RoboJackets

FIRST - IGVC - BattleBots - RoboCup

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Rockwell Automation

The George W. Woodruff School of Mechanical Engineering

Georgia Tech College of Computing

Drive Configurations

September 23, 2008

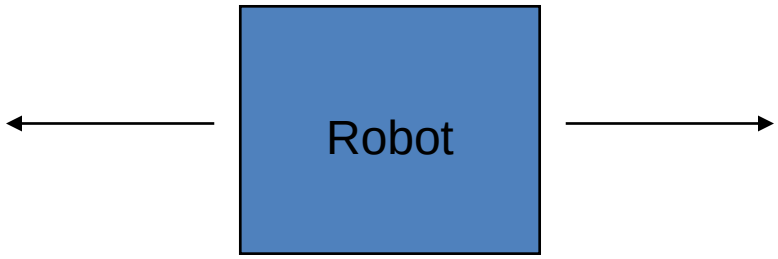
What is a Drive Train?

- A mechanism that moves your robot base to different positions

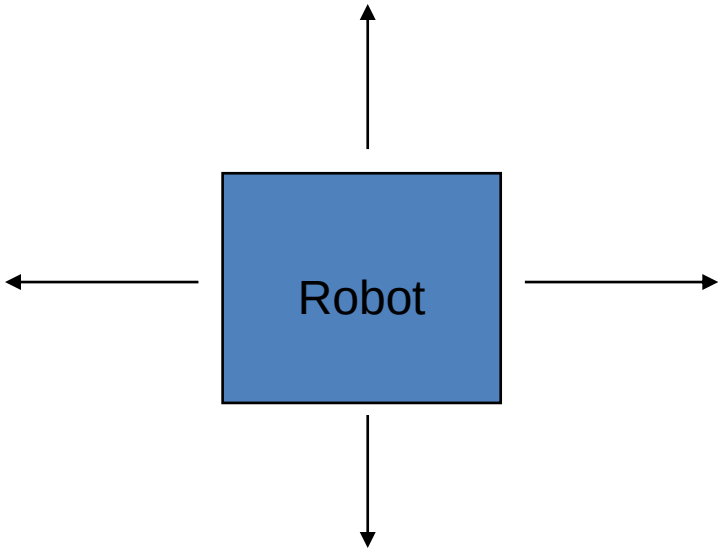
- Includes several components
  - Motor drivers
  - Motors
  - Gearboxes
  - Wheels/treads
  - Chassis

