

# OREGON VEX IDEA FACTORY

10/10/2014



Mid Willamette Education Consortium



# Oregon VEX League Sponsors



## Mid-Willamette Education Consortium

# Approximate Schedule

## Computer Lab

- 9:30 Welcome
  - VEX Program Overview
- 10:00 Drive Trains
- 10:30 Lifting Mechanisms
- 11:00 Hand/Manipulator Mechanisms
- 11:30 Autonomous Programming
- 12:00 Lunch
- 1:00 Driver Controlled Period Programming
- 1:30 Using the competition template
- 2:00 Practice Matches/Skills Challenge/Technical Inspections
- 3:30 Closing
- Field will be open until 5:00 pm for those that would like additional practice

Referee Training Videos will be shown throughout the presentation.



# Objectives

- Gain a better understanding of the VEX Program in Oregon.
- **Share** expertise from around the state
- Have a fundamental understanding of some different **drive train, lifting and manipulation options.**
- Be able to add autonomous and tele-operator code to the **Competition Template.**
- Be able to run **practice matches.**
- Set Official Skills Challenge Scores



# 9:30 Welcome

- Introductions
  - Name, School, Experience
- [VEX Skyrise Video](#)

# Overview: VEX Qualifying Tournaments

- Stand-Alone Qualifying Tournaments of 16 – 32+ teams
  - Most cost \$25/team, hosts set the fees
- Teams are encouraged to compete in two to four Qualifying Tournaments.
- Register at [www.robotevents.com](http://www.robotevents.com)
- Teams that win Qualifying Tournaments advance to the State Championship.
  - Excellence Award Winner
  - All teams on the Winning Alliance
  - Design Award Winner (If 25+ teams in the Qualifying tournament)
- Teams that participate in at least two Qualifying Tournaments also qualify for the State Championship.
  - Wait List

# Overview: VEX Schedule for Oregon

- 11/15/2014 VEX Tournament Phoenix, High School
- 12/6/2014 VEX Tournament at West Salem
- 12/13/2014 VEX Skills Challenge Event at North Marion
- 1/10/2015 VEX Tournament at Evergreen Space Museum
- 1/24/2015 VEX Tournament at West Salem
- 2/7/2015 VEX Tournament at Dallas High School
- 2/14/2015 VEX Tournament at Sandy High School
- 2/21/2015 VEX Tournament at Redmond High School
- 2/28/2015 VEX Tournament at Dallas HS
- **3/6-3/7/2015 VEX State Championship: North Marion High**
  - **Winning Alliance, Excellence and Robot Design Advance to Worlds**
  - **Middle School Excellence Winner advances to Worlds**
- 4/15-4/18/2015 VEX World Championship Louisville, KY

# Overview: Oregon State Championship

- Planning for up to 60 VEX Teams
- Friday afternoon / Saturday event.
- After Qualifying Rounds...
- Platinum Division
  - The top 8 Alliances are Selected and Compete in the Platinum Division.
  - The Winning Alliance teams are the State Champions
- Gold Division
  - The remaining teams have the opportunity to compete in the Gold Division.
  - The Winning Alliance teams are the Gold Division Champions.

# Overview: Advancement to Worlds


- Oregon has Five High School Slots
  - The three teams on the Platinum Division Winning Alliance
  - The Excellence Award Winner
  - The Robot Design Award
  - If a team double qualifies, then the slot is giving to the next robot:
    - Programming Skills Award Winner
    - Robot Skills Award Winner
    - Back and forth between Programming and Robot Skills to fill in the positions
- Oregon has one Middle School Only Slot
  - Excellence Award Winner


# Overview: Judged Awards Given at Events

- Judges
  - Team that deserves special recognition for efforts leading up to, and during, the event
- Sportsmanship
  - Team that is extremely courteous and most enthusiastic throughout the event
- Design
  - Team with a professional design approach (ie Engineering Notebooks!)
- Excellence
  - Overall top honor in the VEX Robotics Competition based on
  - Rank after Qualifying Rounds
  - Rank in Programming Skills
  - Rank in Robot Skills
  - Awards where they were considered as finalists



# Overview: Changes

- Safety glasses need to be worn in the pits and at the field
  - [General Safety Video](#)
- 



# 10:00 Drive Trains

## [simplerobotics.org](http://simplerobotics.org)

- [Referee Training Video: Before the Match](#)
- Drive Train Samples
  - Show robots from Teams
  - Simple Robotics Comparison

# Skid Turn: Two Wheel Drive

2 wheel drive - This type of drive has only two wheels driven each wheel, driven by at least one motor A K A 2 wheel tank .( . . . )

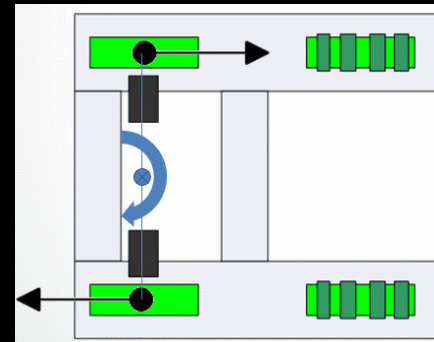
## Pros-

- simple to build
- very flexible
- Not easy to push from side if traditional wheels are used

