

Frame

Bumpers

Tank Drive

Holonomic Drive

Belly Pans

ROBOT CHASSIS AND DRIVETRAIN

The **robot chassis** is the structural component of a robot that provides a foundation for the robot's drivetrain and other mechanisms. When designing a robot chassis, it is important to ask several questions:

- What size will the **frame** be?
- How will the **bumpers** and other robot components attach to the frame?
- Which **drivetrain** will the robot have?
- Will electronics be located in a **belly pan**, or elsewhere?



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The **frame** is a critical part of your robot structure. Important parts of the robot will attach to the frame, so it must be **strong and robust**.

Parts of the Frame

- **Drive Rails** - The sides of the robot where the drive wheels and gearboxes are located.
- **Cross Members or Ladder Bars** – Usually 2x1 aluminum box tube, which connect to the drive rails at the front and back of the robot.

Frame Size and Shape

- Frames can be different shapes and sizes, however the frame perimeter often cannot exceed 120." Make sure to check your season's [Game Manual](#) for season specific details.

Frame Tips and Tricks

- Use 1/8" thick Box Tube for durability.
- Smaller robots are more maneuverable, but make packaging mechanisms and electronics more challenging.
- A robot will not pass inspection if it exceeds the frame perimeter size in the Game Manual.



Frame Materials and Resources

- **Aluminum Box Tube.** Examples include:
 - [REV MAXTube](#)
 - [VexPro VersaFrame](#)
 - [West Coast Products](#)
- **Sheet Metal.** Examples include:
 - [AndyMark Kit Bot](#)
 - Custom fabricated frames

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Bumpers protect the frame perimeter and feature the team's number on all sides of the robot. Teams will need **blue bumpers** and **red bumpers**. Check each season's [Game Manual](#) for details.

Parts of a Bumper

- **Wood Backing** – Typically $\frac{3}{4}$ " thick, 5" tall plywood
- **Pool Noodles** – Check the [Game Manual](#) for specifics
- **Gaffers or Duct Tape** – To attach pool noodles to the wood
- **Red and Blue Fabric** – Similar in color to the *FIRST*® logo
- **Numbers** - Check the [Game Manual](#) for specifics, but numbers are typically white, 4" tall, and clearly readable from 60 feet away.
- **Hardware** – Brackets, bolts/nuts, pull pins, staples, etc.

Bumper Tips and Tricks

- Don't wait until the last minute to construct bumpers. Poorly constructed bumpers can cost a team matches and create headaches during competition.
- Make your bumpers sturdy, durable, and easy to remove and re-attach.
- During matches, bumpers must be firmly attached to the frame, typically with brackets, in at least two spots per side.
- Numbers are often applied before the fabric is put on the bumpers, which takes planning and precision.



Bumper Materials and Resources

The [FIRST® Robotics Competition Bumper Guide](#) is an excellent resource with links for materials and steps for construction.

Watch videos on [How to Make Bumpers](#) and [How to Mount Bumpers](#) on the *FIRST*® YouTube channel.

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One type of *FIRST*® Robotics Competition drivetrain is **Tank Drive**, which includes traction wheels powered on each side by a single gearbox connected by chains located inside, or outside, of the box tube.

Types of Tank Drives

- **West Coast Drive** – Has cantilevered wheels that stick out from the frame rather than be contained within it.
- **4-Wheel Drive, 6-Wheel Drive, or 8-Wheel Drive**

Tank Drive Advantages

- Simple to build and program
- Good pushing power and traction
- Generally easy to maintain

Tank Drive Weaknesses

- Can't drive sideways (strafe)
- Turning issues (skid steer) can cause too much friction and brownouts when turning if not built properly

Design Fixes to Skid Steer Issues

- **Drop Center** - Center wheel(s) are slightly lower (1/16" – 3/16") to make turning easier.
- **Omni Wheels** - Omni Wheels can be used at the front and/or back to help with turning



Tank Drive Materials and Resources

- **Tank Drive Kits.** Examples include:
 - [AndyMark 2024 KitBot Chassis](#)
 - [AndyMark West Coast Drive Kit](#)
- **WPI Lib** includes tutorials for programming
- Wheels are offered by many vendors:
 - [WestCoast Products](#)
 - [REV ION](#)
 - [AndyMark](#)
 - [VEXpro](#)

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Another type of *FIRST*® Robotics Competition drivetrain is **Holonomic Drive**, which allows for omni-directional driving including spin, strafe, and diagonal driving. **Swerve Drive** is a popular holonomic drivetrain.

