The Beginner's Guide to FRC

Engineering Design: Level 2

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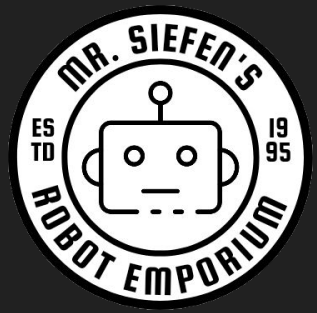
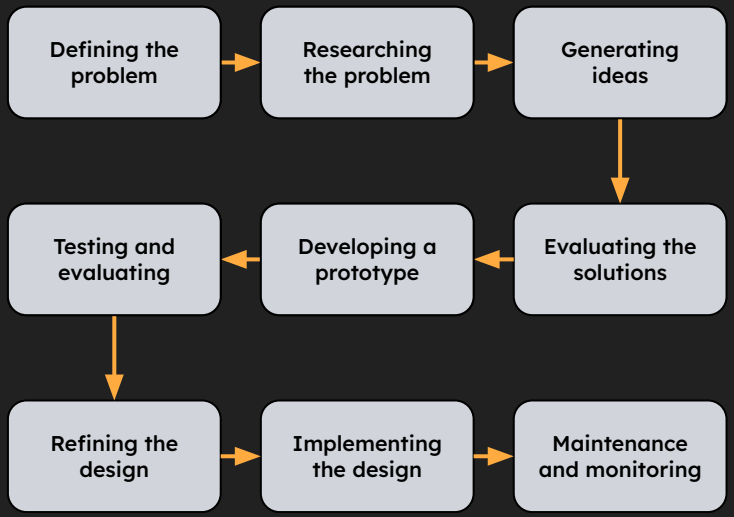


More about Engineering Design



Engineering design is the process of creating and developing a solution to a real-world problem through the application of engineering principles and techniques.

It starts with understanding the problem and defining the requirements. Then, brainstorming and generating ideas to solve the problem, followed by evaluating and refining the best solution.

The next step is prototyping and testing the solution, which helps to identify and solve any issues that arise.

The final step is implementing and refining the solution, regularly monitoring and maintaining it to ensure it continues to perform well over time.

The goal of the engineering design process is to create a solution that is functional, efficient, and safe.

How to Read the FRC Game Manual

1. Familiarize yourself with the game manual structure:
    a. Get to know the organization of the manual, including the table of contents, headings, and subheadings. This will make it easier to locate specific information.
2. Know what you're looking for:
    a. Before you start reading the manual, have a clear understanding of what information you need. This will help you to be more focused and efficient when reading.
3. Use the search function:
    a. Most game manuals are available in electronic format, which means you can use the search function to quickly locate specific information.
4. Read the summary or overview section first:
    a. The summary or overview section provides a high-level view of the rules for each component of the robot, including motors, pneumatics, and other construction components. Reading this section first can give you a good idea of what information you need to look for in the rest of the manual.
5. Take notes:
    a. As you read the manual, take notes on important information, such as specific rules and guidelines, that you need to remember. This can help you to retain the information and easily refer back to it later.
6. Ask for clarification:
    a. If you're not sure about a rule or guideline, don't hesitate to ask for clarification from the FRC community or a mentor. This can help you avoid making mistakes that could impact your team's performance.

Structure of the FRC Game Manual

Official Game Manual Order

1. Introduction
2. FIRST Season Overview
3. Game Sponsor Recognition
4. Game Overview
5. ARENA
6. MATCH Play
7. Game Rules: ROBOTS
8. Game Rules: Humans
9. ROBOT Construction Rules
10. Inspection & Eligibility Rules
11. Tournaments
12. Glossary

To gather engineering design information from the FIRST (FIRST Robotics Competition) game manuals, the most important sections to read, ordered from most to least important, would be:

1. ROBOT Construction Rules
2. Inspection & Eligibility Rules
3. Game Rules: Robots
4. Game Overview
5. FIRST Season Overview
6. Match Play
7. Arena
8. Game Rules: Humans
9. Tournaments
10. Introduction
11. Game Sponsor Recognition
12. Glossary

Note that this list is based on the assumption that the primary focus is gathering information related to the design and construction of robots for the FIRST Robotics Competition.

Where Would I Find Size and Weight Requirements?

