Training L2

Mechanical Drive Train and Chassis Design

Objectives

Understand:

- ❑ Understand the mechanical Chassis Design
- ❑ Understand the mechanical Drive Train Types
- ❑ Understand Center of gravity

Note: References for this training is listed in the mechanical handbook

FIRST Chassis characteristics

Structure:

- The size of the chassis is approx 30in x 30in x 6in

- It should be strong and level for the robot frame which the robot mechanisms are connected to.

- Goal weight to be under 30lbs, total weight of robot is typically under 120lbs

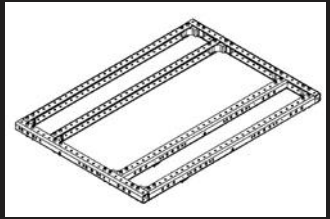
Mobility:

- It provides robot mobility through the arrangement and type of wheels used

- It provides a structure to mount the robot wheel power transmission

FIRST Chassis Examples

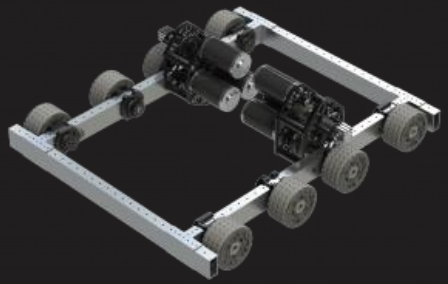
AndyMark C-frame chassis-9lbs



AndyMark Am14U2 -23lbs

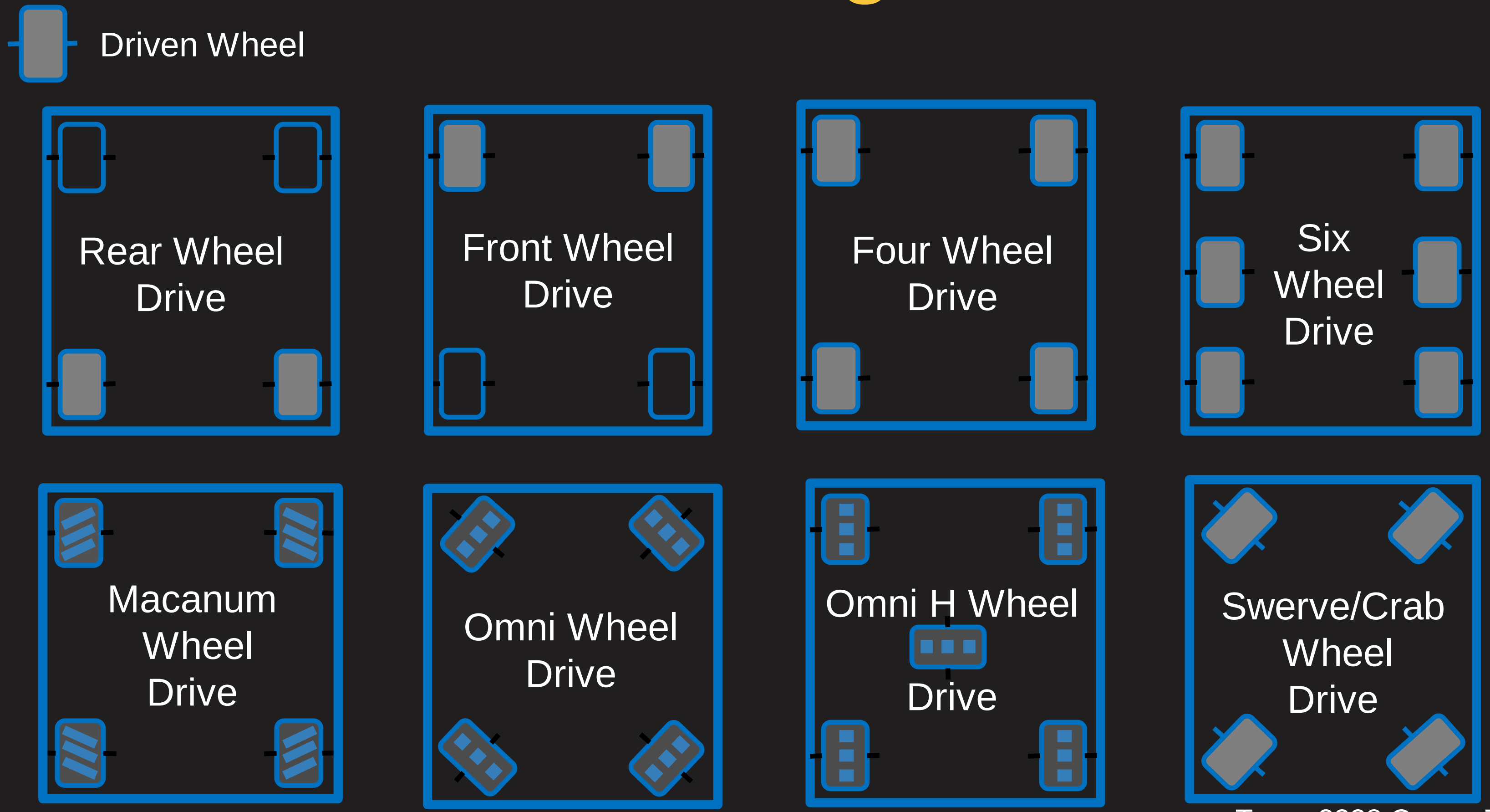
Vex Robotics –VersaFrame- 8.4lbs

Vex Robotics –VersaChassis
VersaTube-1x2 59in-3.28lbs

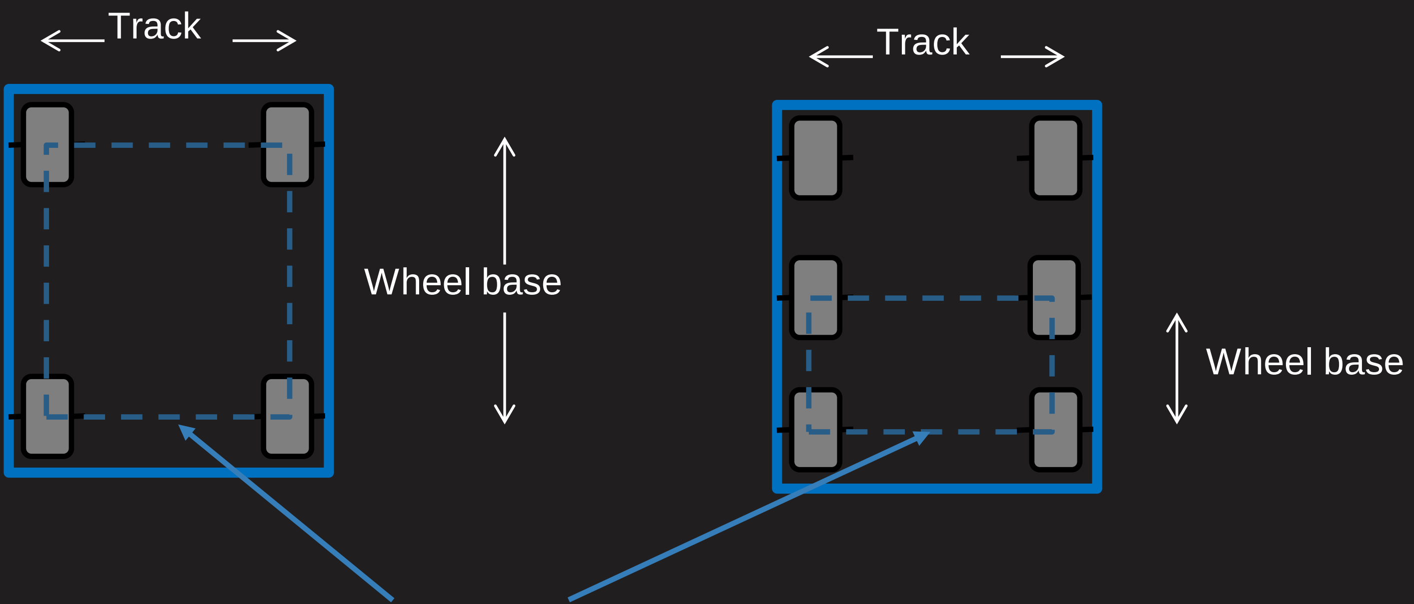


Note: 1 CIM motor/gearbox ~ 5.6lbs

Chassis Wheel Configurations