## Cons –

- more difficult to control than other options
- the non driven wheels take weight off of the drive wheels -
- limited power in the drivetrain

Summary: Good for starters



# Skid Turn: 4-6 Wheel Drive

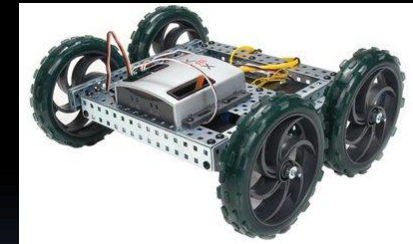
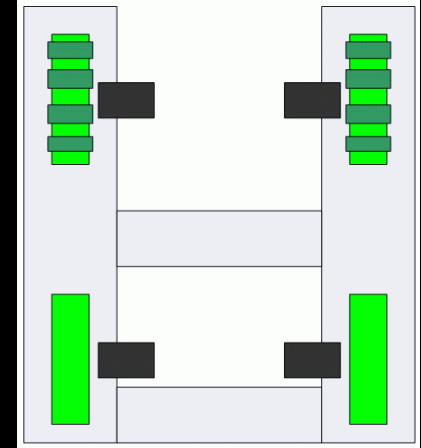
## Pros : Relatively Simple: Common at Competitions

- relatively simple to build
- can utilize multiple motors
- used by many strong teams
- Not easy to push from side if traditional wheels are used

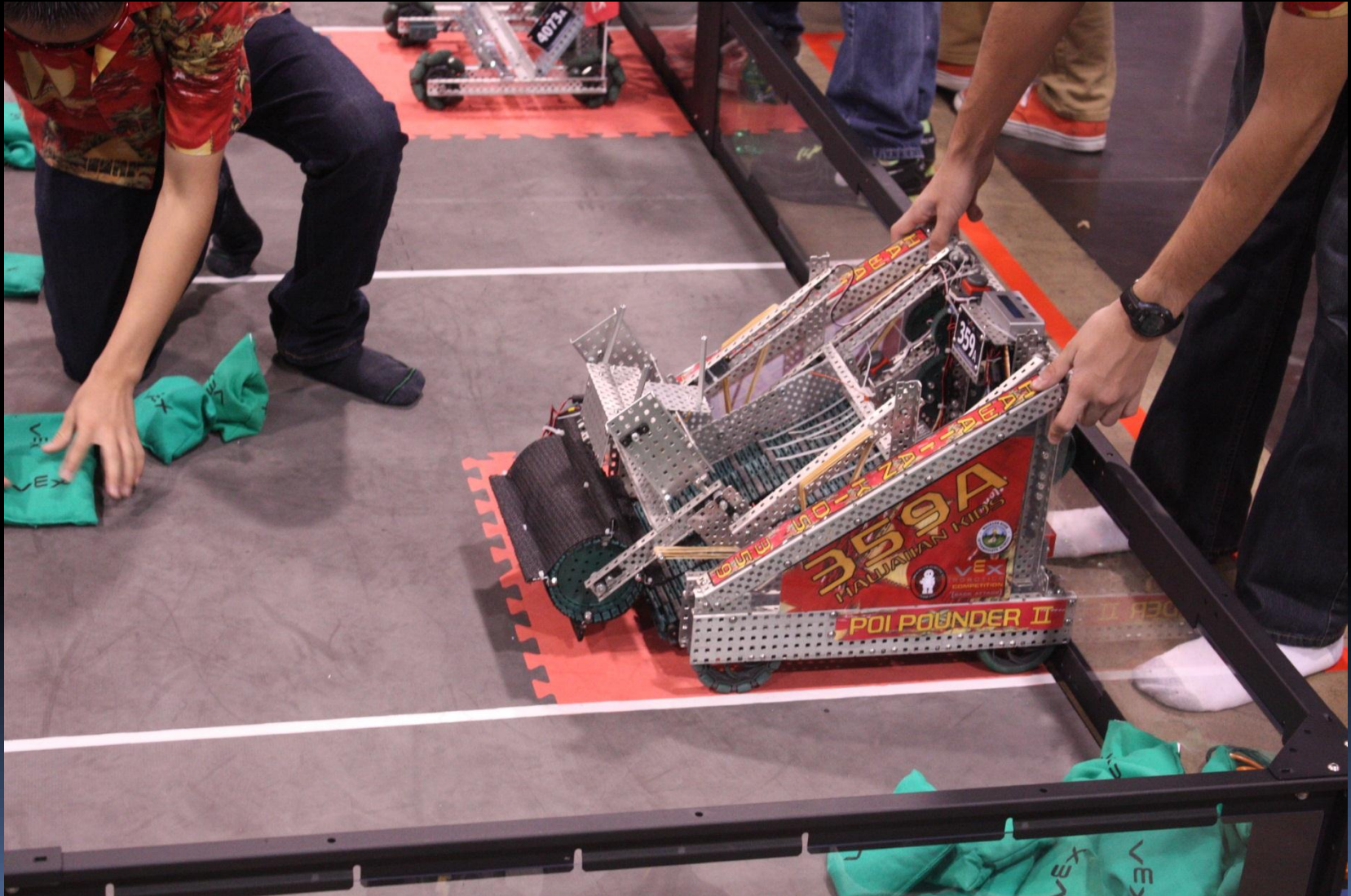
## Cons:

- if gears are used the distance between drive shafts are determined by the gears used
- multiple motors draw more current and use up motor ports on controller
- Can be more difficult to repair and more components to fail
- all the drive wheels need to be close to the same size or they will fight with one another

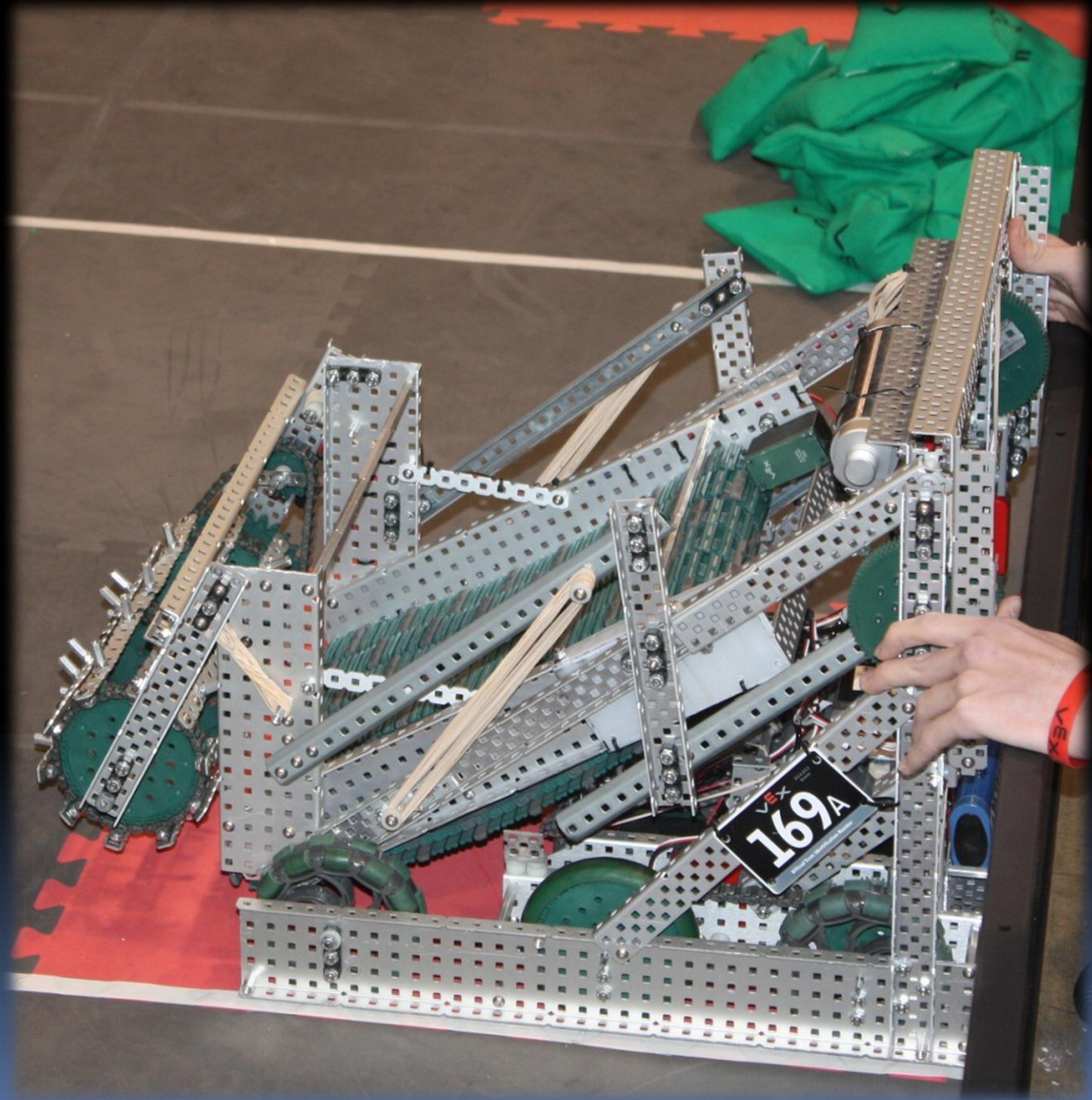
## Summary: Strong, relatively simple



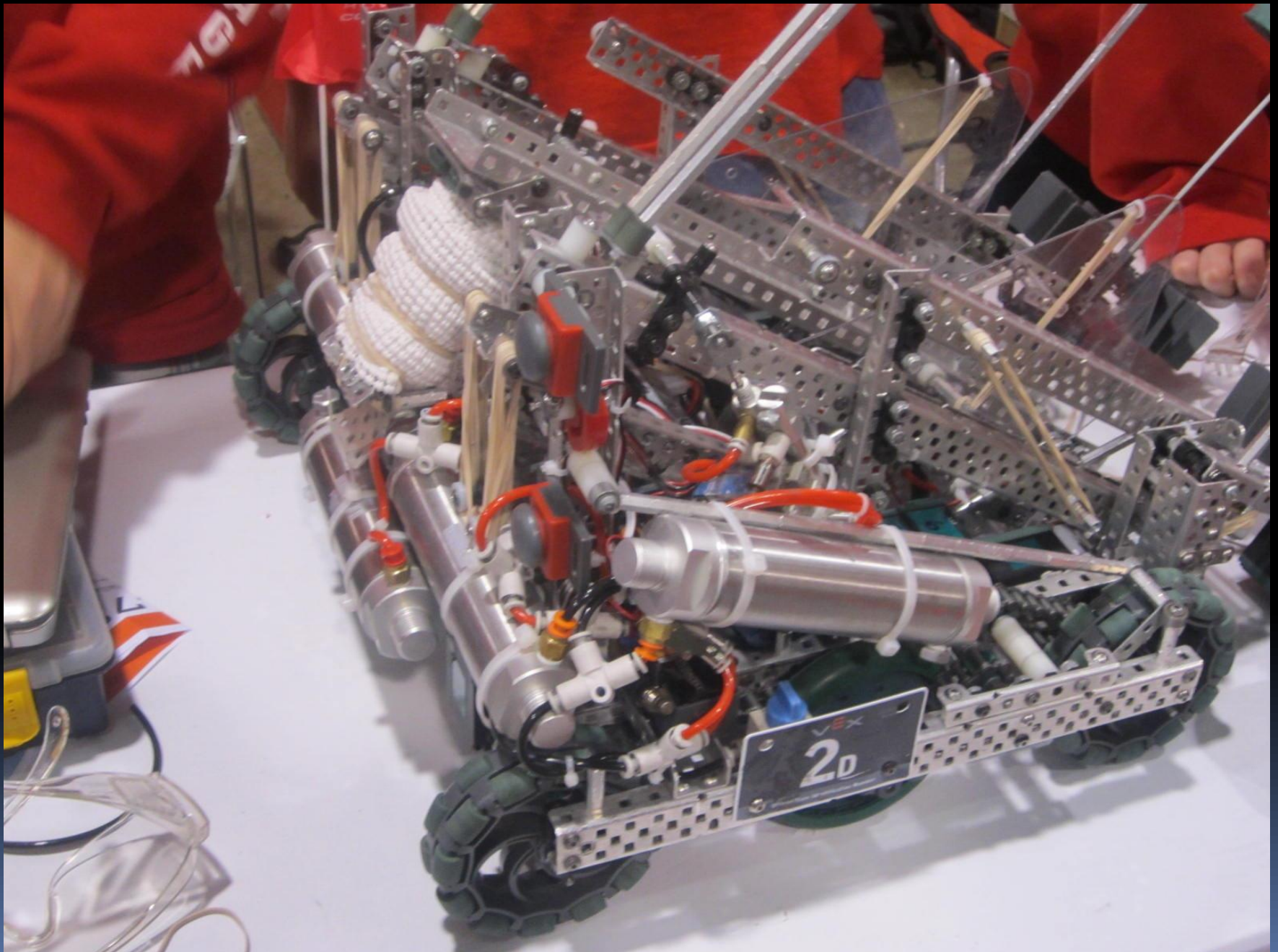
# Example: Four Omni Wheels



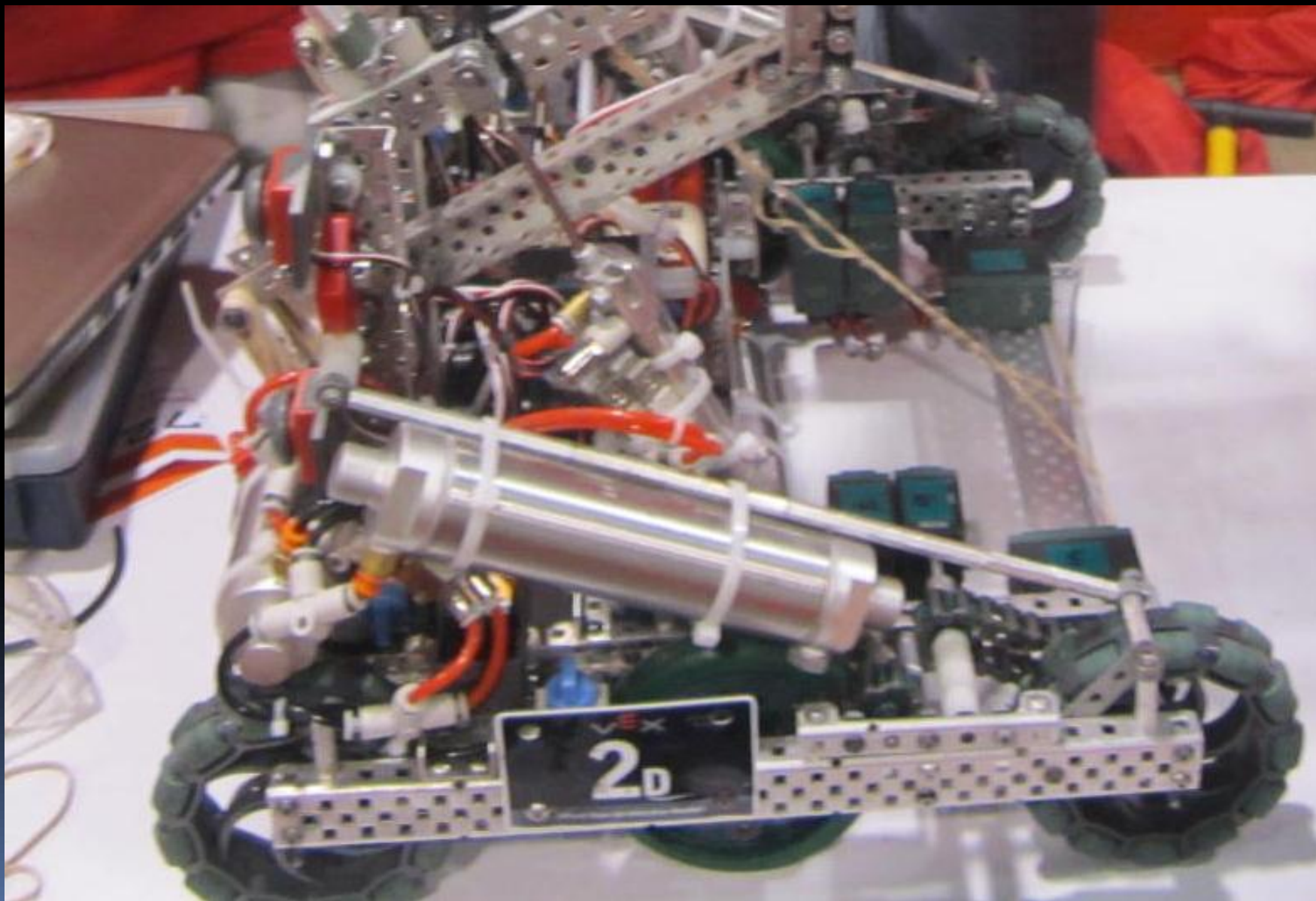
# Omnis Outside, Traction Middle



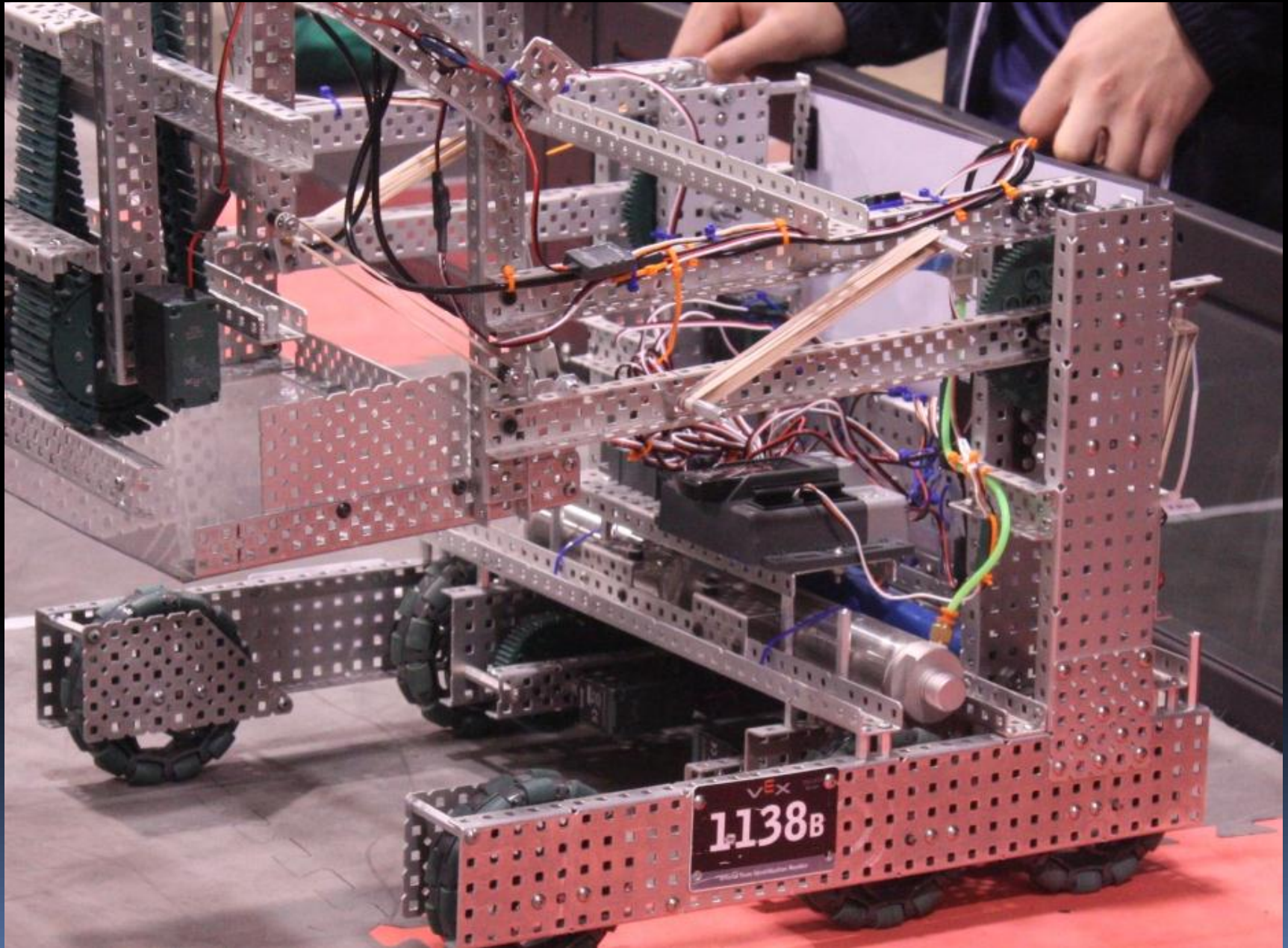
# Another Omni Outside Traction Middle



# Close up




# Six Omni Wheels, Back Four Powered





# Pushing, Pinning and Trapping

- Robust drivetrains are important.
  - Referee Training Pinning and Trapping
  - More drivetrain samples.
- 