You would find the rules about robot size and weight in the "ROBOT Construction Rules" section of the FRC game manual. This is section 9 and these specific rules are found in section 9.1. The maximum weight limit varies little from year to year. The size requirements however change with each new game. There are 3 main size requirements teams should focus on.

1. Starting Configuration
2. Match/End Game Sizes
3. Robot Extension Limit

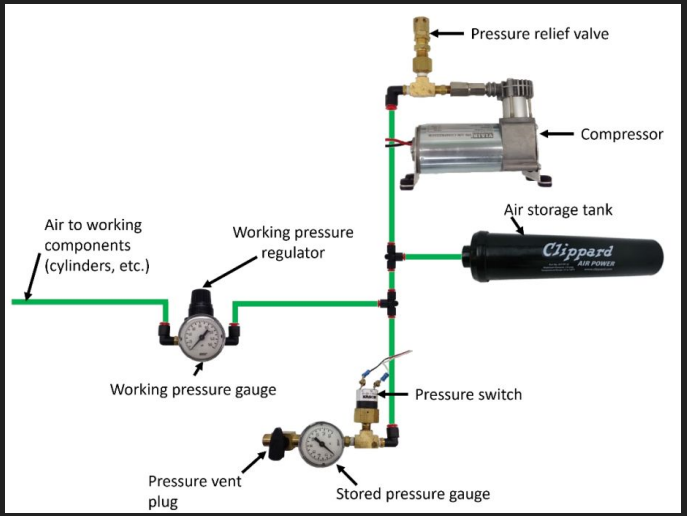
R103 *ROBOT weight limit. The ROBOT weight must not exceed 125 lbs. (~56 kg). When determining weight, the basic ROBOT structure and all elements of all additional MECHANISMS that might be used in a single configuration of the ROBOT shall be weighed together (see I103). For the purposes of determining compliance with the weight limitations, the following items are excluded:

A. ROBOT BUMPERS,
B. ROBOT battery and its associated half of the Anderson cable quick connect/disconnect pair (including no more than 12 in. (~30 cm) of cable per leg, the associated cable lugs, connecting bolts, and insulation), and
C. tags used for location detection systems if provided by the event.

Where Would I Find Motor and Pneumatic Rules?

You can find the rules about Motors in the "ROBOT Construction Rules" section of the FRC game manual. This is section 9 and these specific rules are found in section 9.5. Included in this section is a list of all LEGAL motors and actuators for competition use. Modification of the motors is mostly prohibited. This section also outlines other safety and controls requirements as well.

To find pneumatic operation and assembly restrictions in the FRC game manual, you would need to look in the "Robot Construction Rules" section of the manual. In this years manual this is section 9.8. Stored air pressure on the ROBOT must be no greater than 120 psi (~827 kPa).



Where Would I Find Bumper Rules?

The bumper rules in the FIRST Robotics Competition (FRC) game manual can typically be found in the "Robot Construction Rules" section. This section outlines the specifications and requirements for building the robots that compete in the competition, including guidelines for bumpers, which are typically used to protect the robot and other robots during matches. Specifically section 9.4 describes every facet of bumper construction.

The use of specific types of fabric in FRC bumpers is regulated by the FIRST Robotics Competition (FRC) game manual. The rules and regulations may change from year to year, so it's recommended to check the latest manual for the current rules. It's important to note that all materials used in the construction of an FRC robot, including fabrics, must be safe, non-toxic, and free of hazardous substances.

Silk and bedding are not considered rugged cloths, however 1000D Cordura is. Tape (e.g. gaffer's tape) matching the BUMPER color is allowed to patch small holes on a temporary basis.

It is expected that there may be multiple layers of cloth as fabric is folded to accommodate the corners and seams of BUMPERS.

Excerpt from R408.D in the FRC Game Manual 2023

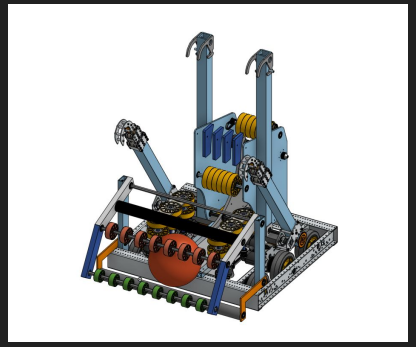
Where Would I Find Information about Inspection?