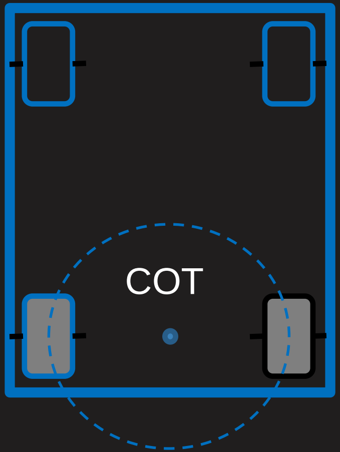
Chassis Wheel Base

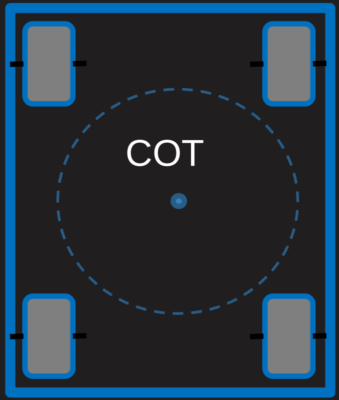


For agile turning
Ratio of Track to Wheel base length: (2.0 to 2.5) : 1

2-wheel Drive 4-Wheel Drive Rotation

COT-Center Of Turning





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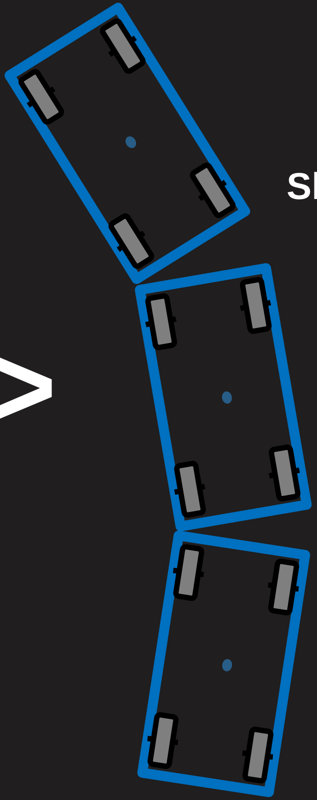
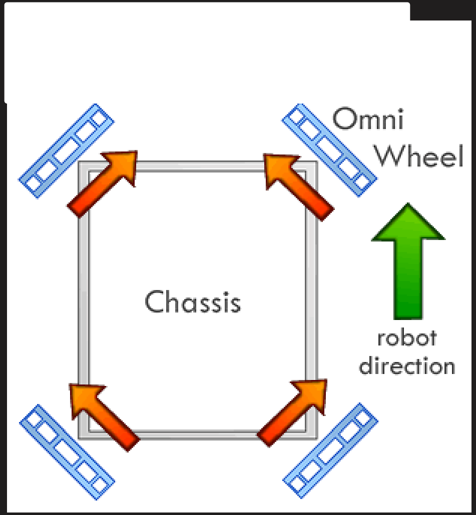


Skid Steering

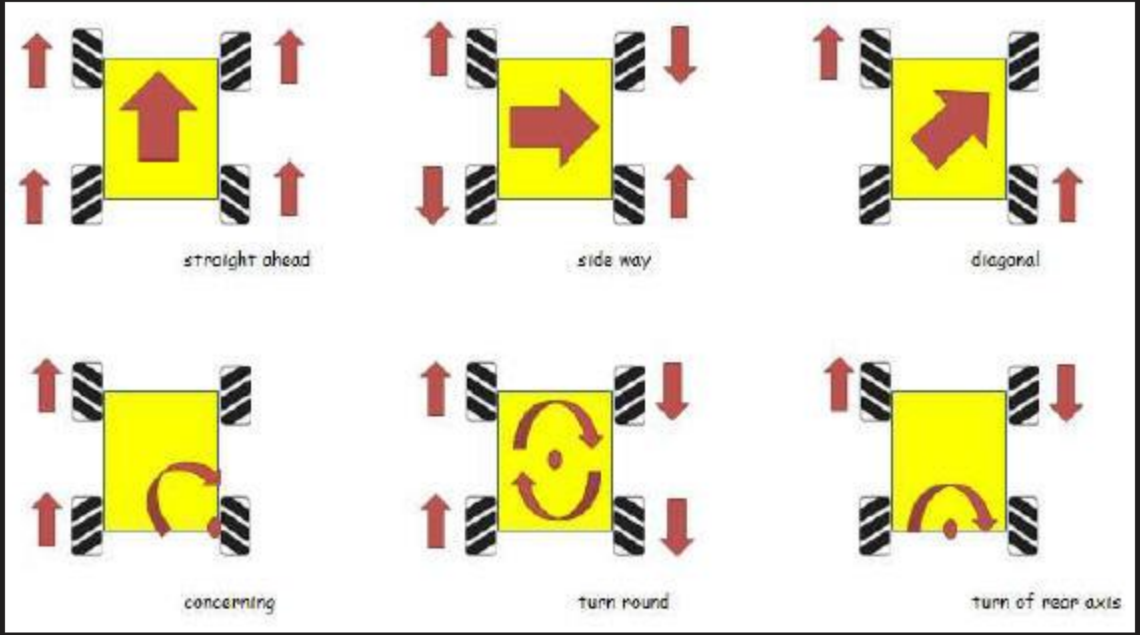
Decreasing the distance between the front and rear set of wheels, results in better zero-radius turning in any direction with 4 wheel drive robot.

