

2024/03/16		First Steps .....	1
2024/03/16		Drive Train Types .....	3
2024/03/17		3d design software .....	6
2024/03/17		New Odometry Sensors .....	7
2024/03/17		New Odometry Sensors .....	8
2024/03/17		Drive Train Prototypes .....	9

## Appendix



## Post Season Build Analysis

For the building of our previous robot even though it unfortunately did not make worlds there were a lot of aspects executed properly and poorly to be identified. This is important as it allows the team to know what works and to keep doing as well as what to change in order to improve for the next season

**Successes:** The intake, which was the most recently designed aspect of the previous robot worked perfectly as it was able to hold onto a triball easily and drive with it as well as insert it into the goal when needed. Flex wheels proved to be invaluable here as not only were they less of a hassle than rubber bands they also proved to be more reliable and provided great traction for grasping the game objects. The use of the various building techniques such as boxing screws with spacers for added strength and using shoulders screws to ensure the design lined up properly helped with this greatly. These techniques were also used across the robot and allowed for greatly increased strength especially after repeated matches.

Another major success of the previous design was the flywheel. It made great use of the weight plates as well as a ratchet to help reduce motor strain. For any future games that need a flywheel this design could be copied easily along with the ratchet for any mechanisms that require it.

**Failures:**

The Drivetrain was one of the biggest failures of the previous design and is the area for the largest improvements to be made. It experienced heavy reliable issues due to a variety of factors. It also experienced a constant slight drift as well as random incidents of extreme drift that were fixed by taking out and putting back random screws until it worked. Finally, the driver was very prone to overheating, which limited testing time as we had to wait for the motors to cool down. There are a variety of causes for this that can be learned from the improved future designs. Firstly, in an attempt to save space lexan with holes drilled into as a form of bearing were used instead of the traditional bearing flats or ball bearings. This not only attempted to save space as the plastic was 1/16in compared to the bearing flat at 1/4in but was used to create a boat shape to cross the middle bar of over under. This led to not only increased friction as the holes were not perfectly aligned as with the standard bearings, but also, they wore down over time and were not easy to replace. They also began to warp out in some places hitting against the gears and causing friction. The inconsistency within these plastic bearings likely led to uneven amounts of friction on either side of the drive. This would cause the drift as well as heightened overheating of the vex motors. To avoid this Lexan should only be used as a bearing sparingly as well as not in a mechanism that sees a lot of wear and tear such as the drive. Additionally high strength axels could be used over low strength ones to increase the drive train's resilience. However, this may not always be possible as some of the wheels the team owns only accept low strength axels. Finally, more thought could be put into making the drive easily repairable to fix any issues that could cause drift or overheating in future designs.

The robot's weight balancing was very poor and led to it lurching at the start and end of fast motion. This led to less control of the robot being possible as these movements were unpredictable. The design focused a lot of weight towards the front with the lift arm, wings, battery, and pneumatic tanks, whilst the rear had the intake and the brain making it mostly empty space. To improve on this, we could focus more of the heavy components such as the pneumatic tanks and batteries towards the bottom middle to weigh the robot down and keep its center of gravity in the middle. Additionally, as I saw another team do at states flywheel weight plates could be screwed onto the lighter half of a robot to weigh it down



and move the center of gravity. The center of gravity through a variety of means should be kept low and in the middle of any future designs.

The previous odometry sensor module designs also proved to be unreliable. The aluminum plates used for the sides were found to warp out after repeated use. Additionally the older design was bulky and had little room to move. This is very important for the autonomous as its algorithms rely on precise readings from these wheels. If they are not able to spin properly or be in constant contact with the ground they make the autonomous unreliable. To fix this the design could use C channels which bends less as well as work to make the modules more compact in order for them to fit with more room to move.