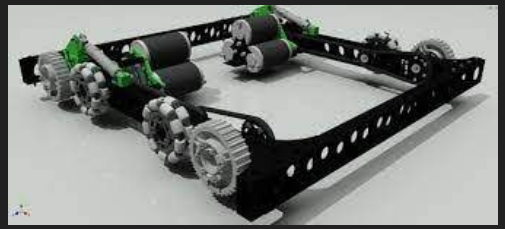
The rules about inspection in the FRC game manual can typically be found under the "Inspection & Eligibility Rules" section. It is recommended to review this section carefully to ensure that your team's robot is compliant with all of the inspection requirements for the competition.

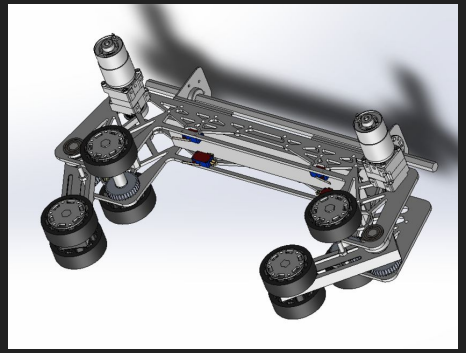
The inspection process in FIRST Robotics Competition (FRC) is a thorough check of the robot's design and construction to ensure that it is safe to operate and meets the competition rules.

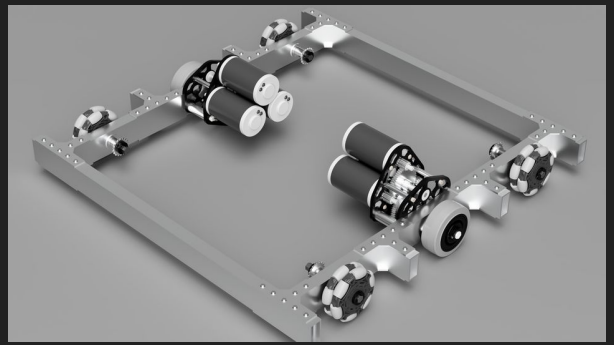
The process typically takes place before a tournament match, where a team of inspectors will review the robot and its components to make sure it complies with the rules set by the FRC organization. This includes checking the robot's dimensions, weight, power sources, and other safety features, as well as making sure that all parts of the robot are securely attached and functioning properly. The inspection process is an important part of the competition, as it helps ensure that all teams are competing on a level playing field and that the robots are safe for everyone involved. Teams should be prepared for the inspection process by familiarizing themselves with the competition rules and making sure that their robots meet all relevant requirements before arriving at the tournament.

What are Mechanisms that are Common in FRC?









What is a Mechanism?

In the context of FIRST Robotics Competition (FRC), a mechanism refers to a specific part or system of a robot that performs a specific task or function. This could be something as simple as a arm that extends to grab an object, or as complex as a drive train that propels the robot around the field. The design and implementation of these mechanisms is a key aspect of the engineering design process in FRC, and teams must carefully consider factors such as reliability, efficiency, and overall functionality when creating their mechanisms.

The use of simple machines allows engineers to create complex and sophisticated systems with fewer moving parts, making the mechanism more efficient and effective. In the context of engineering and robotics, simple machines are often used as building blocks to create more complex mechanisms.

Simple Machines: As Defined by ChatGPT

Simple machines are basic mechanical devices that help to transmit, modify, or magnify force to make work easier. There are six types of simple machines:

1. Lever: a bar that rotates around a fixed point called a fulcrum to lift or move objects.
2. Pulley: a wheel with a groove in its circumference that guides a rope or cable.
3. Inclined plane: a flat surface that slopes at an angle and reduces the force needed to lift an object.
4. Wedge: a type of inclined plane with one end wider than the other, used to split or lift objects.
5. Screw: a type of inclined plane wrapped around a cylinder, used to lift or hold objects.
6. Wheel and axle: a simple machine consisting of two circular objects (wheel and axle) that rotate together to move objects or lift loads.

What are the Different Types of Drivetrains?