Holonomic Drive Motions

Omni Wheel Motion



Macanum Wheel Motion



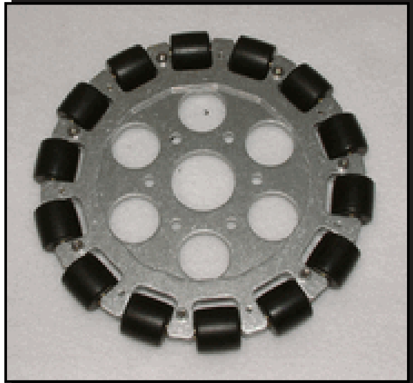
Robot Wheel Examples

Wheel Coefficient of Friction(COF):

- Soft “sticky” materials have higher COF
- Hard, smooth, shiny materials have lower COF

Holonomic Wheel Examples

Omni Wheels



Macanum Wheels

Four Wheel Configuration (4WD)

Characteristics:

- Gearbox in middle with chains/belts to each wheel
- Faster than two wheel
- Better traction than two wheel

Issues:

- Suffers at turning – short wheel base improves turn radius
- Has been outdated by offset 6 wheel configuration

Six Wheel Configuration (6WD)

Characteristics:

- Higher traction than four wheel drive
- The middle wheel is slightly lower. This effectively divides the wheel base in half.
- During acceleration or deceleration the robot is a 4WD robot depending on the center of gravity

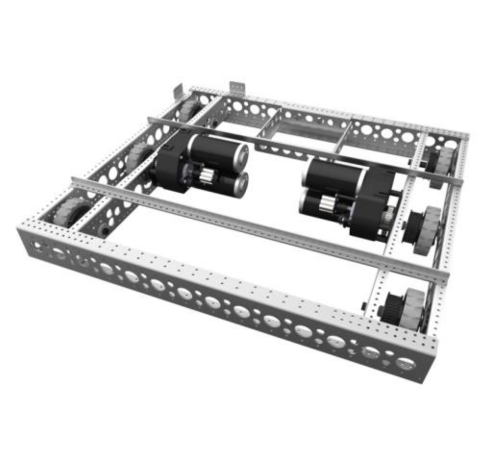
Issues:

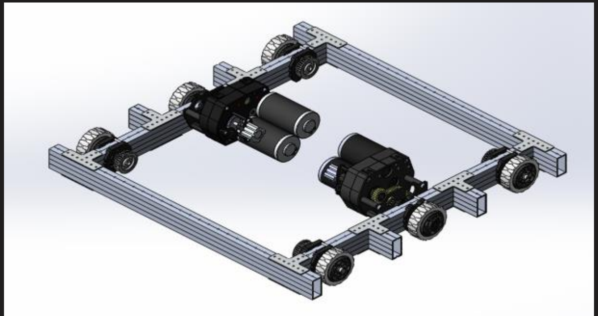
- Requires chains or belts to drive all the wheels
- For smooth two wheel turning the location of center of gravity is important (Should be closer to the center wheel)

Six Wheel Configuration Examples

Andymark

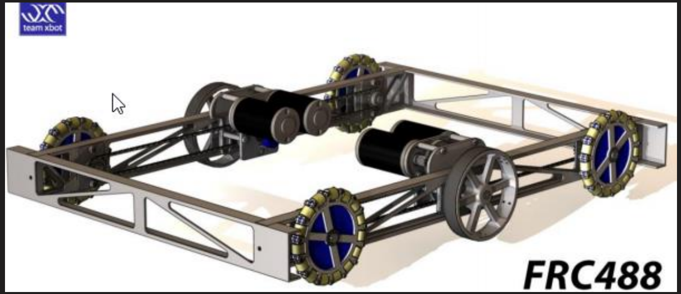
Vex-pro





"West Coast drive first used by many teams on the west coast. It also has the wheels cantilevered"

Custom



Omni Wheel Configuration

Characteristics:

- Provides more maneuverability(rotation, strafing[left-right movement])

- Easier to align to game objects and playing field objects

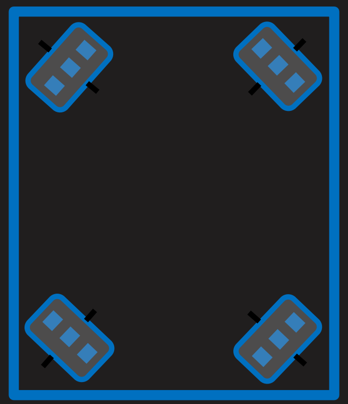
Issues:

- Fairly complex wheels

- Lower traction

- Less speed and pushing force

- More complex to mount and control



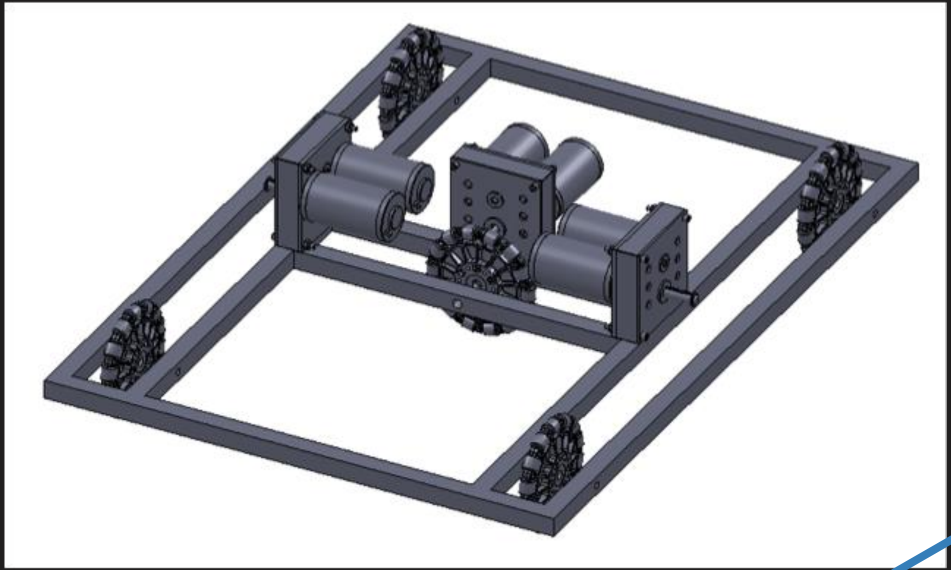
Omni Wheel Configuration Examples

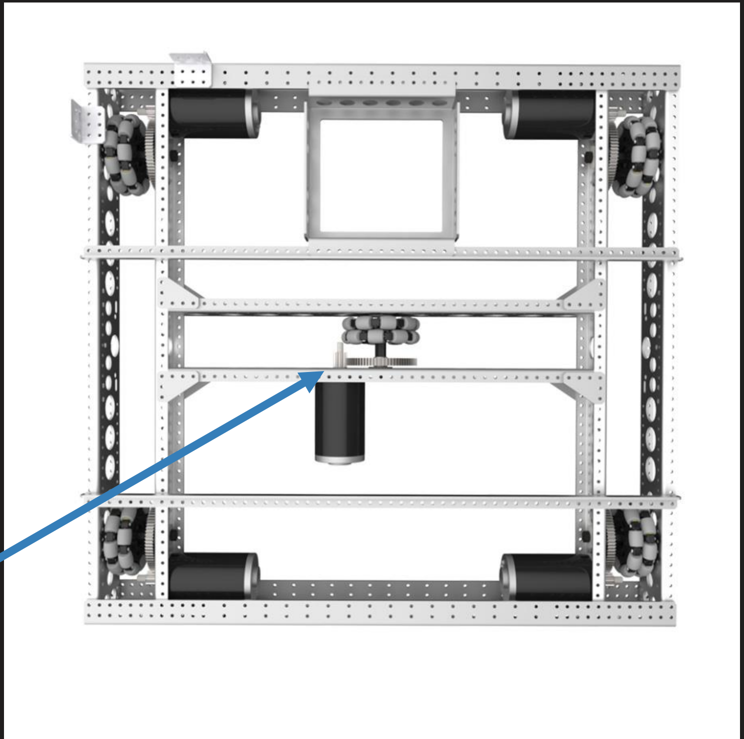
“Kiwi Drive”

Team 1114 - 2015

Omni Wheel “H” Configuration Examples

Team 1114





Requires pneumatic cylinder to engage strafing wheel

Mecanum Wheel Configuration

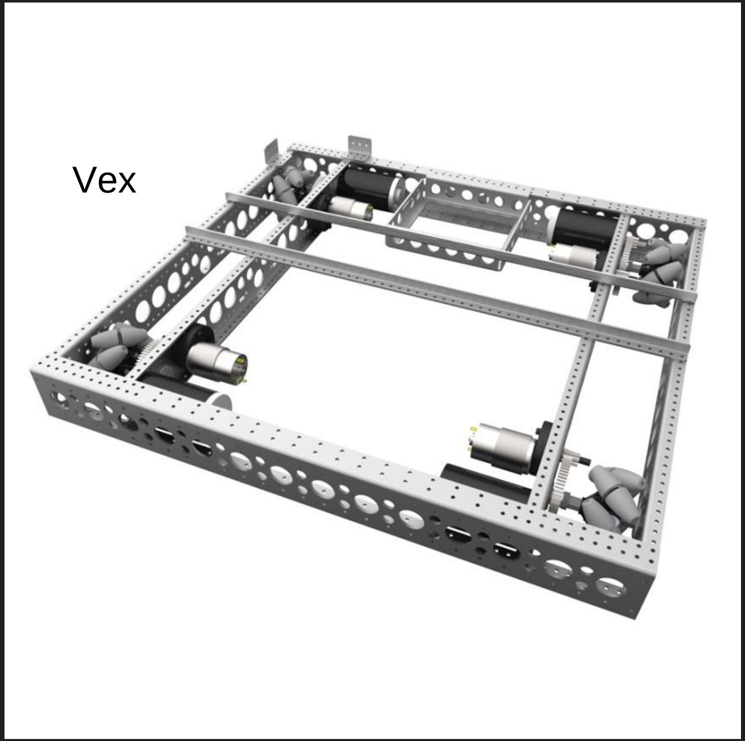
Characteristics:

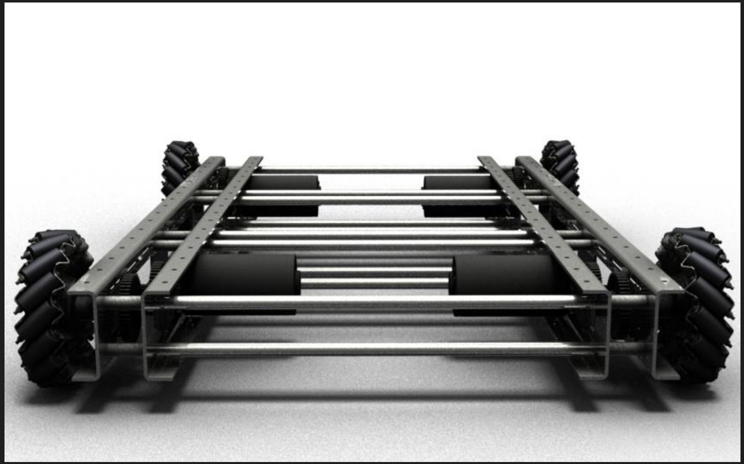
- Provides more maneuverability(rotation, strafing[left-right movement])
- Easier to align to game objects and playing field objects

Issues:

- Complex wheels
- Lower traction
- Less speed and pushing force
- Complex to control effectively
- Requires a lot of driver training

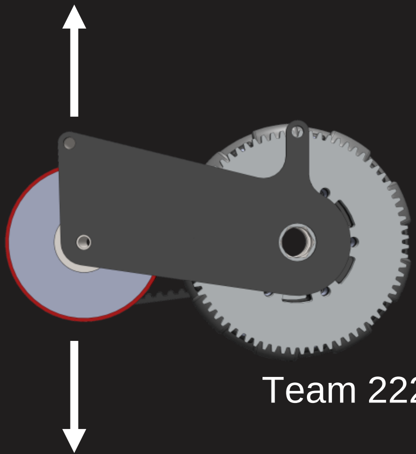
Mecanum Wheel Configuration Examples





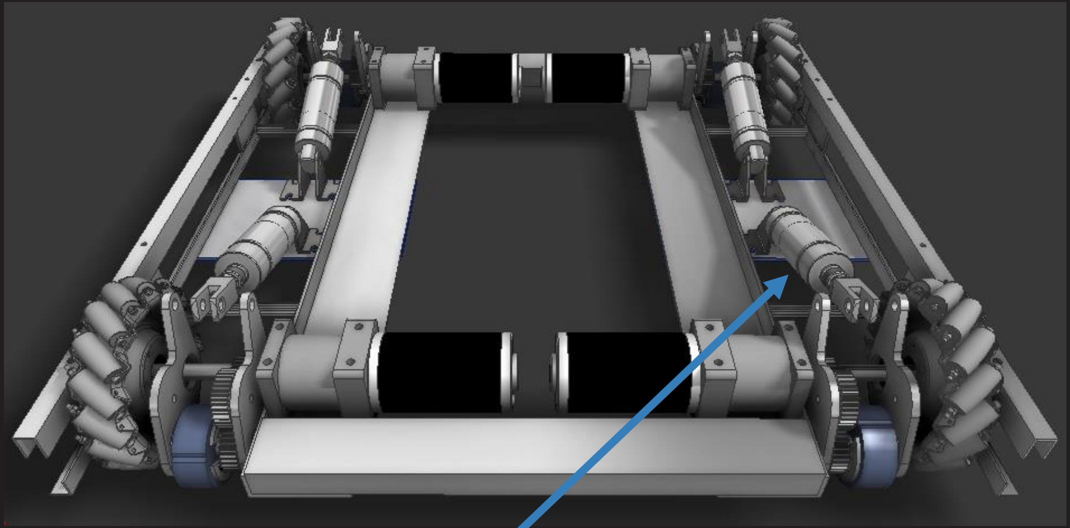
Octocanum Wheel Configuration

Mecanum Configuration



Team 2220

4WD Configuration



Team 1212

Requires pneumatic cylinder to engage friction wheels

Swerve/Crab Wheel Configuration

Characteristics:

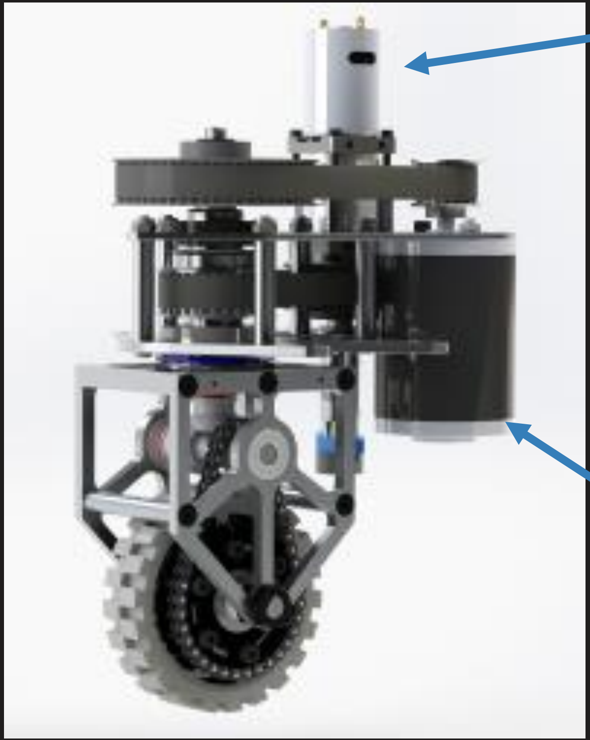
- Each wheel independently steered
- Good traction and maximum pushing force
- Easier to align to game objects and playing field objects