Drive Train Concepts

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

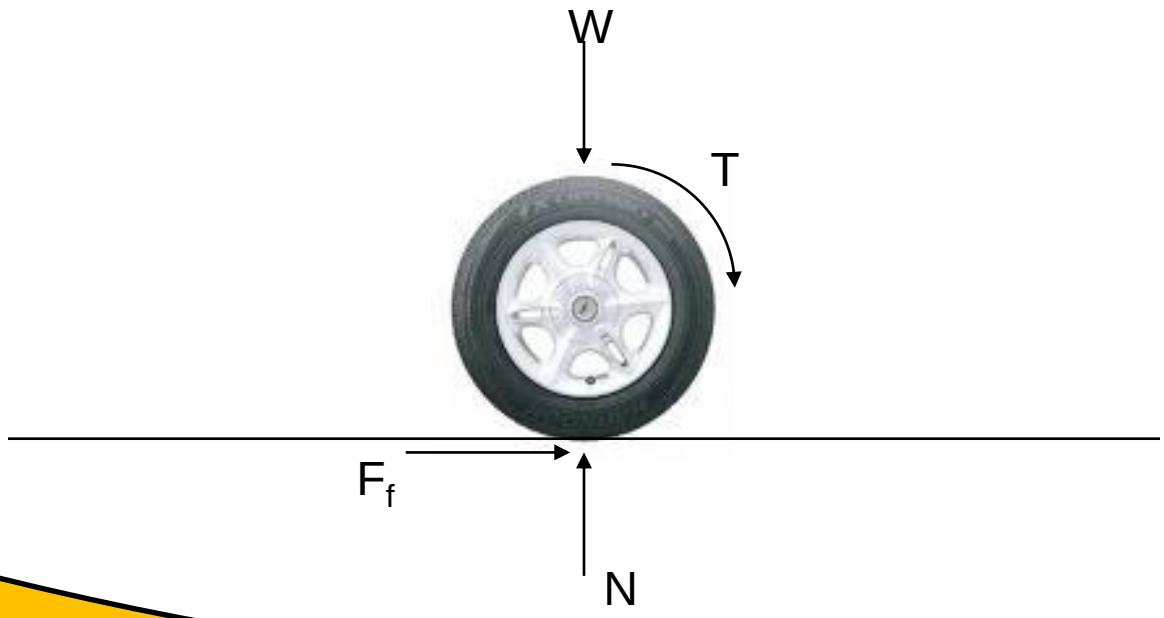


- Double axis drive
  - Can move forward, backwards and sideways without changing the robots orientation



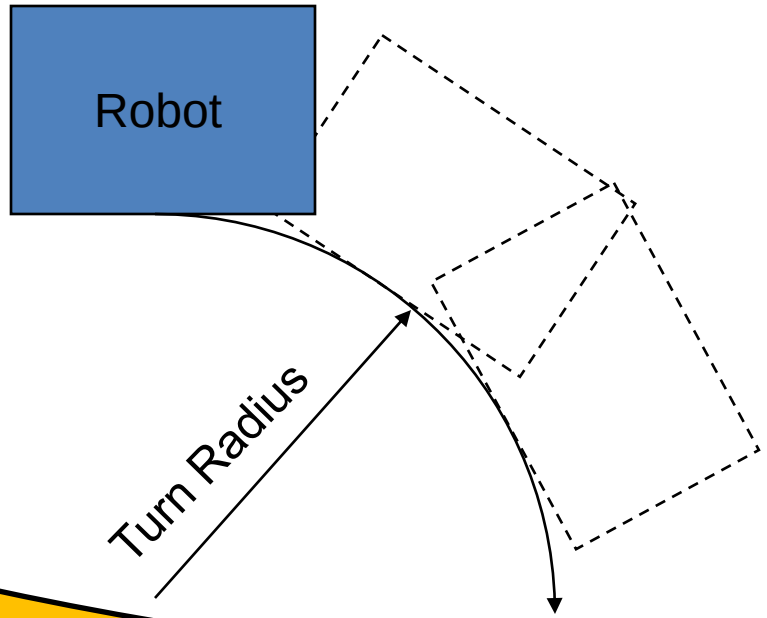
Drive Train Concepts

- 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.