Non-Holonomic

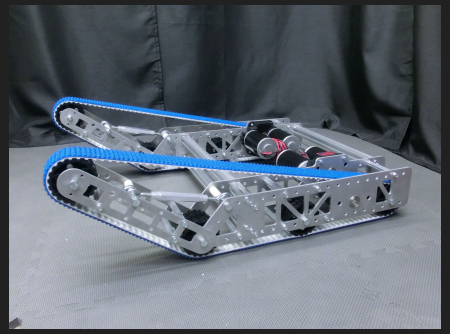
Non-Holonomic means it cannot move in freely any direction without rotating, which can make it challenging to achieve precise movements and control

- Tank Drive: A classic drivetrain configuration where each side of the robot is driven by a separate motor
- West Coast Drive: Similar to tank drive but with a cantilevered drop wheel in the middle to help with turning.
- 2 Wheel drive: Very uncommon, but using proper sensor feedback a robot could balance on only two wheels.

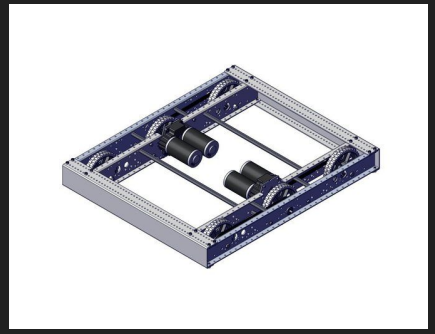
Holonomic

Holonomic means that the robot can move in any direction, including forward, backward, sideways, and diagonally, without having to change its orientation.

- Swerve Drive: A swerve drive consists of multiple small motors that control the direction of individual wheels, while larger motors provide driving force to the wheel
- Mecanum/Omni/X-Drive/H-Drive: The wheels are specially designed with a series of rollers on the circumference, which allows them to grip the floor in any direction

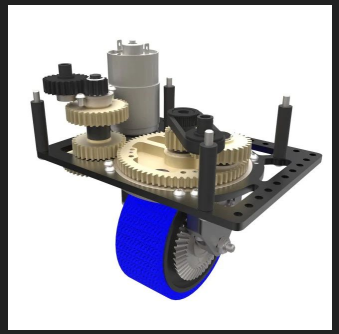


Tank Drive

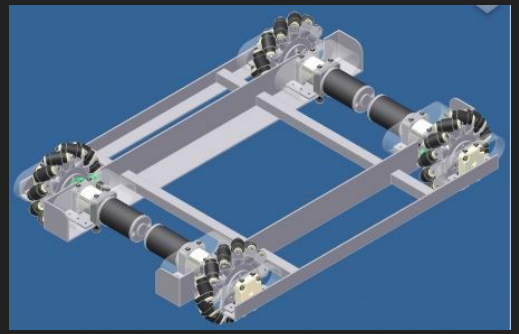


West Coast Drive
(Yes K.O.P. is WCD)

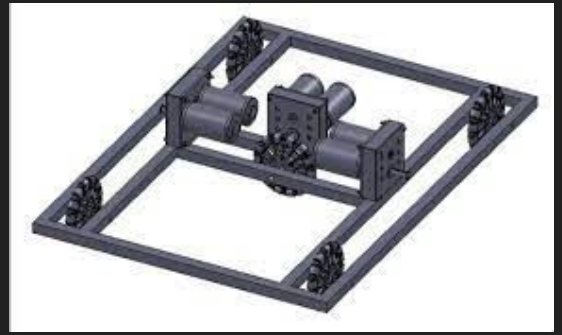
Two-Wheel Drive
(Self balancing Needed)



Swerve Drive
(You need one for each corner)



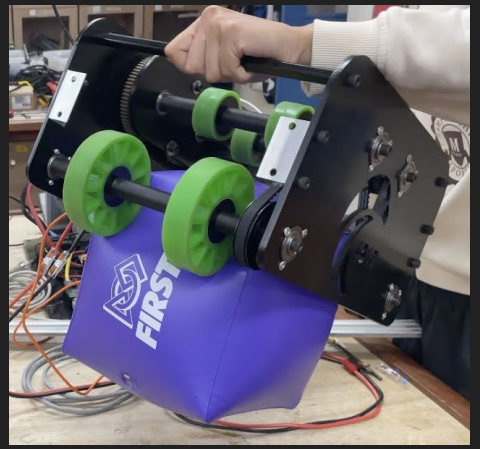
Mecanum Drive
(Special Wheels)

