RoboJackets

CAT®

The Arthur M. Blank Family Foundation

2007 TE Sessions
Drive Trains
10/9/07

www.robojackets.org

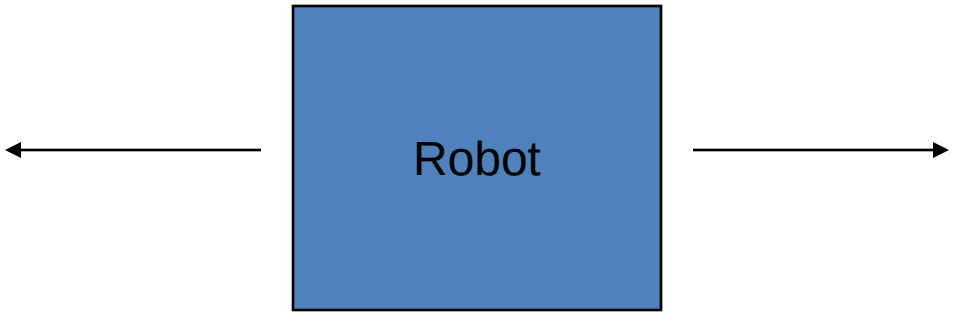
What is a Drive Train?

- A mechanism that moves your robot base to different positions

- Includes several components
  - Motor drivers
  - Motors
  - Gearboxes
  - Wheels/treads
  - Chassis

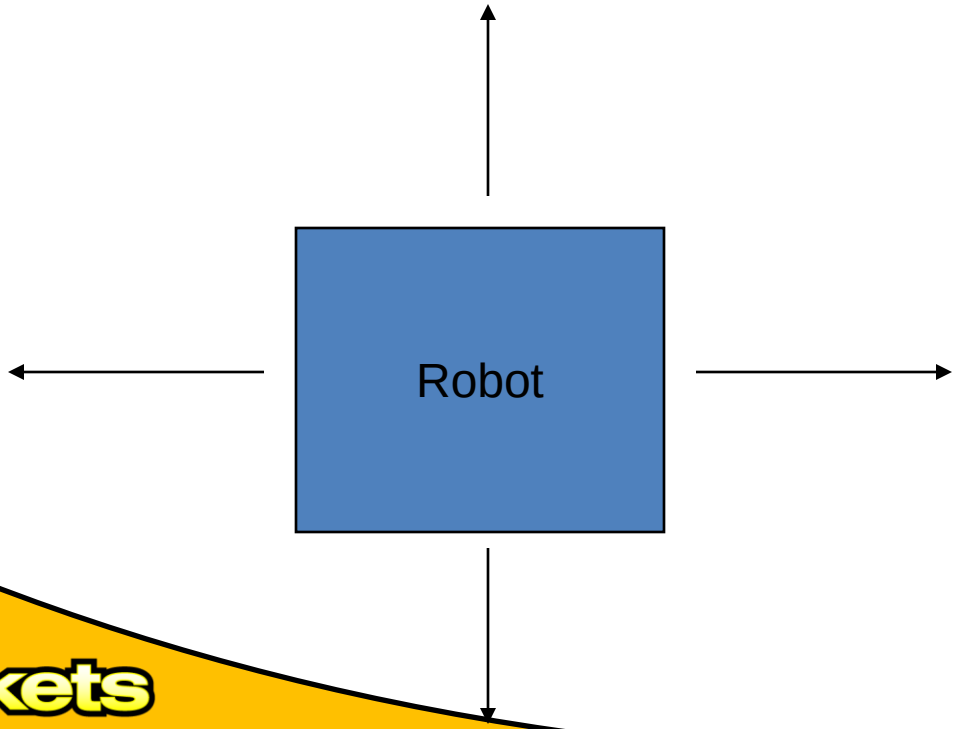
Drive Train Concepts

- Single axis drive
  - Can only move forward or backwards relative to the robot's orientation
  - Turning requires re-orienting the robot