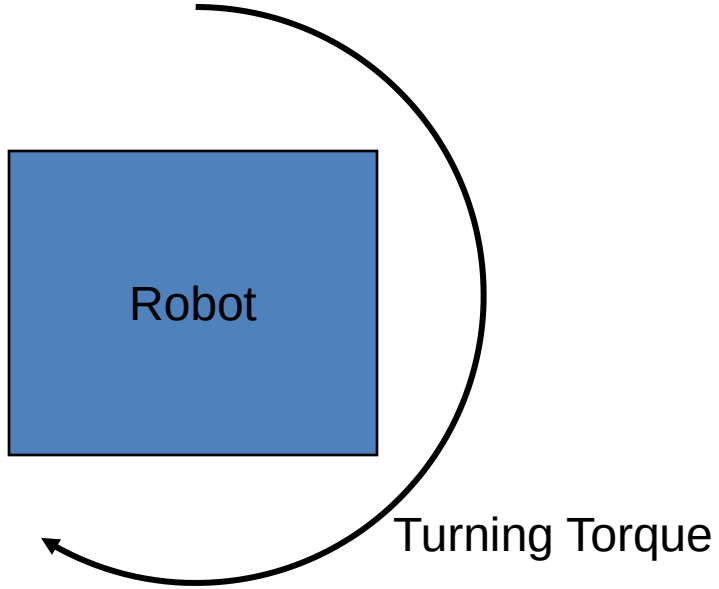
Drive Train Concepts

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



Drive Train Concepts

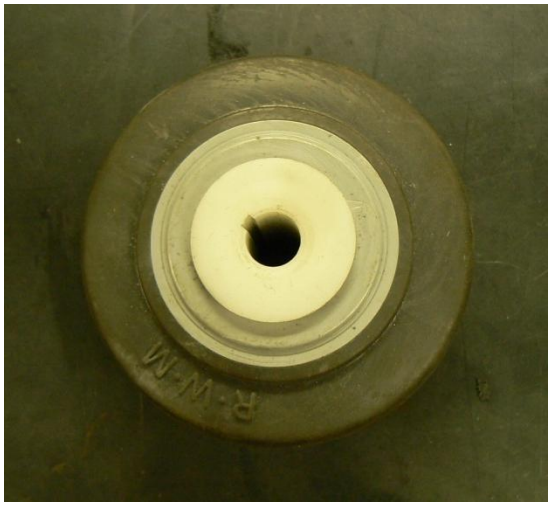
- Turning effort
  - The force/torque at the wheels required to turn
  - compared to the force required to drive in a straight line.

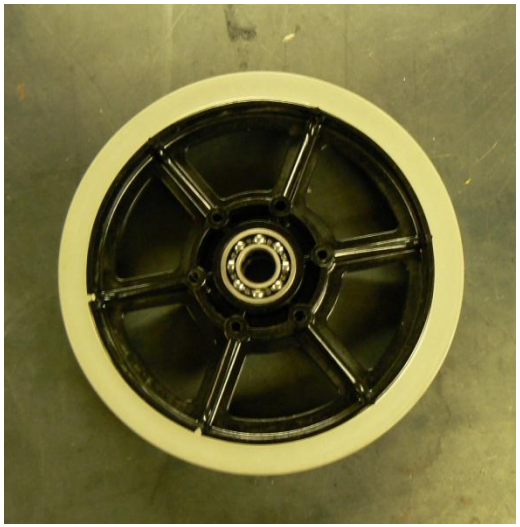


Traction Devices (Wheels)

Solid Wheels

- Construction
  - Inner plastic core (delrin)
  - Outer rubber molding
  - With or with out bearings
- Key Aspects
  - One solid piece
  - Wont go flat
  - Durable





Pneumatic Wheels

- Construction (think bicycle wheels)
  - Inner core (spoked, metal hub, plastic, etc)
  - Outer rubber air supported surface

Keep inflated!

Other Wheels

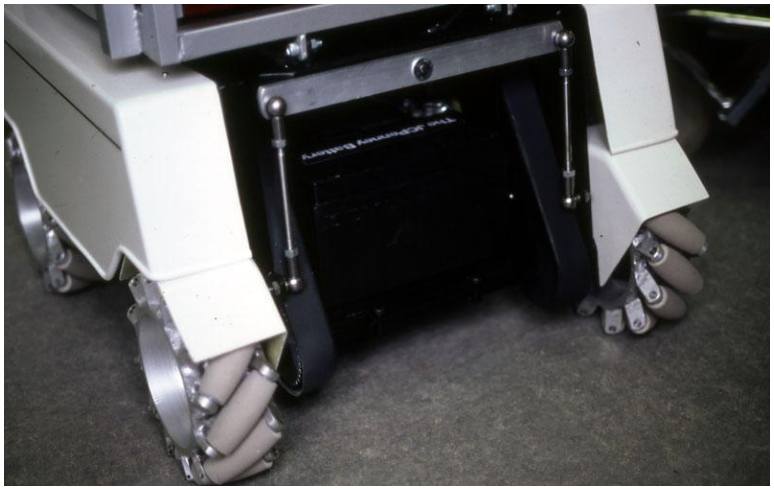
- Semi Pneumatic
  - Foam filled
  - Metal strip reinforced
- Spoke Wheels
- Casters
  - Easy to mount
  - Direction bias

Omni Wheels

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

Mecanum Wheels

- Similar to omni except rollers are at 45 deg



What to look for in wheels

- Construction
  - Sturdy rims
    - No bicycle tires, no thin plastic rims
- Modifications
  - Inserts
    - If they don't come with bearings → easier
- Intended traction surface (carpet)
  - Don't need huge tread's