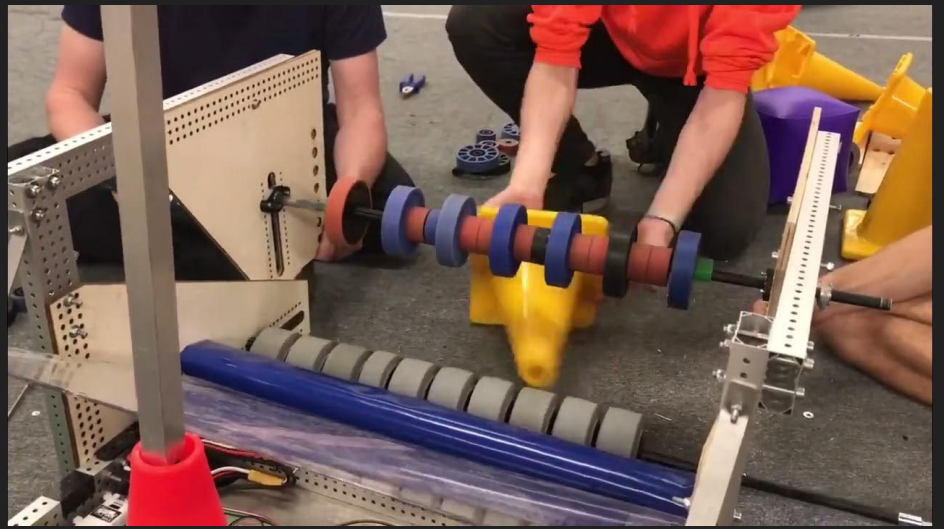


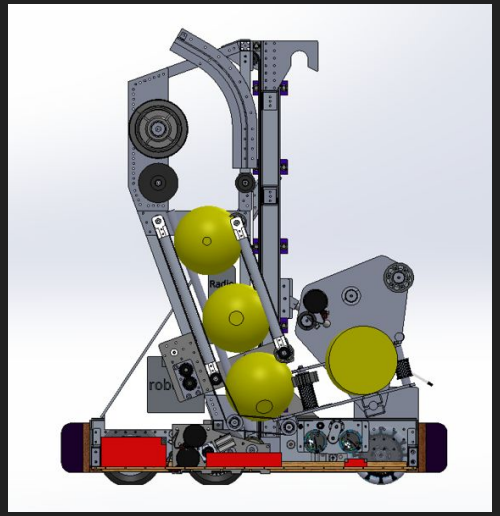
Omni H-Drive
(Special Wheels)

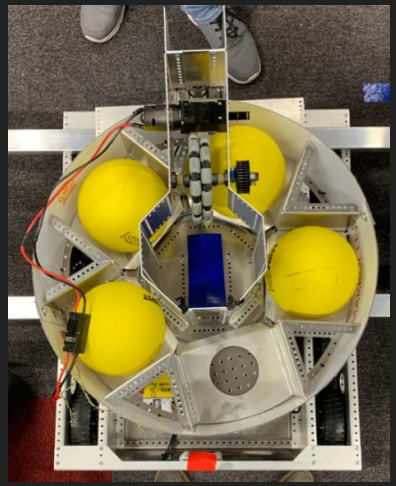
What are Intakes?

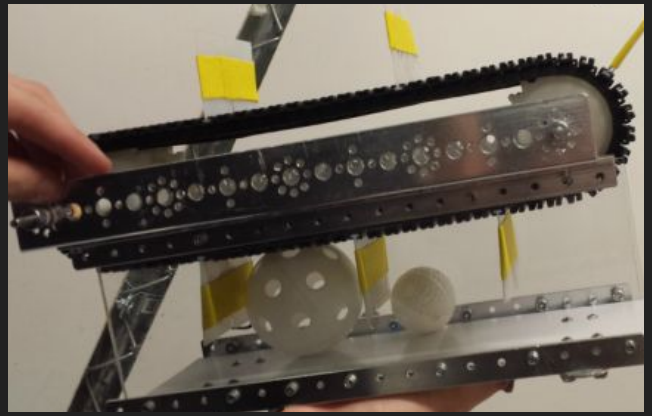
Intakes in FRC are mechanisms used to pick up and acquire game objects, such as balls or power cells, and move them into the robot's scoring mechanism. They are a crucial part of the robot's design and can range in complexity from a simple roller mechanism to more complex mechanisms with multiple stages of conveyors and feeders. The design and use of an intake will depend on the specifics of the game and the team's overall strategy.









