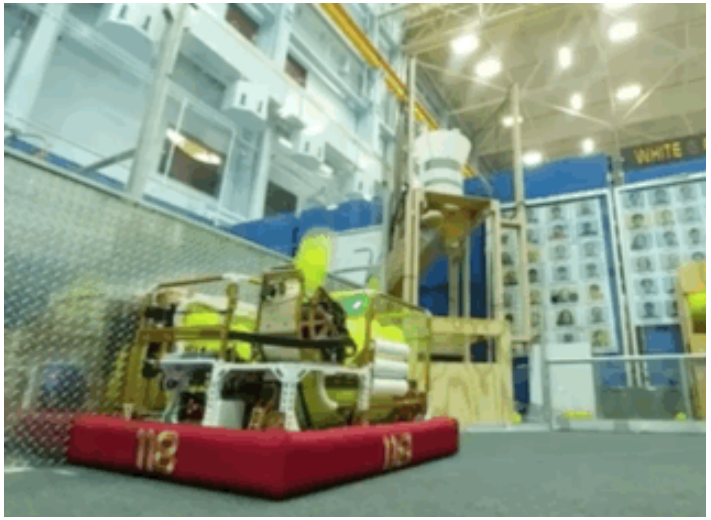
Module 2: How Do *FIRST*® Robotics Competition Robots Work?

LAUNCHERS AND PLACERS

FIRST Robotics Competition games are often either **launch games**, where a game piece shoots out of the robot and into a goal, or **pick-and-place games**, where a game piece is placed onto a field element to score points. Before deciding on the type of mechanism used to **launch or place** game pieces, ask:

- How many game pieces can the robot possess at one time?
- How does the size, shape, and flexibility of the game piece impact the design?
- Where does the game piece need to land in order to score?
- How will the **launcher or placer** interact with other mechanisms in the robot?

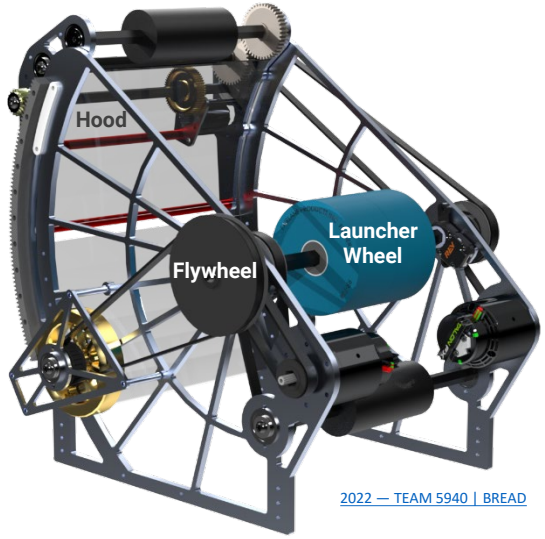


Team 118 Robonauts 2017

A **single-wheel launcher** is often used when a robot needs reliable, repeated shots in quick succession. These mechanisms are often called **flywheels** or **hooded launchers** due to their components.

Parts of a Hooded Flywheel Launcher

- **Launcher Wheel** –A variety of wheels are used, depending on the game piece and its ability to be compressed.
- **Inertia Wheel (Flywheel)** – Flywheels help solve a problem: When a game piece goes through the launcher, the shooter wheel slows down, which can cause the next shot to be inaccurate. A flywheel adds inertia, which helps keep the wheel turning at a more consistent speed.
- **Hood** – The hood provides direction and compression on the game piece, allowing it to have consistent contact with the launcher wheel.
- **Turret** – A turret is sometimes added to flywheel launchers to allow the mechanism to rotate. Other teams prefer to turn the robot to aim.