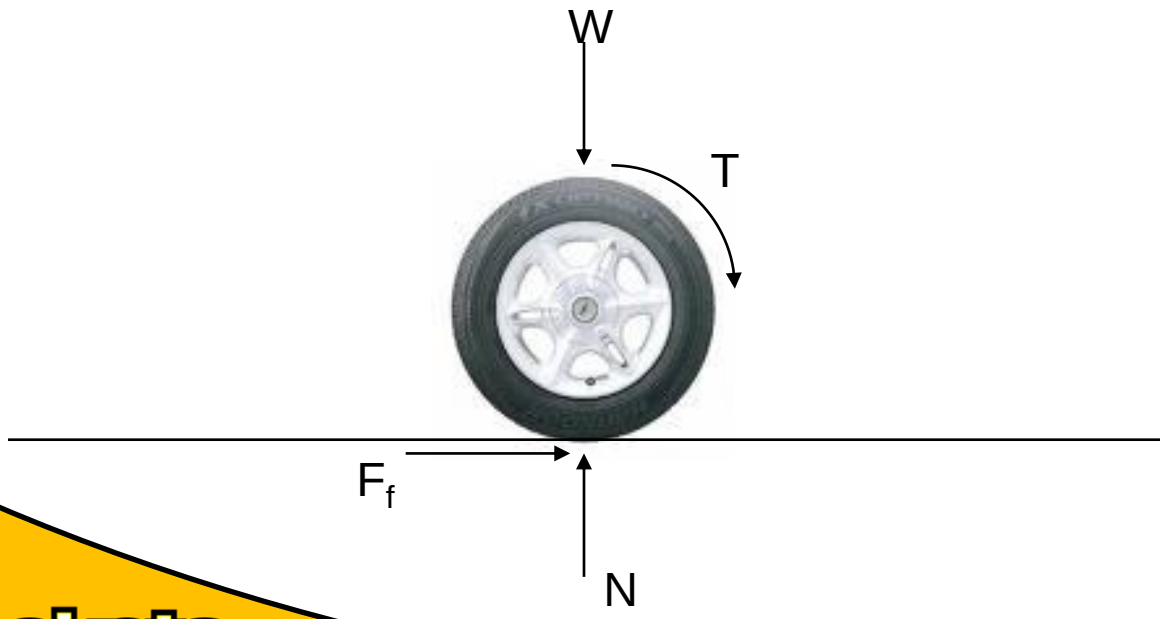
Drive Train Concepts

- Double axis drive
  - Can move forward, backwards and sideways without changing the robots orientation



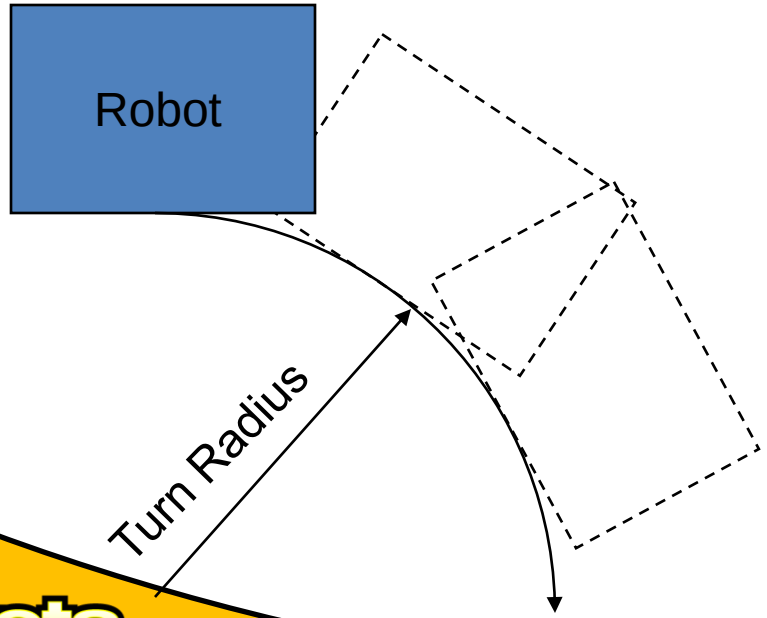
Drive Train Concepts

- Traction
  - A term referring to the amount of force that a wheel or track can apply along the ground without slipping.
  - Related to wheel or track material and contact area.