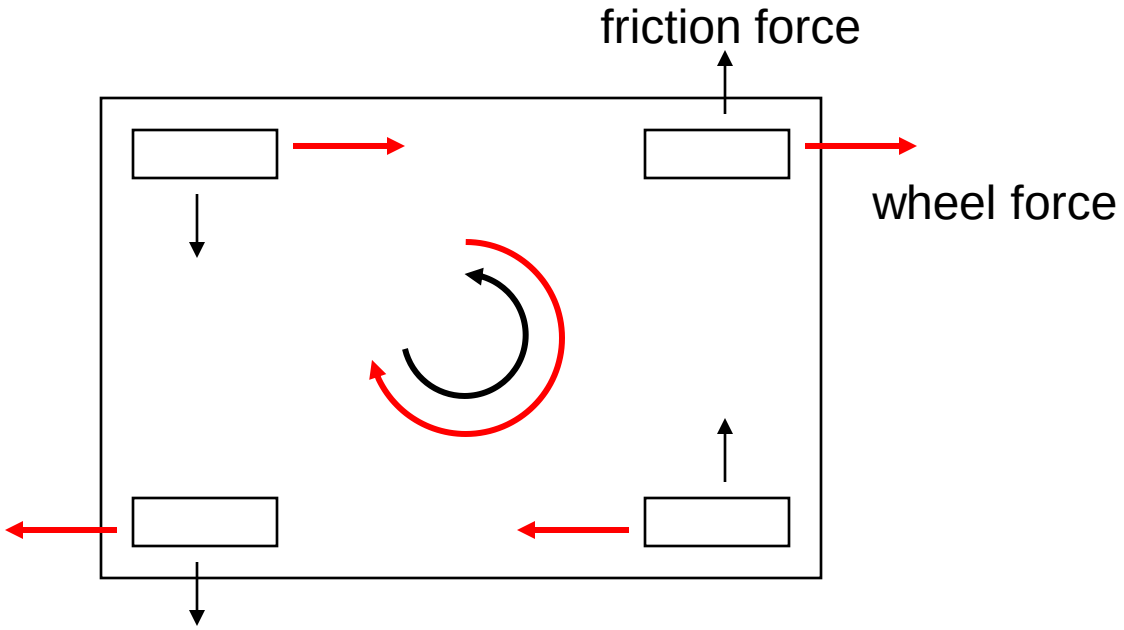
Drive Methods
(Wheel Configurations)

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.