Types of Holonomic Drives

- **Swerve Drive** – Allows for an optimal combination of speed, pushing power, and maneuverability and is quickly becoming a gold-standard for drivetrains.
- **Mecanum/Omni Drive** - Maneuverable, but lacks pushing power compared to tank and swerve drives.

Swerve Drive Advantages

- Excellent maneuverability and speed
- Good pushing power
- There are a variety of Commercial Off-the-Shelf (COTS) swerve modules and products

Swerve Drive Weaknesses

- Expensive
- Complex to assemble
- Heavier than most Tank Drives
- Each wheel requires two motors, which can drain a battery faster
- Can be challenging to code, but code libraries are available



Swerve Drive Materials and Resources

- **COTS Swerve Drive Modules:**
 - [REV Robotics](#)
 - [Swerve Drive Specialties](#)
 - [AndyMark](#)
 - [ThriftyBot](#)

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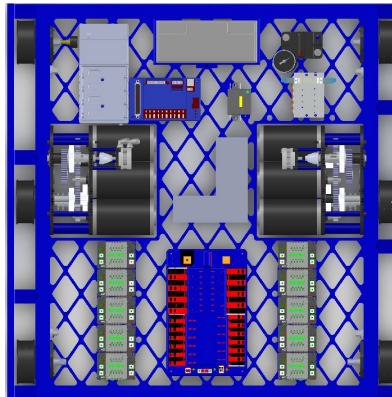
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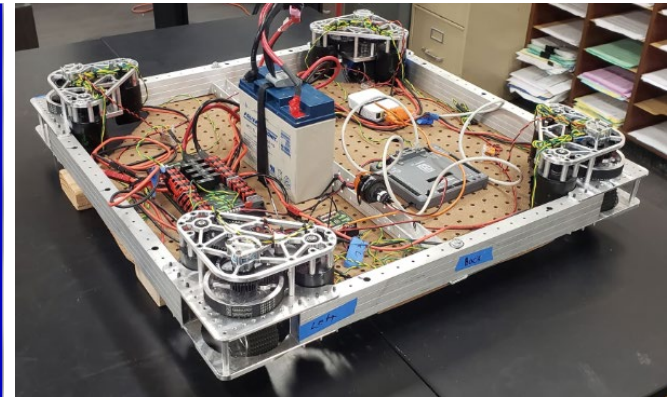
Some teams use a **belly pan** at the bottom of the robot, which connects the drive rails and ladder bars. A **belly pan** can be used as a spot to mount the electronics, battery, compressor, and other robot mechanisms.

Belly Pan Advantages

- Provides needed structural support to the robot frame. Robots without a belly pan often need cross supports for the frame.
- Commonly made out of $\frac{1}{4}$ " - $\frac{1}{2}$ " plywood, $\frac{1}{16}$ "- $\frac{1}{8}$ " aluminum, or $\frac{1}{8}$ " perforated polycarb.
- Provides a mounting location for electronics and other components



FRC Team 254 West Coast Drive with Belly Pan



FRC Dark Matter 2643 Swerve Drive with Belly Pan

Belly Pan Weaknesses

- Adds weight to a robot
- Can make some electronics difficult to access, depending on the design of the robot and its mechanisms.
- Be cautious if attaching a belly pan to tank drive rails that have a chain-in-tube drivetrain. Rivets could hit and damage the chain inside the box tube.

Belly Pan Materials and Resources

- **COTS Materials:**
 - [AndyMark Perforated Polycarbonate Sheet](#)
 - [Aluminum Perforated Sheet](#)
 - Plywood or Sheet Metal can be purchased at many hardware stores