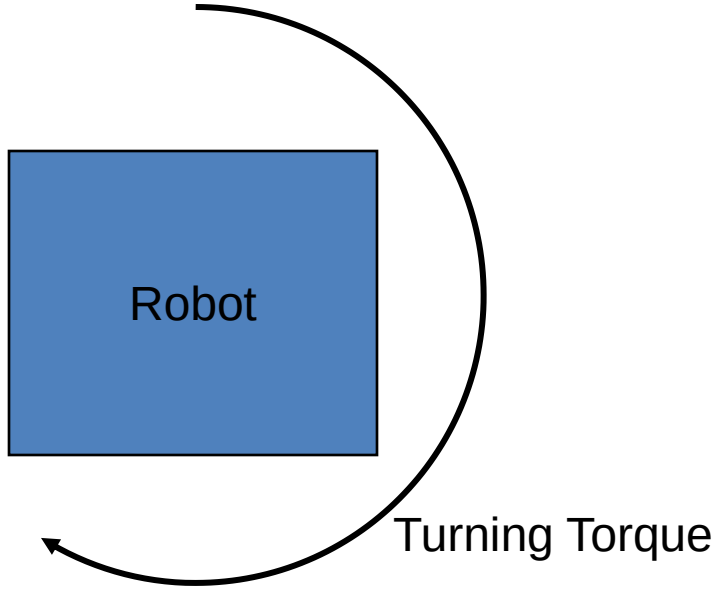
Drive Train Concepts

- Turning Radius
  - The radius of the curve created by a point on the robot when changing the robots orientation.



Drive Train Concepts

- Turning effort
  - The force/torque at the wheels required to turn
  - compared to the force required to drive in a straight line.