Though not directly related to the build it was found by the Cole the driver that it was not possible to keep the robot in motion with the joysticks whilst pressing the arrow or letter buttons on the controller. To alleviate this, we plan to 3D print attachments that press the controller's buttons using fingers other than the thumbs so that motion can be maintained while performing key actions

## What to do now?

- With the biggest problem being the drive a variety of drives should be modeled and tested in order to have a better idea of what works for the next season
- Work to create new odometry module designs that are stronger and more compact
- Take inventory of the parts available to our team so that when designing we know what parts we can use and how many of them are available
- Put together an order list of parts that the team wants to assess the needed funds
- See what funding is available to the team and what amount should be allocated to new parts
- Look into making a functional PTO (power take off) as they can allow for more powerful drives while still having all the desired mechanisms to manipulate game objects
- Look for or model our own paddles for the controller that suite the needs of our driver



## New Drive Models

There exists a variety of drive models both practicle and impracticle that can be made with the VRC legal parts. It is important to judge where each one can shine to see which is the most practical when the next game releases. A decision can not be made yet for which drive is best, but the strenghts and weakness of each one can be assesed as well as models for the more practical ones generated. These models can give us a head start on the next seasons bot if they prove adequate for the next game as well as allow the team to test various ideas.

## Tank Drive

A large variety of what can be considered a tank drive or differential drives exist within vex. These work by having two sides where each sides wheels all spin together. This allows for linear motion(Both sides spin the same direction), turning (Both sides spin opposite), and arcing (One side spins slower then the other in the same direction). These drives are often the simplist and provide a wide range of motion while remaining able to push back against other robots. These drives can also be achieved in a variety of ways with varying numbers and sizes of wheels that augment their performance.

4in wheels provide greater speed as per each rotation the robot moves farther, however they give the robot less torque. Additonally since less of them can fit onto a dirve with the 18\*18\*18 size limit there is also less points of contact. Additionally with the older 4in wheels the team currently own the traction versions are .125in smaller then the omni versions

3.25in wheels provide slower speeds, but are able to give the robot more pushing power as they have more torque and points of contact. These wheels are also easier to work with as the traction and omni versions are the same size unlike with the older 4in wheels

Omni wheels have rollers that allow the wheel to move side to side as well as forward and back. This makes them great for turning, but poor for traction.

Traction wheels wheels are all rubber and provide exceptional ground adherence for any robot, however they greatly limit turning making them impractical unless used as the middle wheel where there effects on truning are midigated.

From our teams expirience a 3.25in drive with 2 traction wheels in the middle and 2 omni wheels on either end appears to be the optimal way to execute this drive. Our previous drive with 3 4in omniwheels failed to push back agaisnt other robots that were using 3.25 in tank drives with the same amount of motors. These robots also were just as fast and maneuverable as ours showing little trade off for this design.

### Pros

- Simplicity
- Versatility
- Easier to Control

### Cons

- Limited Mobility
- Wheel incompatibilities

-> Tank Drives



## H/X Drives

These use either 4 or 5 omni wheels to achieve a robot that has the same range of motion as a Tank Drive, but with the addition of diagonal and horizontal movements. They either use in the case of an X drive 4 individually powered omni wheels in each corner at 90 degrees from one another or 4 individually powered omni wheels in a traditional tank drive setup with one horizontal omni wheel for the H drive. These drives can however, prove difficult to control and in the case of the H drive impractical as the horizontal wheel rarely makes contact. They are also very easy to push around since all the wheels are omni. X drives can prove highly practical given the right game and design but in games such as over under the middle bar limits their use.

### Pros

- Maneuverability
- Complex Autonomous
- Strafing

### Cons

- Mechanical Complexity
- Motor Usage
- Practicality
- Low Traction/Easy to push

-> X/H Drives

## Mecanum Drives

Mecanum drives are likely the most special as they use specialized mecanum wheels. These like omni wheels have a roller attached, but at an angle to provide uniquely augmented movement. When set up correctly 4 individually powered mecanum wheels can provide the same movement as a X drive. However, since to go in any direction it directly turns the mecanum wheels they are harder to push as the motors resist the pushing directly. This along with other issues can also lead to faster overheating with mecanum drives. The vex edr 4in mecanum wheels are very bulky putting more strain on the motor additionally, the vex mecanum wheels unlike most designs have limited contact with the ground due to the irregular design of their rollers. It is also important to note it is easier to gear and build a frame for a mecanum drive over an X drive as it does not require the 45 degree angles to achieve its unique motion. Though also possible with an X drive an additional powered omni wheel could be put into the middle to provide more drive power. Since this wheel isn't needed at all times if a successful PTO can be developed it could allow for a very versatile robot and drive.

