

Intake Arms

Roller Claws

Intake Wheels

Belts

Passive Intakes

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

# GAME PIECE INTAKES

The **intake** is the mechanism that allows robots to acquire and possess game pieces. The goal for an **intake** is “Touch it, own it.” Consider these questions when designing an **intake**:

- Where will the robot **intake** a game piece: from the floor, a human player station, and/or another location?
- How does the size and shape of the game piece impact the design of the **intake**?
- If the **intake** extends outside of the frame perimeter of the robot, what will its starting configuration look like?
- How will the **intake** interact with other mechanisms in the robot?
- How will the **intake** avoid damage and penalties if it collides with another robot or field element?



[Cranberry Alarm Ri3D CRESCENDO 2024](#)

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An **intake arm** is a common mechanism. Intake arms often start inside the robot frame, then extend **over the bumper**.

### Intake Arm Mechanics

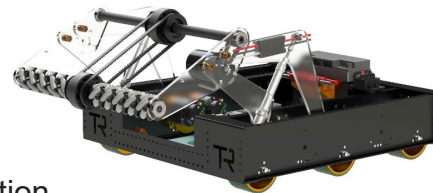
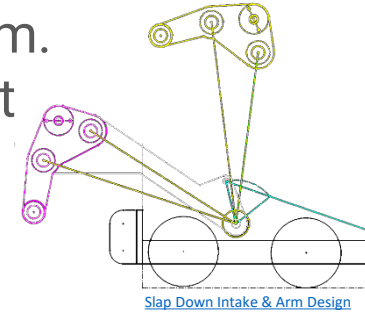
- **4-Bar Linkages** - Many over-the-bumper arms use four-bar linkages, which are examined later in this lesson.
- **Slap Down** - Other arms are designed to “slap down” from a pivot point inside the robot frame.

### Parts Often Used on an Intake Arm

- **Wheels** – See the Intake Wheels tab for more information.
- **Belts** – See the Belts & Tubing tab for more information.
- **Rollers** – Rotating aluminum or polycarbonate tubes, sometimes with grip material applied to them are common.
- **Hex Shaft** – Wheels, belts and/or rollers are often located on one or more axles, typically made from ½” Hex Shaft.

### Intake Arm Tips and Tricks

- Consider using **polycarbonate** for the sides of the arm to make the arm flexible, strong and lightweight. **DO NOT use Acrylic** – it can shatter on impact.
- Design the arm to move back inside the frame perimeter when not picking up a game piece. This will decrease the chance of damage to the arm from collisions with field elements or robots.



## Arm Examples and Resources

- **Polycarbonate or Lexan.** Examples include:
  - Local Hardware Stores and Vendors
  - Online Vendors
- **Hex Shaft.** Examples include:
  - [AndyMark](#)
  - [WestCoast Products](#)
- **Rollers.** Examples include
  - [McMaster-Carr](#)
  - [AndyMark Roller Intake Kit](#)

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**Roller Claws** are mechanisms that can **intake** a game piece, and if the motors for the wheels or belts are reversed in direction, can also **launch** or **place** a game piece.

### Types of Roller Claws

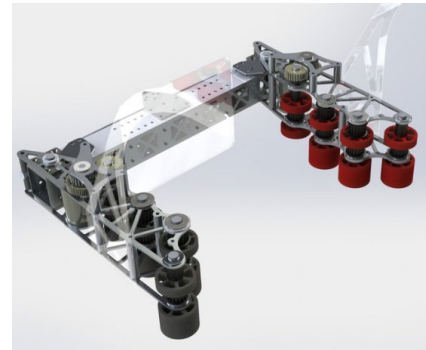
- **Side-to-Side** – This intake is good for picking up box-shaped game pieces, since it can grab a game piece from both sides. It often uses compliant wheels.
- **Top-and-Bottom** – This intake typically features rotating wheels or belts that draw in a game piece from the floor or another flat surface.

### Parts Often Used on Roller Claws

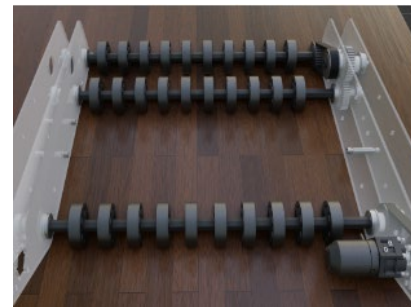
- **Wheels** – See Intake Wheels tab for more information.
- **Belts** – See Belts & Tubing tab for more information.

### Roller Claw Tips and Tricks

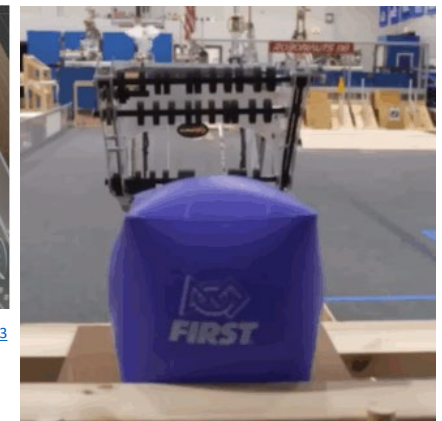
- Make sure the game piece is secure within the claw, even when the robot travels at high-speeds, turns quickly, or takes a hit.
- Some roller claws also open and close to pinch the game piece tighter between the rollers. This may or may not be necessary, depending on the game piece.
- Even slight changes to the wheels or shape and angle of the claw can make a big difference in effectiveness.



[2018 Robot – Citrus Circuits](#)



[The Robonauts 118 Everybot 2023](#)



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Intake Wheels

Belts

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Wheels are used on both intake arms and roller claws, helping to intake a game piece and release it as well.