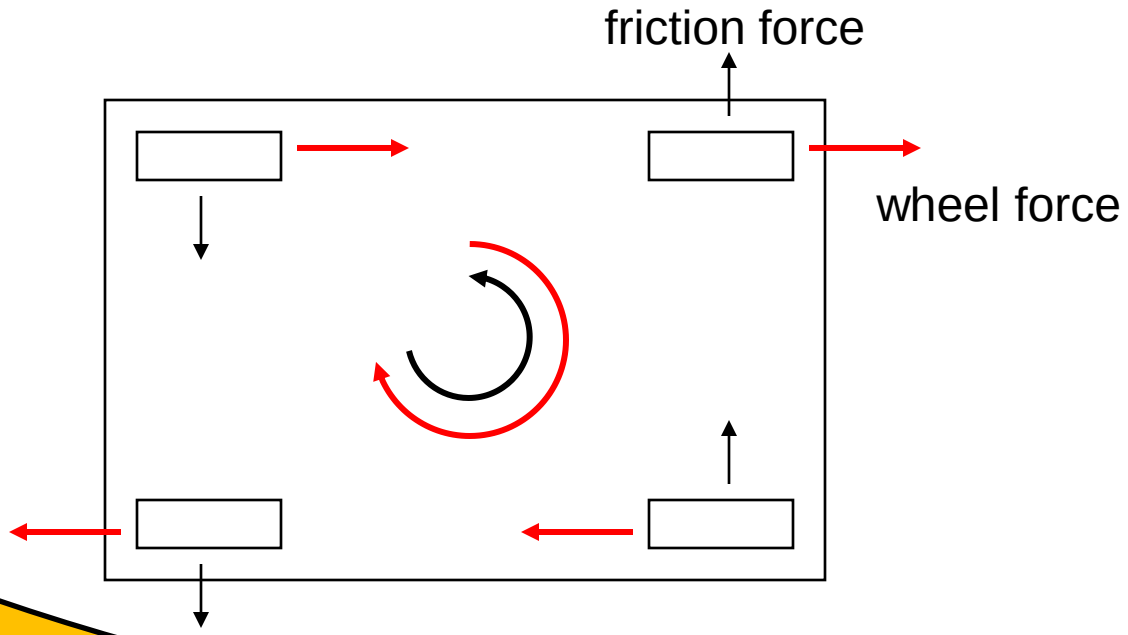
Drive Methods

Tank Drive

- Uses two separately controlled drive sides
- Can use wheels or tracks.

Tank Drive

- Wheel forces generate a turning torque while friction from dragging wheels sideways resists the turning torque
- By having a wheelbase wider than long the turning torque is guaranteed to overcome the frictional resistance torque.



Tank Drive

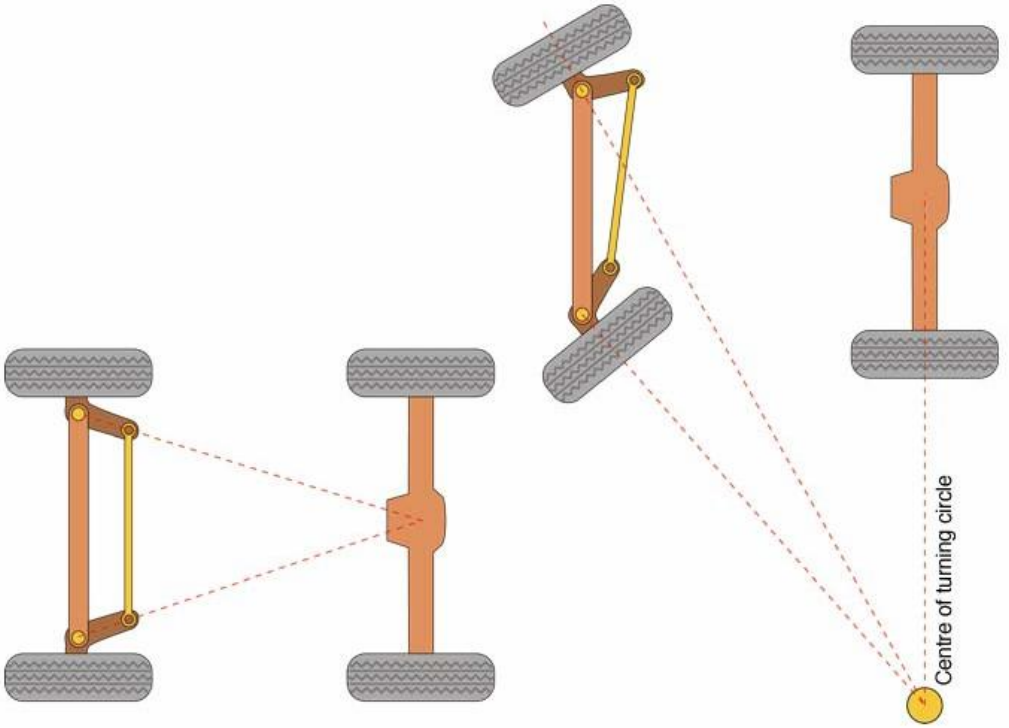
- Advantages
  - mechanically simple
  - saves space
  - zero turning radius
  - simple controls (intuitive)

- Disadvantages
  - more turning effort/traction tradeoff
  - single axis of motion

- Other
  - High traction can be achieved although at the cost of more turning effort

Swerve Drive

- Uses Ackermann style steering with wheels that pivot to create a curved driving path.