### Pros

- Maneuverability
- Complex Autonomous
- Strafing

### Cons

- Mechanical Complexity
- Motor Usage
- Practicality
- Requires balanced weight

-> Mecanum Drives

## Swerve Drives

Previously considered impractical for vex swerve drives involve either 3 or 4 independently steered and powered wheels. These focus around modules that can both rotate the orientation of and spin the wheels. This allows for the robot to turn rapidly as well as turn while moving. The wheels can be positioned



in the manner of a traditional tank drive for linear movement and then turned to go the desired direction. However until the addition of the 5.5w motors these would either use 6 or all 8 of the robots available motors. The 5.5w motors now allow for this drive to be possibly practical as a 3 wheel swerve drive could be made from 3 11w motors and 3 5.5w motors allowing for 38.5w of motors to be allocated to the robots mechanisms and manipulators. The advantages of swerve drives can be seen from other competitions like frc where they are often used to great success to create highly maneuverable bots. The use of one within vex would be highly dependent on the game as one that with limited room to move such as over under takes away many of a swerve drives advantages. It is worth creating a model for a swerve drive module in case the next game is one that prioritizes movement. It would also provide practice using more complex gearing which the team has yet to experiment with.

Pros	Cons
<ul style="list-style-type: none"><li>• Maneuverability</li><li>• Complex Autonomous</li></ul>	<ul style="list-style-type: none"><li>• Mechanical Complexity</li><li>• Motor Usage</li><li>• Practicality</li></ul>

-> Swerve Drives



Before any models for possible drive trains or new odometry sensors can be made a decision on what software to use is necessary. In the previous season we adopted Autodesk inventor. There were a variety of reasons for this the primary one being familiarity. At Eastern Technical Highschool there is an Engineering Magnet program which teaches Autodesk inventor. This not only means over half the team who is in this program know the software, but also there is 3 teachers who can assist us with any issues. Also with Inventor being used by the school the county provides a VDI or Virtual Desktop Interface where you can log in remotely to a desktop with Inventor. This allows the team who does not all have access to a high quality laptop to access the model on the school issued chromebooks. Due to these reasons we find it impractical to switch design softwares. Not only would we have to remake some of our premade assemblies such as for flex wheels, but we would have to spend time learning new software which outweighs any of the other softwares advantages.







Odometry is a position tracking algorithm used by the coder to implement complex autons. It relies on three sensors 2 vertical and 1 horizontal. The failures of the previous design were compactness and resiliance and the new designs makes a few imprpovments to this area. It is important to complete this first as any prototype drives made must be designed to fit the sensors. This along with a basic mecnum drive which can act as a tank drive when need be will allow the coder to begin making some basic frameworks for next year.

New Design:

- Verical Wheels save space by being in the same module
- No plate is used without being reinforced
- Pillow bearings used to simplfy mounting
- Newer 3.25in wheels used for better traction



To experiment with more complex Drives a Mecanum drive and a Swerve Drive module were completed. These should provide good practice for designing before the next season as well possibly giving us a head start if we choose to use these drives.

The first model made was that of a Mecanum Drive:

- 4 Mecanum wheels geared to 300 RPM with a 72:48 ratio driven by an 11w motor with the 600rpm cartridge.
- 24in HS axels with holes drilled in them as the main frame to ensure it was stronger then our previous drive trains.
- Center Omni Wheel for additional power
- PTO to allow for the center omni wheel to power other system while not in use
- Battery and Air Tanks kept low to ensure a proper center of gravity
- New Odometry Sensor fitted in the rear

Before we could enter school to test this I created a Model for a Swerve Drive module:

- Keeps design compact with motors below the frame
- 72 tooth gear is screwed to the frame so they spin together
- Circular insert within the gear to allow the drive shaft to turn
- Chain runs to connect the Drive Shaft to the 11w motor
- 5.5w motor used to turn module



## Note

It is unlikely any of these drives will be used as tank drives have proved superior for many games in a row. They simply serve as a way to practice building and design techniques and mechanisms before the next season.