Issues:

- Complex to build ~$300-$400
- Very complex to program effectively

Team 1640

Swerve/Crab Wheel Configuration Example



Rotation Motor

Drive Motor

Team 1640

Einstein Drive Train History - (%) in Qtr Finals

Year n	TANK TREAD	2DW	4WD	6DW	8WD	SWERV E	BUTTERFLY
2005			59	34		7	
2006	50	29		21			
2007				100			
2008				90		10	
2009				91		9	
2010				68	32		
2011				100			
2012				93		7	
2013				100			
2014			6	56	19	13	6

http://frcdesigns.com/2014/10/10/hl-einstein-drivetrains/

Rules of Thumb for Robot Speed

Single Speed:
- Fast speed is typically 10 – 18 feet per sec

Two Speed:
- Slow speed is typically 4 - 8 feet per second
- Fast speed is typically 10 – 18 feet per second

Choosing a Drive System

During the development of the game strategy the motions of the robot and game object acquisition process should be established.

In determining the drive system the following questions should be asked:

- Does the robot need speed?
- Does the robot need to push or block?
- Does the robot need to strafe?
- Does the robot need to make quick turns?

Center of Gravity-Newton and Momentum

Newton's first law of motion states:
"An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force." Objects tend to "keep on doing what they're doing.“

For example: You are driving in a car at high speed and stop quickly. What happens to you?

Momentum:
When something is moving it has momentum. The heavier it is and the faster it is moving, the harder it is to stop. So momentum is a kind of measurement of how hard it is to stop something in motion

Center of Gravity-Center of Mass

Definition of *CENTER OF GRAVITY*
The point at which the entire weight of a body may be considered as concentrated so that if supported at this point the body would remain in equilibrium in any position(Merriam-Webster)

For example: The center of mass for a cube is the center of the cube.

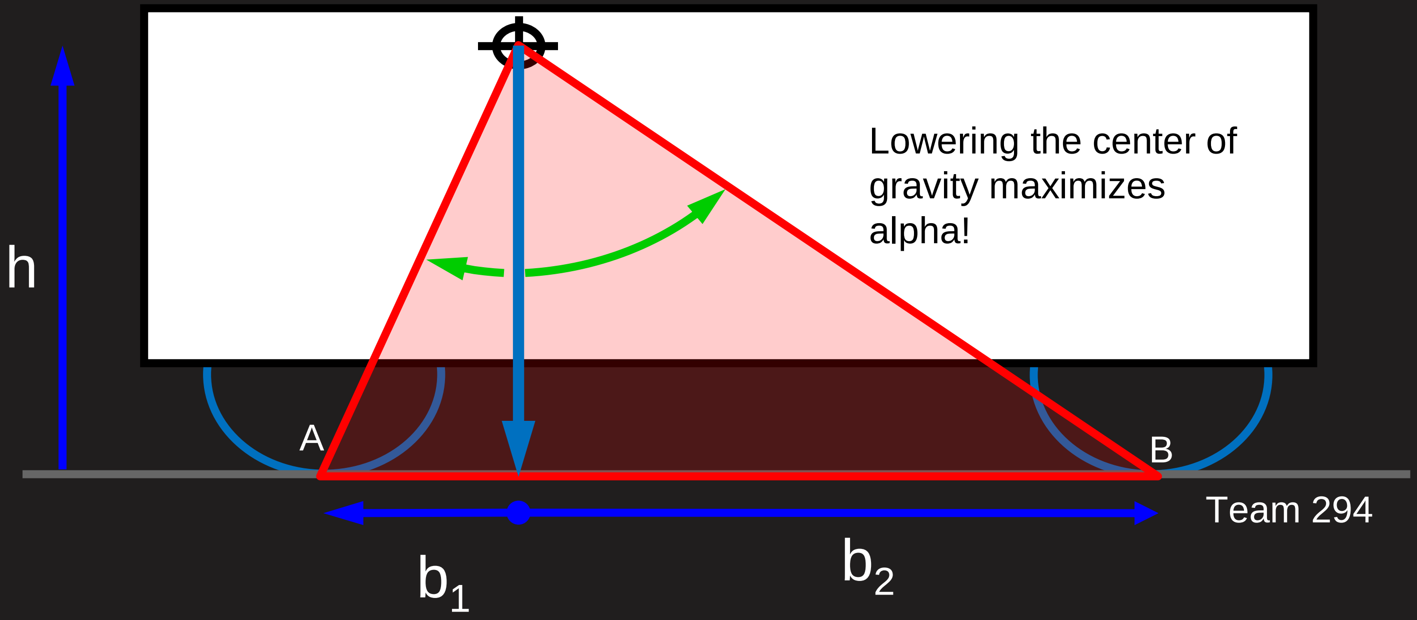
Some rules for stability:

- It is more difficult to make an object with a low center of gravity topple than a structure with a high centre of gravity.