# Track System

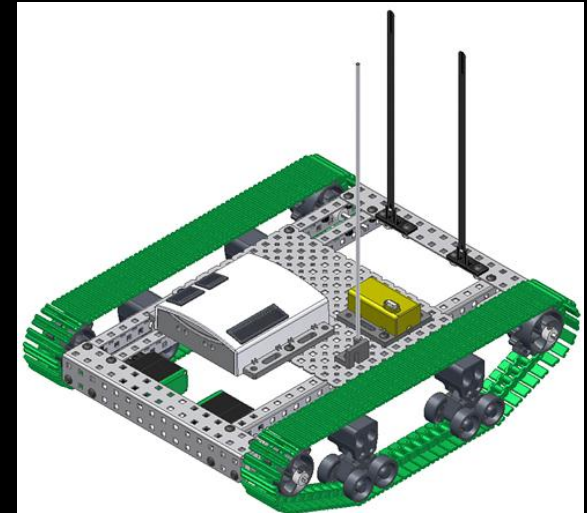
## Pros

- pivot point is at the center of the drive system
- can use only 2 drive motors or multiple motors
- extra traction treads are available ( P/N: 276-2214.)
- able to climb over field obstacles

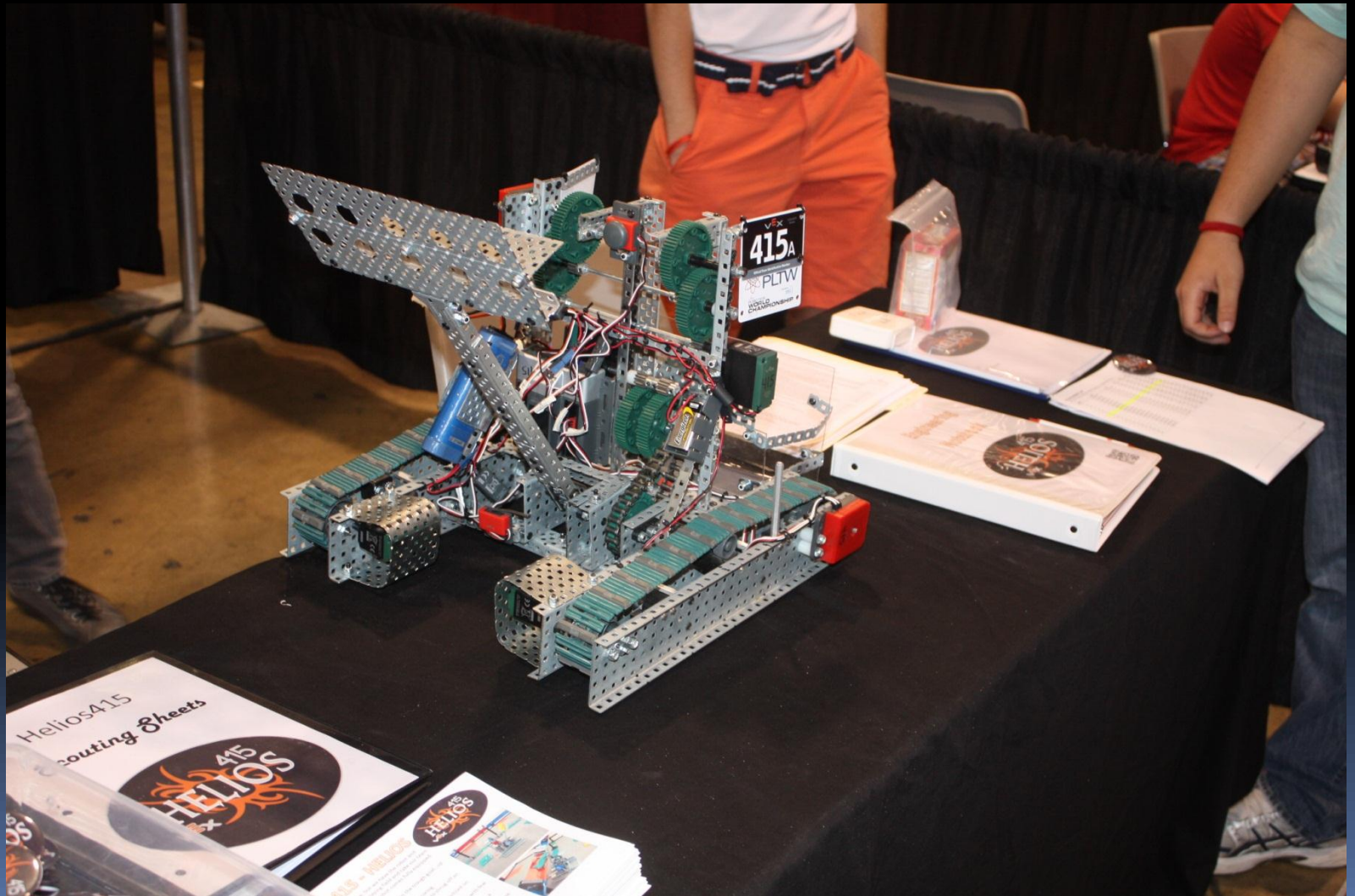
## Cons

- Slick: the standard track lacks traction on some surfaces
- Slow: the distance traveled per rotation is limited by the size of the drive sprocket ( note some teams have used the larger high strength chain sprockets, P/N: 276-2252 as drive sprockets to overcome this limitation.)