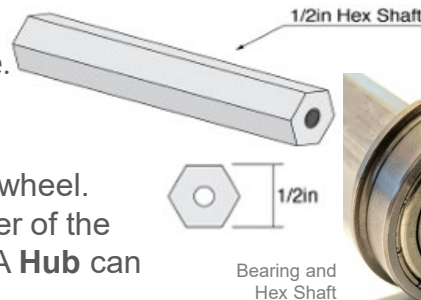
### Types of Intake Wheels

- **Compliant** – Compliant wheels provide grip and come in a variety of durometers. **Durometer** measures how “squishy” a compliant wheel is. The lower the durometer, the squishier the wheel.
- **Mecanum** – Used to center an object for indexing.
- **Omni** – Also used to center an object for indexing.
- **Stars** – Used for their ability to sweep in a game piece.



### What is Bore?

- **Bore** refers to the size of the hole in the center of the wheel.
- **Axles**, such as a Hex Shaft, should match the diameter of the bore. 1/2" is a common size for a Bore and Hex Shaft. A **Hub** can be attached to a wheel to change the size of the bore.



### Bearings and Intake Wheel Mechanics

- **Spacers** and **Shaft Collars** hold wheels in place on an axle.
- Axles that spin must be supported in at least 2 places by either a motor with a gearbox or a bearing.
- **Bearings** are metal components that allow the inside portion that contains the axle to rotate smoothly and independently from the outside part that is mounted to the robot.
- One motor can power multiple axles of intake wheels if they are connected by belts, gears, or chains.

### Intake Wheel Examples and Resources

- [REV Robotics](#)
- [AndyMark](#)
- [West Coast Products](#)
- [ThriftyBot](#)



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Some intakes use **flat belts** or **round belts** to draw a game piece into the robot, as well as index or load the game piece into another mechanism.

## Flat Belt Mechanics

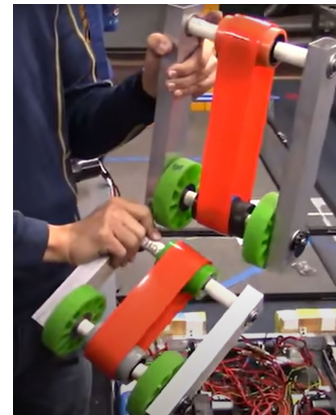
- **Polyurethane flat belts** or “**Polybelts**” are typically 1-2 inches wide and roll on crowned pulleys to keep them in place. Belts can be cut and “welded” together with heat to make loops.
- **Crowned pulleys** have a raised center that keeps flat belts centered on a roller.
- **Timing belts** use **toothed pulleys** to prevent slipping, but cannot be re-sized and have a specific center to center distance.

## Round Belt Mechanics

- **Polyurethane round belts** look like tubes and run on rollers with channels to keep the belts in place.
- **Solid round belts** can be “welded” together to make a loop.
- **Hollow round belts** use small metal connectors to attach the two ends instead of welding them together.

## Welding Polyurethane Belts

- Belts need to be partially melted with either a heat gun or a hot knife, then clamped together to “weld” them into a loop.
- Make belts about 10% smaller than the needed length to make sure they remain tight on the rollers.



[Flat Pulley Belting Transfer System](#)



[Round Belting Transfer System](#)

## Belt Examples and Resources

- [How Do I Use Polybelt?](#)
- **Heat Gun** – Available at most hardware stores
- [Clamp tool](#) and [Hot Knife](#)
- **Flat Belts**
  - [AndyMark](#) – also has [Crowned pulleys](#)
  - WCP - [Timing Belts and Pulleys](#)
- **Round Belts**
  - [McMaster-Carr](#)

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Some teams use a **passive intake**: one that does not require motors or mechanisms to function. A passive intake can be combined with motorized mechanisms as well.

### Dust Pans and Shovels

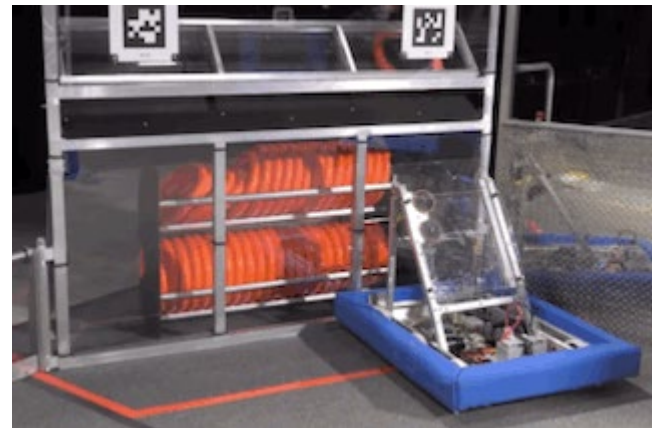
- **Dust Pans** are thin pieces of material that move along the floor or carpet to scoop up game pieces, particularly with flat game pieces. Mechanized rollers are sometimes added for indexing.
- **Shovels** are a simple way to move game pieces along the floor, often to assist alliance partners to “feed” them game pieces to score.



[Team Titanium 1986 - 2013 Reveal](#)

### Ramps and Slides

- **Ramps and Slides** are sometimes used as a way to gather game pieces from a Human Player Station, depending on the game.
- Typically, a robot aligns its ramp or slide with the station, then Human Player pushes a game piece through the field element, where it slides directly into the robot.
- The 2024 KitBot featured a passive intake which loaded the game piece into a motorized launching mechanism.



[2024 FIRST Robotics Competition KitBot Reveal](#)