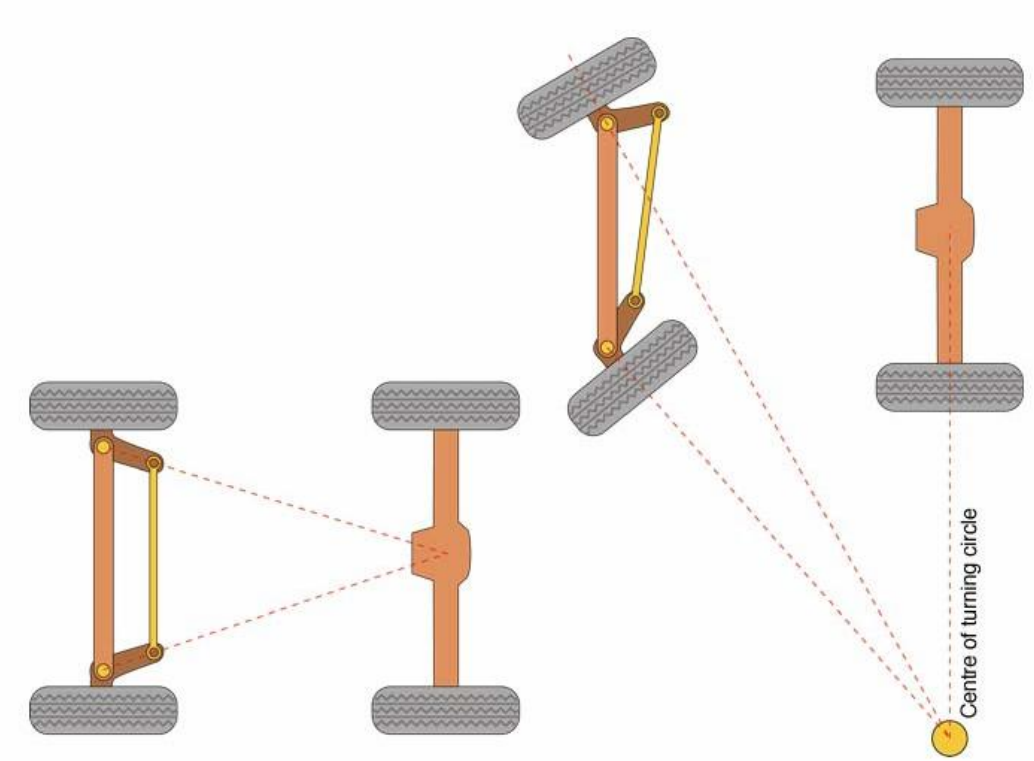


Tank Drive

- 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

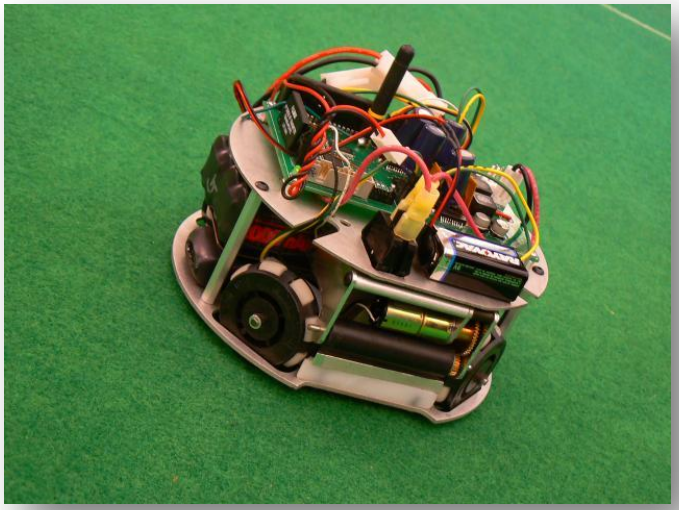
Crab Drive

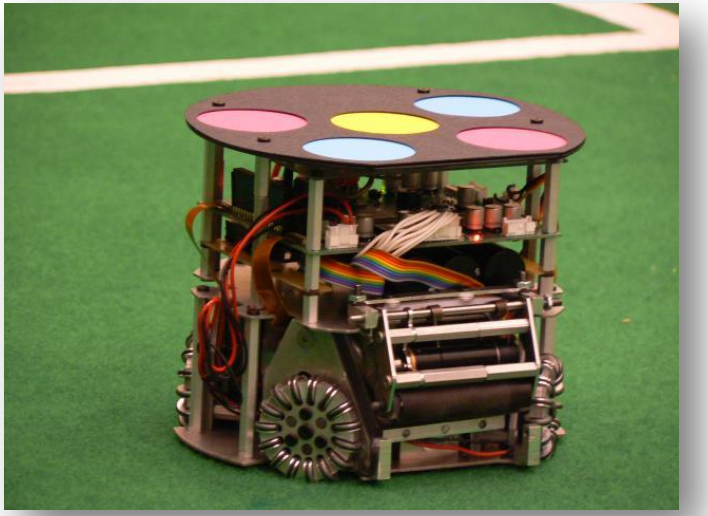
- Advantages
  - Very low turning effort
  - High traction with all wheels in driving direction
  - Very maneuverable