Swerve Drive

- Advantages
  - mechanically simple (with 2WD)
  - low turning effort with high traction wheels
  - Simple controls in open areas

- Disadvantages
  - large turning radius
  - difficult to power all wheels
  - can lose traction on non-level terrain
  - difficult to control in tight spaces due to turn radius

Crab Drive

- Allows each wheel to pivot so all wheels face the driving direction.
- Wheels can pivot independently or synchronously

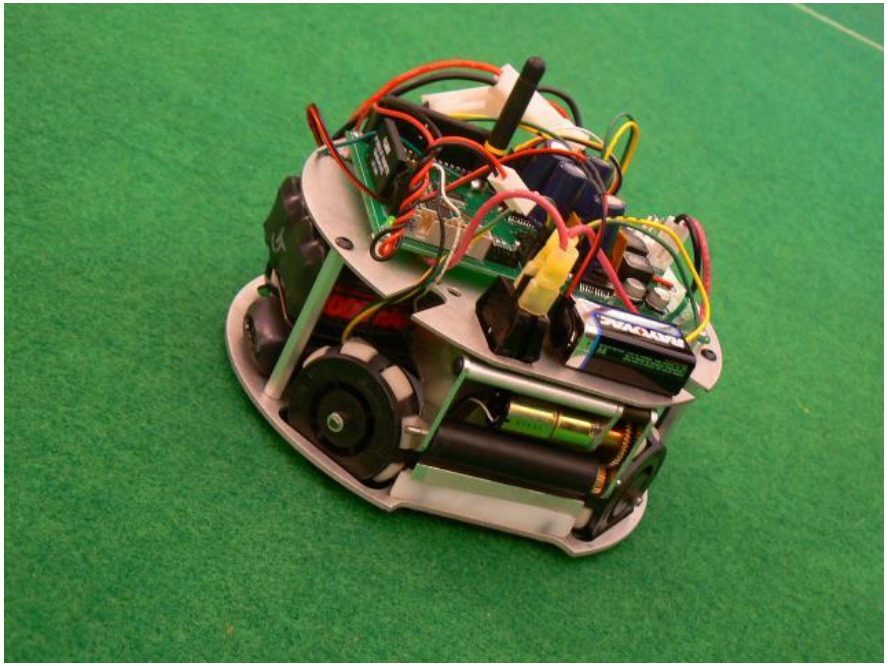
Crab Drive

- Advantages
  - Very low turning effort
  - High traction with all wheels in driving direction
  - Very maneuverable

- Disadvantages
  - Complex mechanically
  - Current designs take up a lot of space
  - Difficult controls (non-intuitive)

Omni-Drive

- Uses omni-wheels to achieve double axis drive
- Sacrifices traction for maneuverability