Summary: Looks cool and can climb, but vulnerable



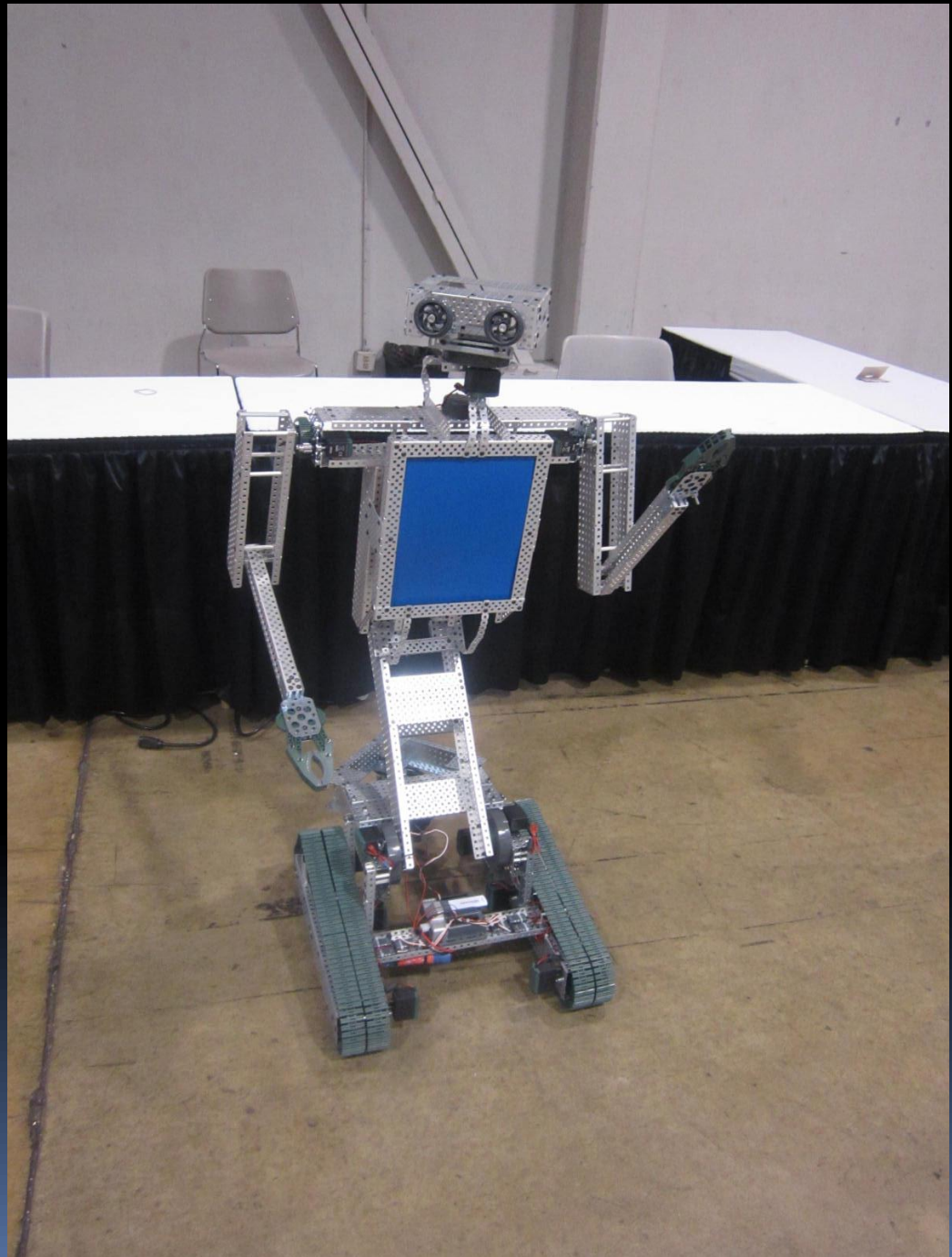
# Sack Attack Track Bot



# Nerf Tank Gun



# Mascot



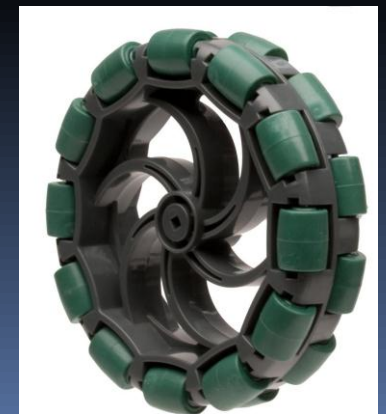
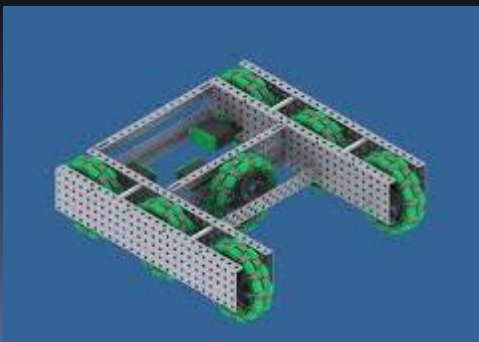
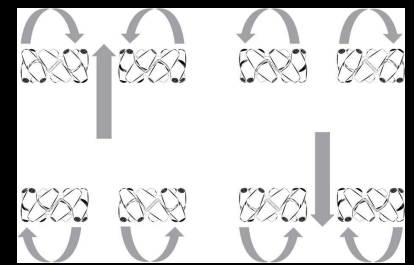