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

Holonomic - Omni-Drive

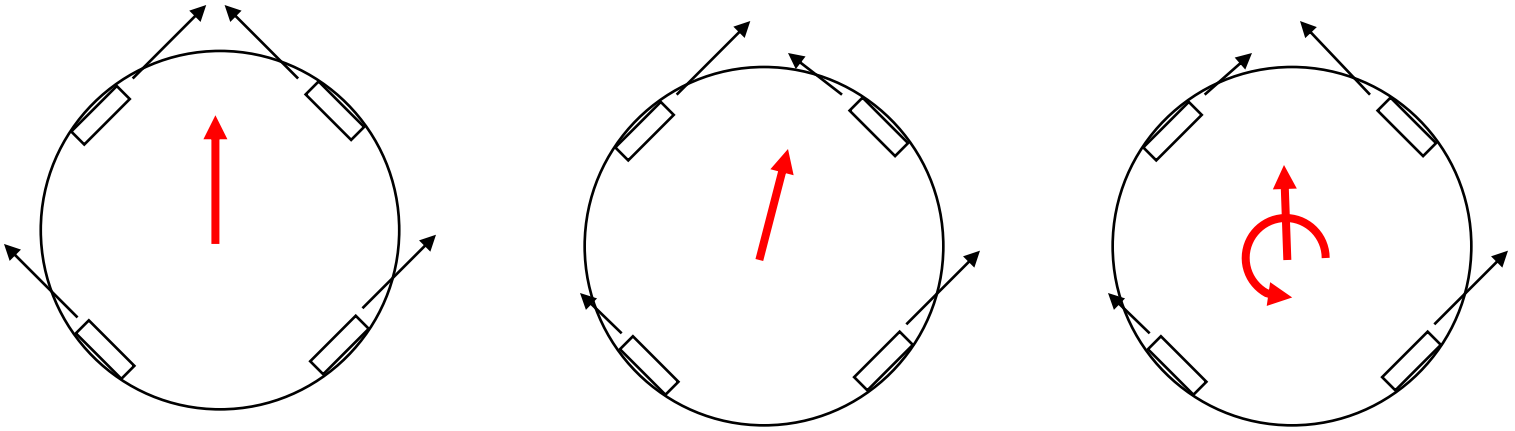
- Uses omni-wheels to achieve double axis drive
- Sacrifices traction for maneuverability





Holonomic - 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



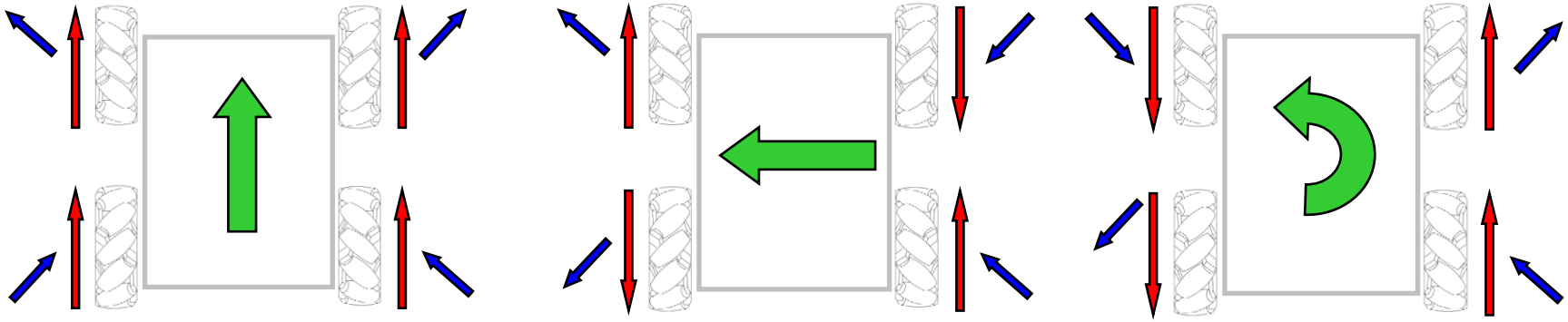
Holonomic - Omni-Drive

- 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 (plastic)

Holonomic - Mecanum

- Wheels are placed in a tank style layout
- Forces are at 45 degrees due to rollers
- Add up velocities similar to omni.