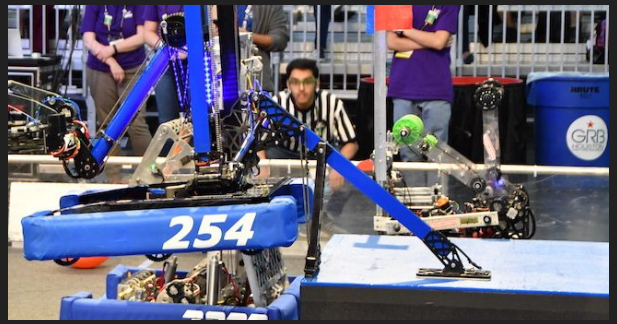


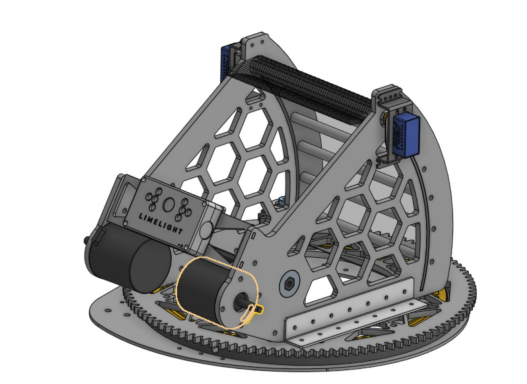
What are Indexers?

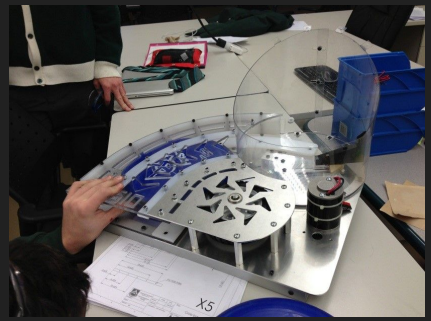
An indexer is a mechanical system in an FRC robot that is used to control the flow of game objects from one place to another within the robot.The indexer may use various types of simple machines such as wheels, gears, and belts to move the objects through the system. It helps to align, sort, and arrange objects in a specific order so they can be effectively processed by other mechanisms, such as a shooter. The design and function of the indexer can play a crucial role in the overall performance of the robot and its ability to score points during a game.

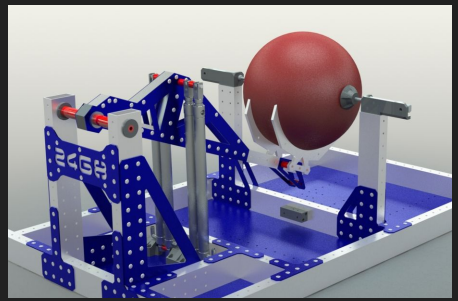
What are Climbers?

In the context of the FIRST Robotics Competition (FRC), climbers are robots or robot components designed to climb up a structure, holding onto objects such as a bar or a rope. Climbing is one of the many challenges that teams have to overcome during the FRC game season. The purpose of a climber is to demonstrate the robot's ability to maneuver and interact with its environment, typically by climbing up a structure and reaching a certain height within a certain time frame.