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Hooded Flywheel Launcher Tips and Tricks

- Be careful! Flywheels often spin at several thousand RPM. Be sure to secure loose items (scarves, ties, lanyards) and keep hands away.
- Hooded flywheel shooters create backspin on a game piece.
- A shot's trajectory can be adjusted by changing the speed of the wheel or the geometry of the hood. Some teams design an adjustable hood that can extend or retract to adjust how a game piece is launched from various places on the field.
- A hood that wraps farther around the wheel will result in a lower, flatter trajectory, while a hood that does not wrap very far around the wheel creates more of a lob shot.

Flywheel Materials and Resources

- **Flywheel and Launcher** examples include:
  - West Coast Products
  - AndyMark
- **Turret** examples include:
  - Armabot
  - Commercially available lazy Susan

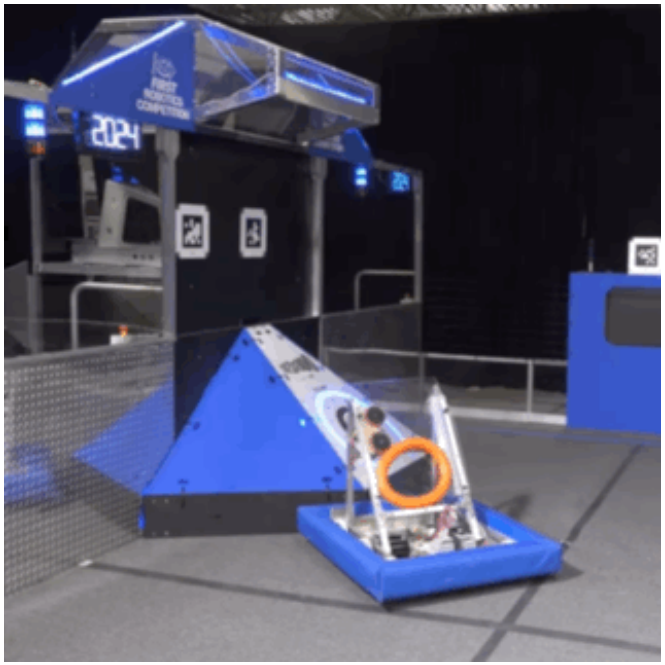
Multi-wheel launchers are designed in a variety of ways, depending on the game piece.

Types of Wheeled Launchers

- **1-Sided** – Wheels are on one side, while a piece of aluminum or other material provides compression on the other side. Good for launching disks or rings, creating spin that adds stability and accuracy to the flight of the game piece.
- **2-Sided** – Wheels are located on both sides, compressing the game piece between them. Good for creating a shot without backspin.
- **Top-and-Bottom** – Wheels are located on the top and bottom, compressing the game piece between them.

Wheeled Launcher Tips and Tricks

- The type of wheel used matters! If the game piece is hard, consider using compliant or pneumatic wheels. If the game piece is malleable, consider using harder wheels.
- Velocity, trajectory, and spin can be adjusted based on compression, speed that the wheels rotate, and type of wheel.
- Wheels may be programmed to rotate at different rates to provide different spin on the game piece.
- If possible, make the launcher adjustable to vary compression and angle. This allows teams to tune their design for accuracy and repeatability.



2024 FIRST Robotics Competition KitBot Reveal

Launcher Examples and Resources

- NASA Robotics Alliance Project: Robotics Design Guide
- FRCdesign.org CAD Shooter Designs
- Ri3D Stronghold Ball Launcher Tutorial

By reversing the direction that the wheels spin on a **roller claw** intake, it can become a **launcher or placer**. Designing mechanisms to complete more than one action has several benefits.

