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CAT
THE ARTHUR M. BLANK
FAMILY FOUNDATION

2007 TE Sessions
Drive Trains
10/9/07




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


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Drive Train Concepts



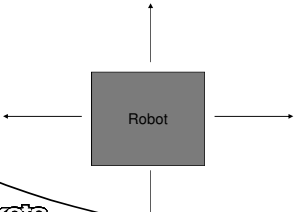
- Single axis drive
 - Can only move forward or backwards relative to the robot's orientation
 - Turning requires re-orienting the robot





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 **Drive Train Concepts** 

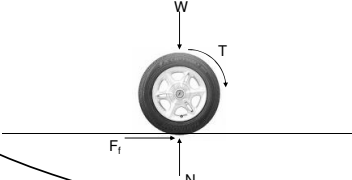
- Double axis drive
 - Can move forward, backwards and sideways without changing the robots orientation





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 **Drive Train Concepts** 

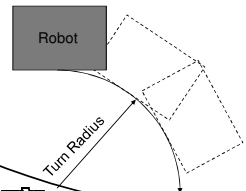
- Traction
 - A term referring to the amount of force that a wheel or track can apply along the ground without slipping.
 - Related to wheel or track material and contact area.





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 **Drive Train Concepts** 

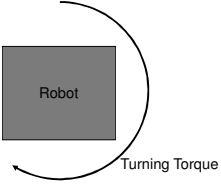
- Turning Radius
 - The radius of the curve created by a point on the robot when changing the robots orientation.






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 **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** 

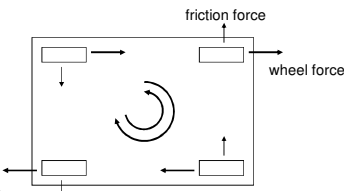
- Uses two separately controlled drive sides
- Can use wheels or tracks.







 **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.



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 **Tank Drive** 

Advantages

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



Disadvantages

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

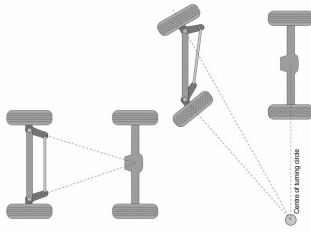
Other

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


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 **Swerve Drive** 


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



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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


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Crab Drive




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



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Crab Drive

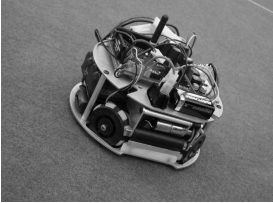


- Advantages
 - Very low turning effort
 - High traction with all wheels in driving direction
 - Very maneuverable
- Disadvantages
 - Complex mechanically
 - Current designs take up a lot of space
 - Difficult controls (non-intuitive)



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 **Omni-Drive** 


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





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 **Omni-Drive** 

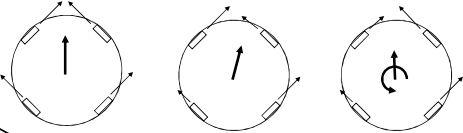
- Omni-wheels
 - provide force in only one direction
 - use sideways rollers to slide in the other direction




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 **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



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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

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Mecanum Drive



- Demonstration by ...

**Norcross High School
Team 1379**



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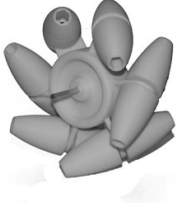
Mecanum Based Drivetrain

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





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 **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

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 **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

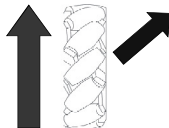
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 **How It Works – Wheel Design** 



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

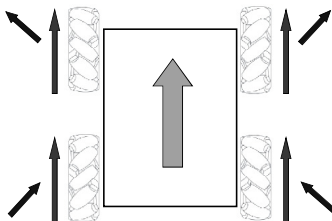
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 **How It Works – Force Vectors** 





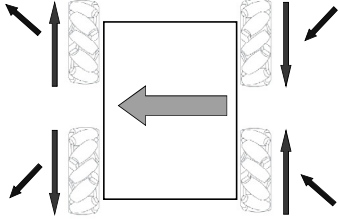
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 **How It Works – Forwards Travel** 





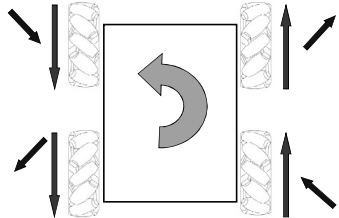
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 How It Works – Sideways Travel 





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 How It Works – Spin in Place 




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 Benefits 

- Highly agile
- Major cool factor

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Issues




- Efficiency
- Complexity
- Vibration
- Cost

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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

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Demo




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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







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





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