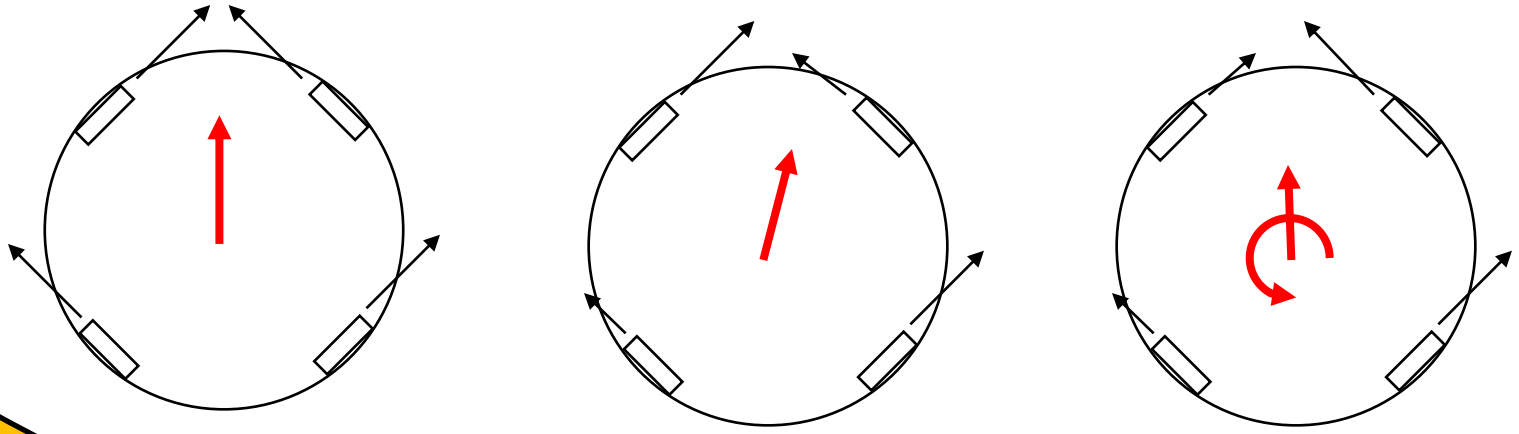


Omni-Drive

- Omni-wheels
  - provide force in only one direction
  - use sideways rollers to slide in the other direction

Omni-Drive

- Wheels are placed in a formation that allows for motion in all directions.
- By adding velocity vectors (speeds and directions) the motion of the robot can be controlled



Omni-Drive

- Advantages
  - Very low turning effort
  - Very maneuverable
  - Mechanically simpler than crab drive

- Disadvantages
  - Complex controls (non-intuitive)
  - Low traction
  - Omni wheels can fail with so many moving parts

Mecanum Drive

- Demonstration by …

Norcross High School

Team 1379

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Mecanum Based Drivetrain

2007 FRC Robot

Norcross High School

Team 1379

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What Is Mecanum?

- modified wheel design allows motion in any direction
- Instead of a tire or other traction surface at the rim, free spinning rollers are placed at an angle to the wheel's axis

Origin of Mecanum

- Invented by Swedish inventor Bengt Ilon in 1973
- Patent rights acquired by US Navy for shipboard use in 1980's
- Airtrax and other companies acquire rights for commercial use in 1997
- Commercial products are now available

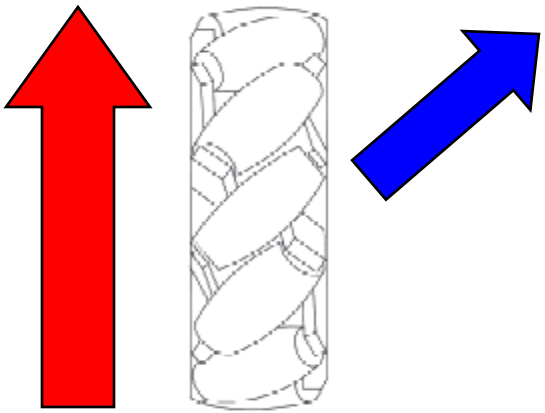
Team Experience

- Seen at 2005 FRC Championships and on Chief Delphi
- Designed wheel for VEX sized use Summer 2006 – First prototype
- Designed drivetrain for 2007 Rack n’ Roll
- Customized AndyMark wheels