Roller Claw Mechanics

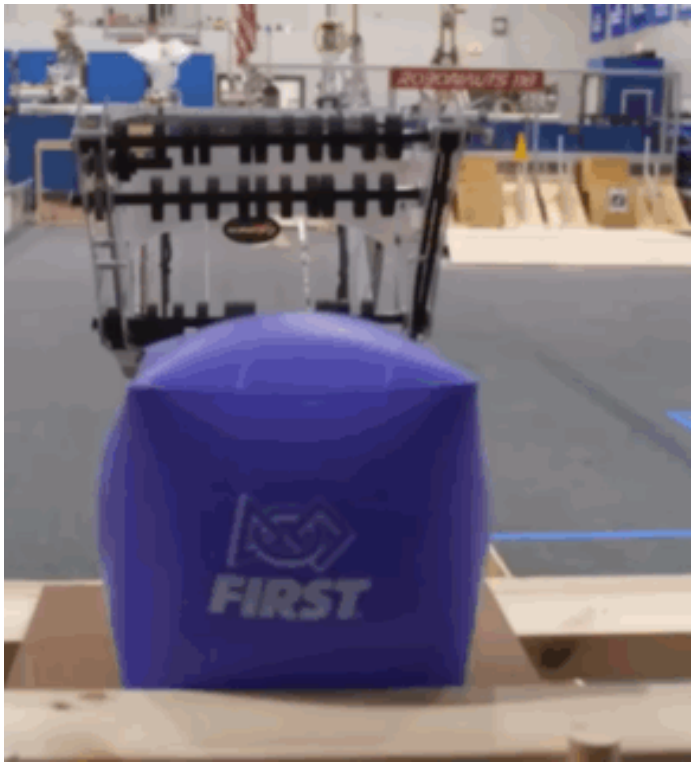
- **Roller claws** can be similar in design to multi-wheel launchers.
- Roller claws are used more commonly in pick-and-place games, where the game piece doesn't need to travel very far.
- See the **Game Piece Intakes** slide deck for more information.

Benefits of a Multipurpose Mechanism

- **Saves Weight** – Fewer mechanisms often makes for a lighter robot, helping to keep the robot within weight limits.
- **Less to Repair** – Fewer mechanisms can mean fewer parts that could break or need repairs during a competition.
- **Elegance in Design** – Designing a mechanism with many functions, efficiently packaged to save power and weight, is one way to create simple but effective robot design.

Challenges of a Multipurpose Mechanism

- If the mechanism breaks mid-match, that means there are multiple actions on the field that the robot can no longer perform.
- If possible, have backups of all components of key mechanisms to make repairs easier at competitions.



The Robonauts 118 Everybot 2023

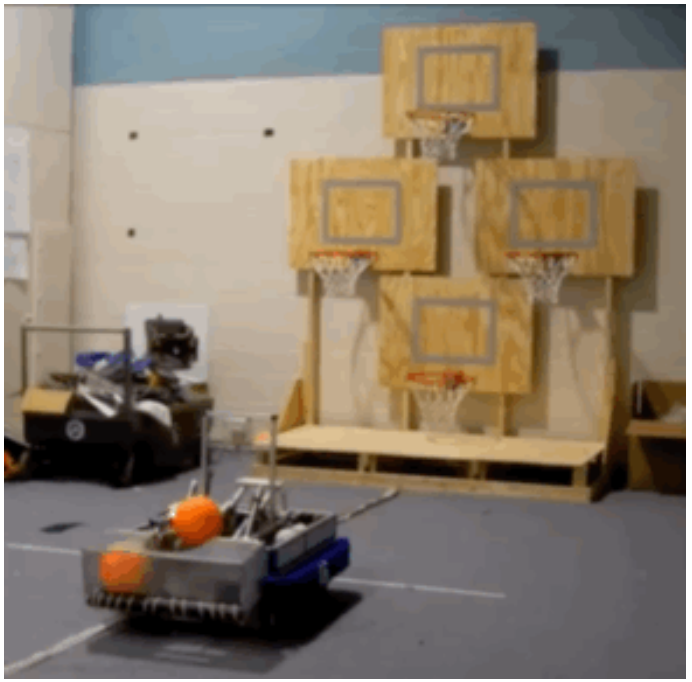
Catapults are good at launching one game piece at a time but not in rapid succession.

Parts and Mechanics of Catapults

- **Catapult Arm** – If considered as a simple machine, a catapult arm is a lever connected to another mechanism that pulls back and releases the arm.
- **Pull Back and Release Mechanism** – A variety of mechanisms can be used to pull the arm back and release it. These include belts and bands, pneumatics, drop cams, and "choo-choo" linkages.