Holonomic - Mecanum

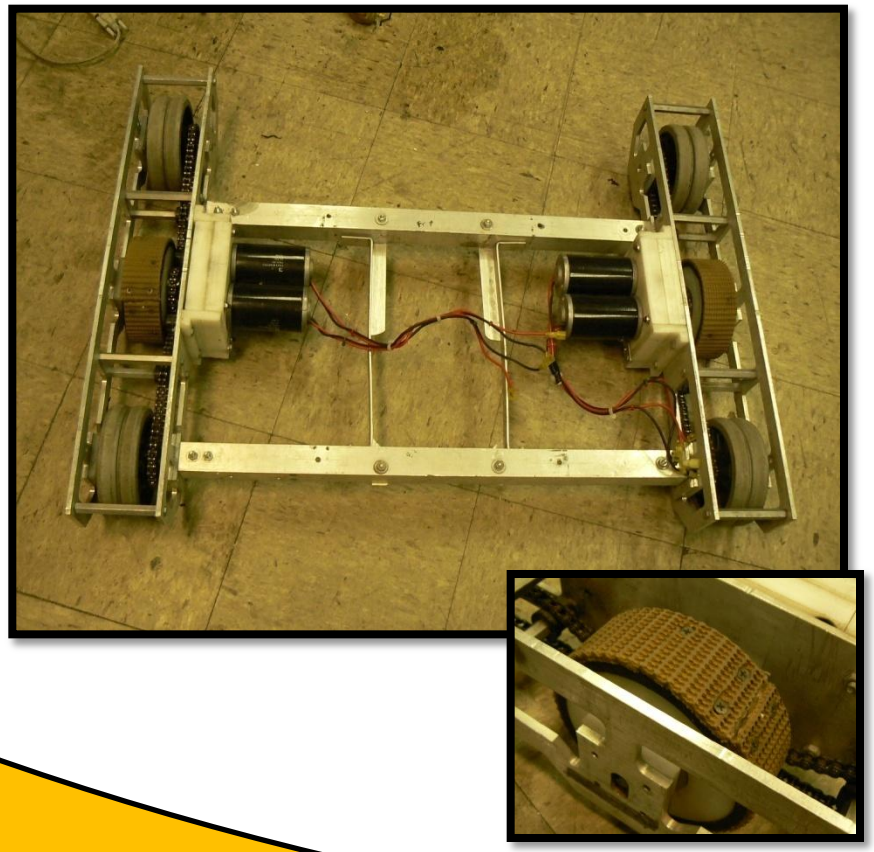
- Advantages
  - Very low turning effort
  - Very maneuverable
  - Same wheel layout as tank

- Disadvantages
  - Complex controls (non-intuitive)
  - Mechanum wheels are more complex than omni wheels