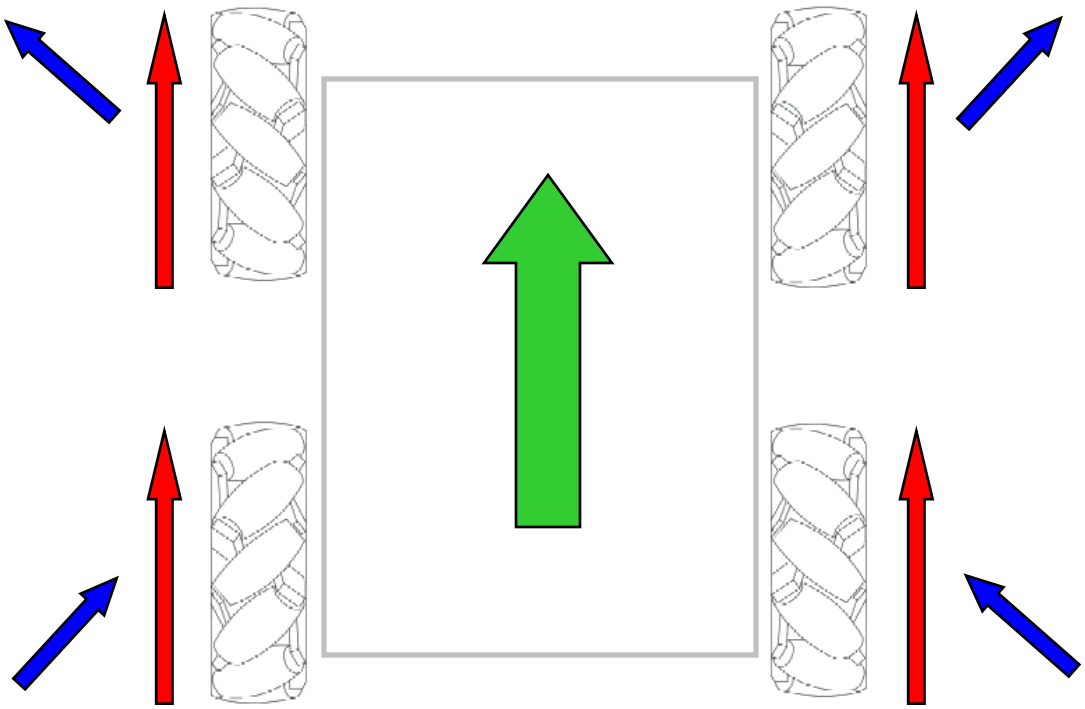
How It Works – Wheel Design

- Rim is made of rollers angled to edge
- Rollers spin freely on their shaft
- Wheel rotation imparts force along roller axis