Pros and Cons of Catapults

- Catapults can launch irregularly shaped game pieces that would be difficult to launch with a wheeled shooter.
- Catapults are not efficient at quickly at loading and launching multiple game pieces, one right after another.
- Catapults can vary from quite simple to surprisingly complex!

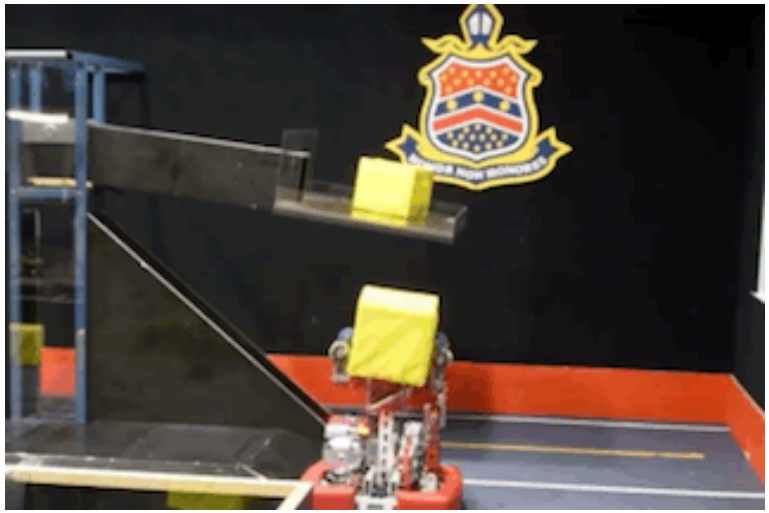


Bomb Squad 2012:Robot Unveil

Catapult Examples and Resources

- Ri3D 2016: 'Snow Problem - Catapult and Intake
- What are Cams?
- NASA Robotics Alliance Project: Robotics Design Guide

A **linear punch** pushes a game piece as if it were being punched or kicked. Like a catapult, it requires a pull-back and release mechanism.



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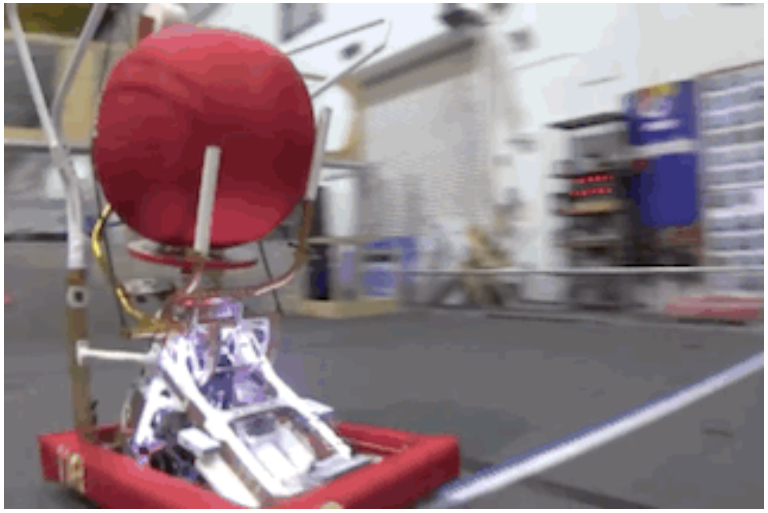

Team 118 Robonauts 2014

Linear Punch Tips and Tricks

- **Linear punch** mechanisms can be very effective in both launch games and pick-and-place games due to their high level of repeatability and ability to handle odd-shaped game pieces but can't launch in quick succession.
- **Pull back and release** mechanisms must pull back, build energy, and release to provide the punch or kick motion. Pneumatic pistons are the most common form of linear motion mechanisms, but it can also be done with compression springs. Learn more about pneumatics in the Actuators: Creating Movement slide deck.