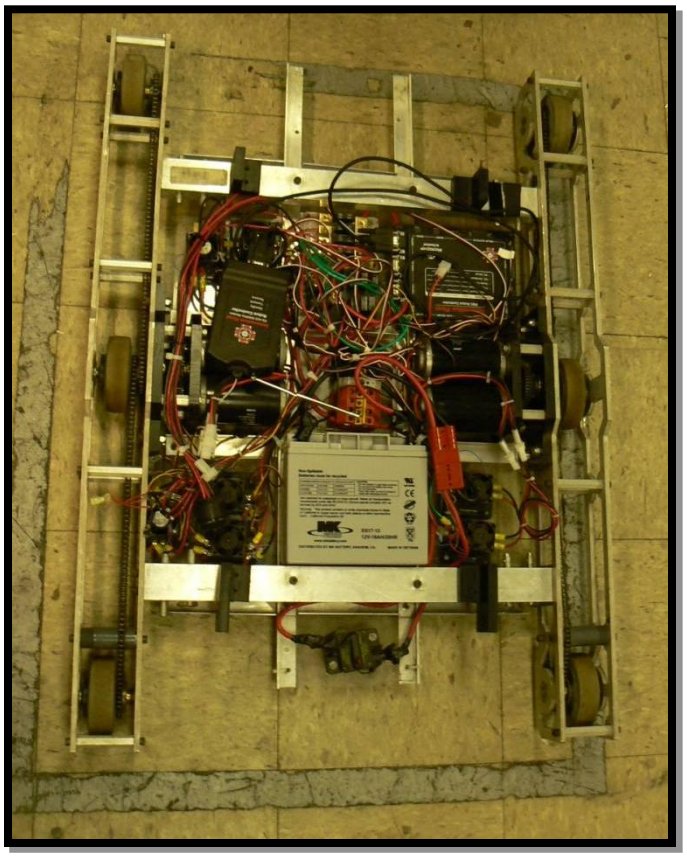
Drive Base Inspection

Wide or Narrow

2006 CircuitRunners



2008 TechnoTitans

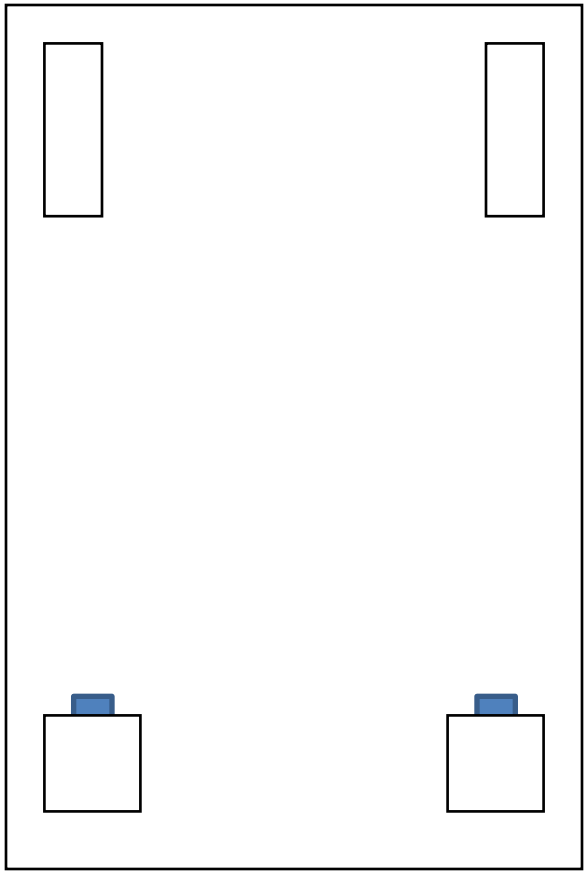


Configurations Seen in FIRST

3x3 Tank

- Past kit bots have this configuration (2x2)
- Middle wheels should be lower to give added turning performance.
- Advantages
  - Good strength for pushing
  - Relatively simple
- Disadvantages
  - Less turning performance than Ackerman

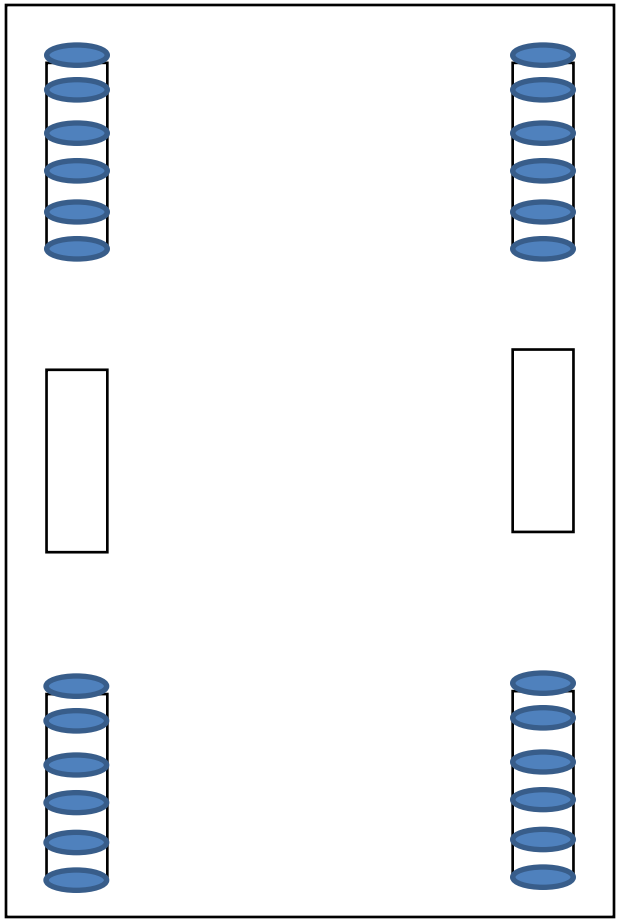
Tank w/ castors



- Advantages
  - Mechanically simple
- Disadvantages
  - Castor bias
  - No traction in front or back (depending on configuration)
  - If motors aren't properly controlled
    - Could pop up

Tank w/ Omnis

- Idea
  - Make it easier to turn while still retaining some traction.
- Advantages
  - No castor bias
  - Reduced turning friction
- Disadvantages
  - Easier to get spun around by opponent



Activity

- Develop a drive train with NXT kit

40 min

Resources for wheels

- Further reading
  - http://en.wikipedia.org/wiki/Wheel
- Places to buy
  - http://www.mscdirect.com
  - http://www.robotmarketplace.com
  - http://www.mcmaster.com
  - http://www.andymark.biz

Legal

These slides and more are available at

http://www.robojackets.org

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