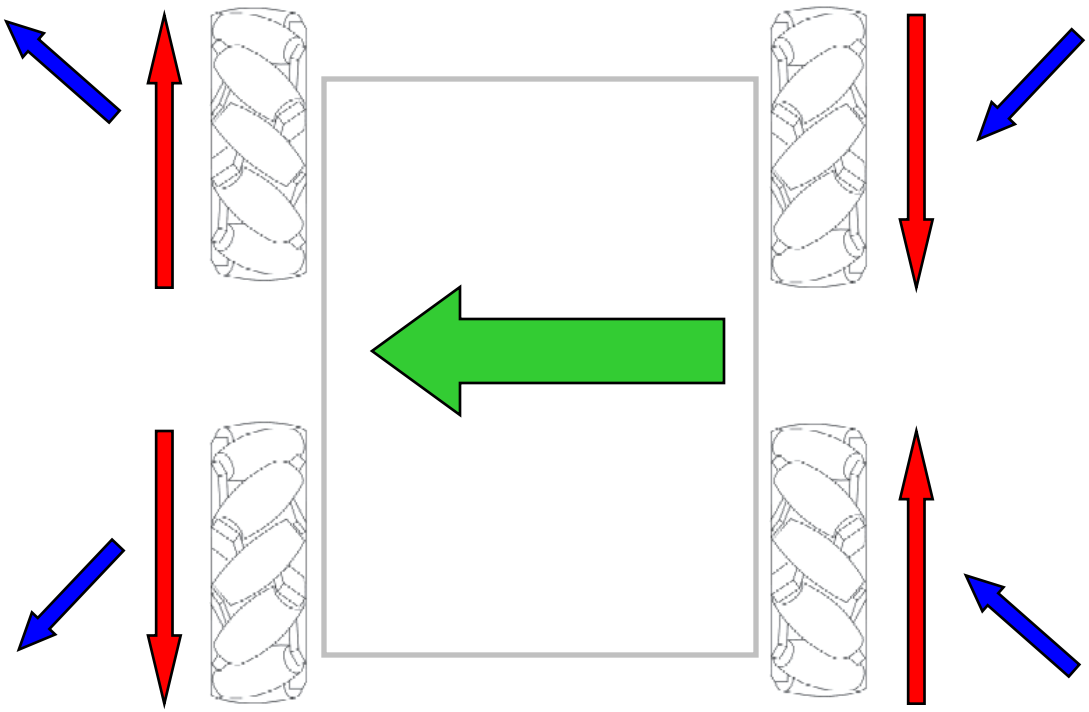
How It Works – Force Vectors



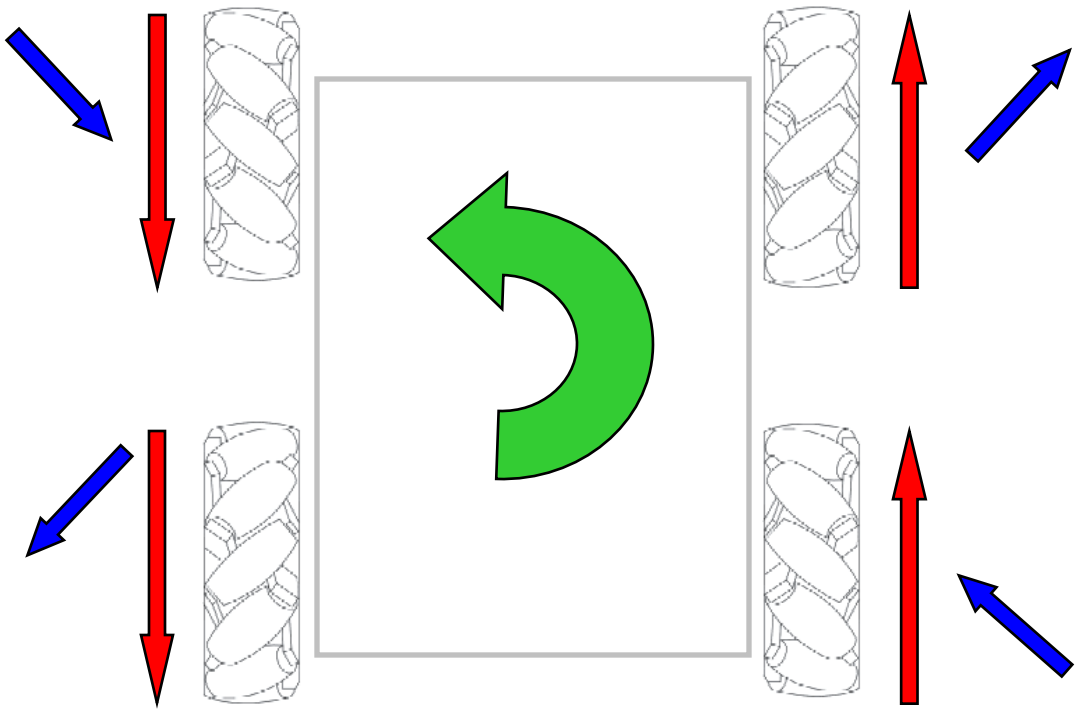
How It Works – Forwards Travel



How It Works – Sideways Travel



How It Works – Spin in Place



Benefits

- Highly agile
- Major cool factor

Issues

- Efficiency
- Complexity
- Vibration
- Cost

More Information

- Airtrax website with forklift video
  http://www.airtrax.com/
- AndyMark stock wheels for FIRST
  http://andymark.biz/am-0083.html
- Chief Delphi and VexLabs forums
  http://www.chiefdelphi.com/
- Google search terms: omnidirectional, holonomic, mecanum

Demo

Activity

- Given this year's FTC game come up with concepts for a vex drive train.
  - Be sure to justify your concepts with strategy options

15 min

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Activity

- Find a pertinent part of your possible drive concept and build a prototype of it.
  - Examples
    - Swerve drive (steering mechanism)
    - Tank drive (chassis with easy manipulator mounts)
    - Crab drive (pivoting drive module)

60 min

Legal

These slides and more are available at

http://www.robojackets.org

For more information contact the RoboJackets. (contact info available via the web)

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