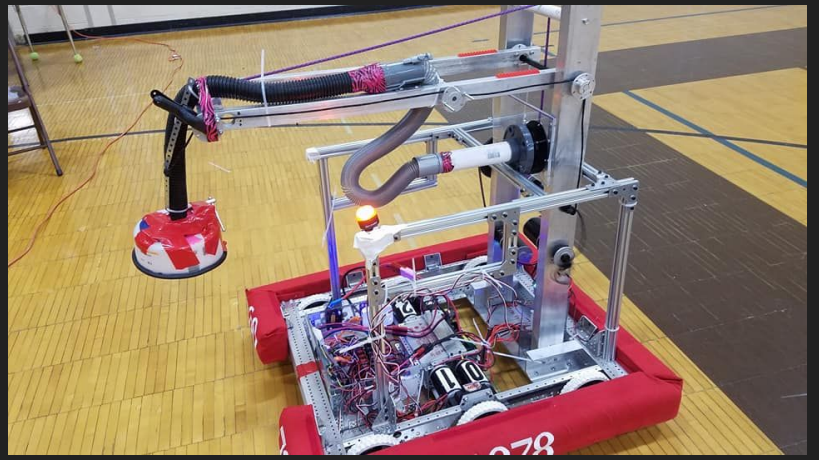


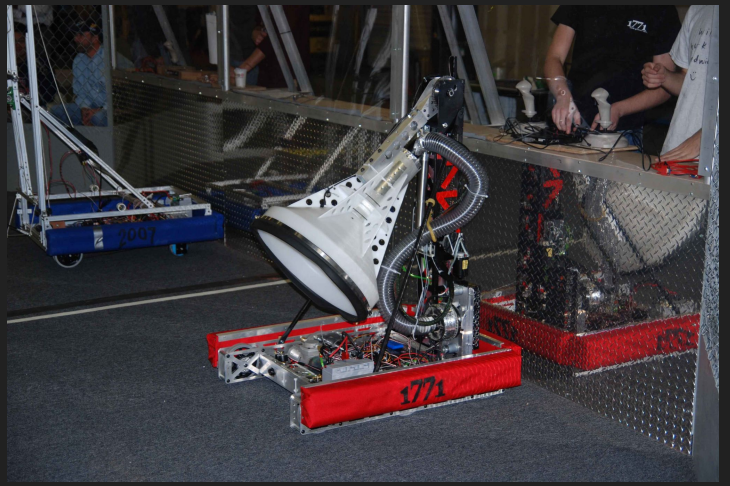
What are Shooters?

A shooter mechanism is a device or system used by robots to shoot game objects into specific targets. A shooter mechanism typically consists of several components, including a motor, a wheel or a flywheel and a feeder mechanism. The motor powers the wheel or flywheel to generate the necessary energy to launch the game object. The control system is used to coordinate the actions of the various components of the shooter mechanism, as well as to control the speed, direction, and trajectory of the shot.

What are Unique Mechanisms?

Teams are encouraged to think creatively and build mechanisms using unconventional parts as long as they follow the rules set forth in the FRC game manual. Teams should always make sure that their mechanisms are safe, reliable, and adhere to the rules of the competition. Teams should also consider the weight and durability of the materials they choose to use in their mechanisms, as well as the manufacturing and assembly processes involved. Building mechanisms with unconventional parts can challenge teams to be creative, innovative, and to think outside the box, but it also requires careful consideration and design to ensure that the mechanisms are functional and effective.





Places to get Mechanism Ideas

There are several places to find inspiration and ideas for mechanisms in FRC:

1. Past FRC games: Observing the mechanisms used in past FRC games can provide ideas for new and improved mechanisms for future games.
2. Scrimmage Competitions: Observing mechanisms used by other teams during competitions can provide inspiration for new and innovative designs.
3. The FIRST Robotics Competition online community: The online community provides resources and forums for teams to collaborate and exchange ideas about mechanisms.
4. Online resources: There are many websites and videos dedicated to providing information and tutorials on mechanism design and building in FRC.
5. Mentors and coaches: Teams can reach out to their mentors and coaches for guidance and advice on mechanism design.

Tips for Designing Mechanisms

When designing mechanisms for FRC, here are some tips to consider:

1. Start with the end goal: Consider what the mechanism needs to achieve and work backward to find the best solution.
2. Keep it simple: A complex mechanism is harder to design, build, and maintain, so try to simplify it as much as possible.
3. Use reliable components: Choose high-quality, durable components that can withstand the rigors of competition.
4. Plan for maintenance: Consider how easy it will be to maintain and repair the mechanism during the competition season.
5. Test and iterate: Build prototypes and test them to see how they perform. Make modifications and improvements based on the results of these tests.
6. Make it efficient: Make the most of the available space, power, and weight allowances to design the most efficient mechanism possible.
7. Consider the team's strengths: Take advantage of the skills and expertise of your team members to design a mechanism that they will be able to build and operate effectively.
8. Learn from others: Look at other teams' designs and mechanisms to see what works well and what doesn't. Take these lessons and apply them to your own design process.