- A structure with a wide base is generally more stable than a structure with narrow base.

Stability Triangle

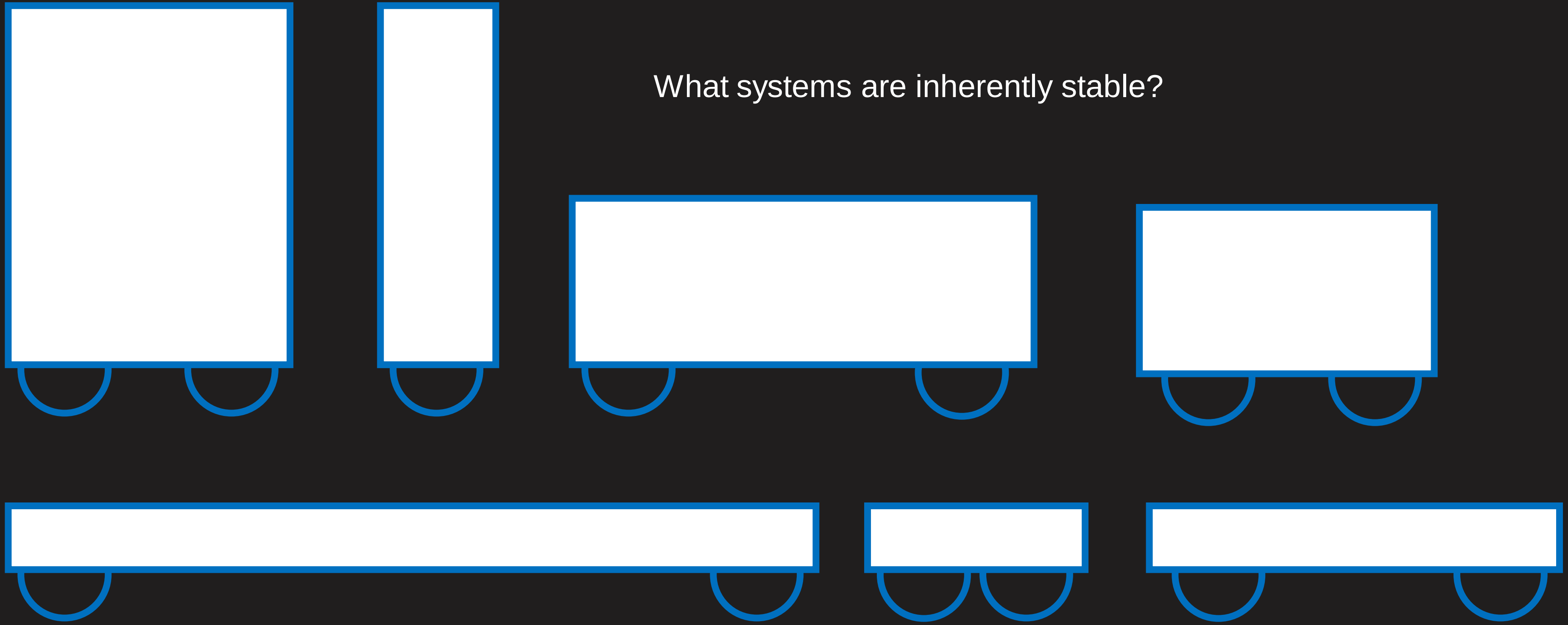
- If B raises off the ground and the brown arrow moves past A, the robot will fall backwards
- If A raises off the ground and the brown arrow moves past B, the robot will fall frontwards



Stability Examples

Where is the Center Of Gravity (COG)?

What systems are inherently stable?



Best Practices

- All Wheels should be driven. Especially for wheels that support significant weight.

- The chassis should be level. An uneven chassis has a large effect on steering

- Weight of the robot should be over the drive wheels. The battery is a large weight component and should be place at the center of the wheel base.

- For traction: maximize weight & friction coefficients

- A common drive-train (wheels driven from one gear box and one set of motors with power transmitted via chains or belts) has an advantage over individually driven wheels in that, a common drive-train provides all the torque to loaded wheels as wheel loading changes.

Revisions

V160612 – RJV-updated to Team 2228 format
V151018 – RJV, Review changes
V150929 - Original