# Holonomic: Robots that can go sideways

## Pros

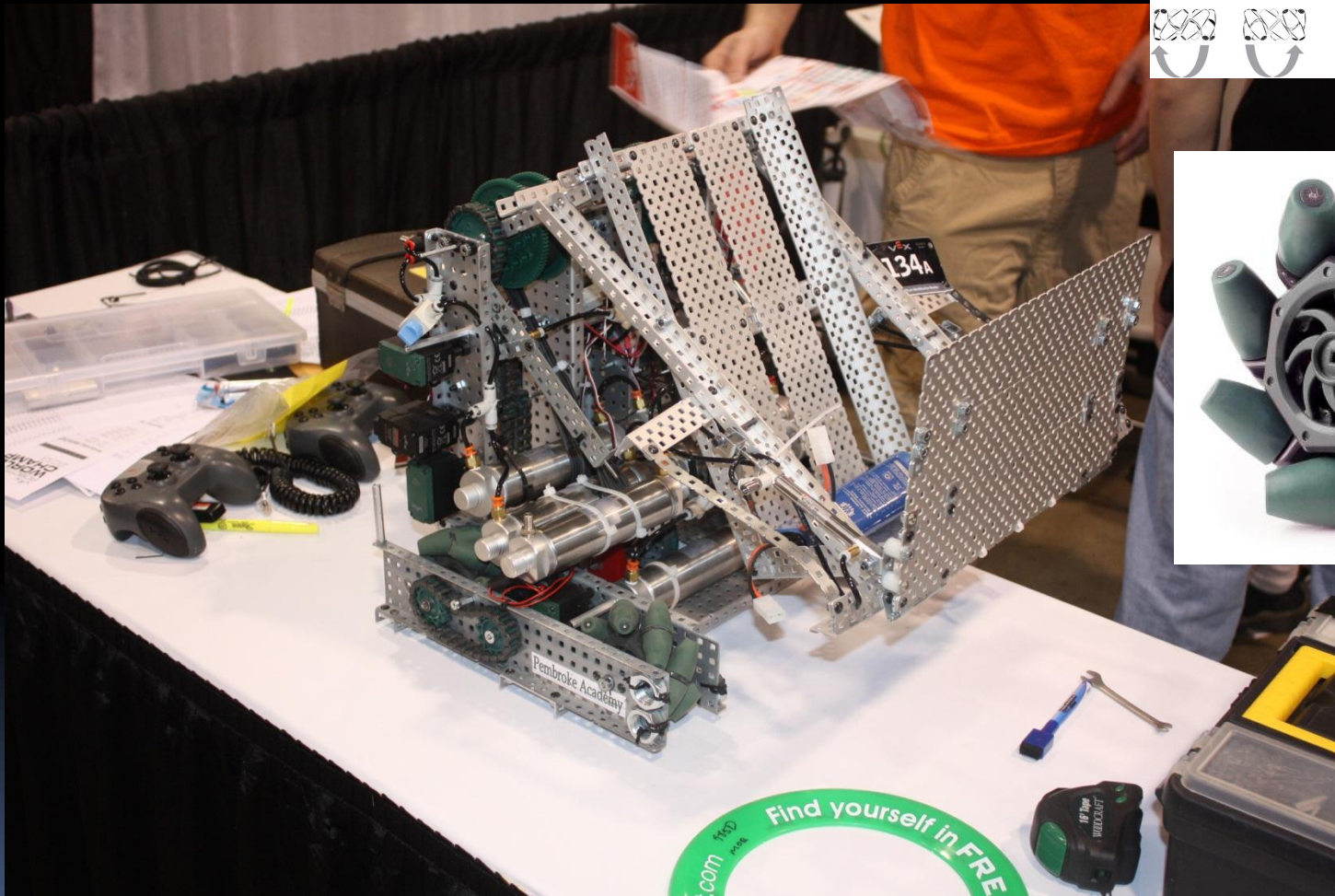
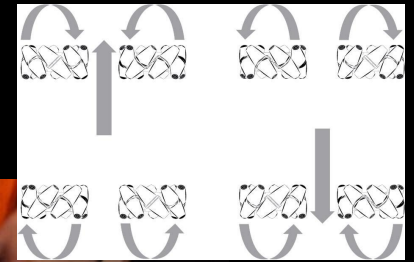
- can move in 2 different planes (front to back and sided to side), plus pivot
- very hard to trap in a corner
- very effective for lining up with game pieces

## Cons

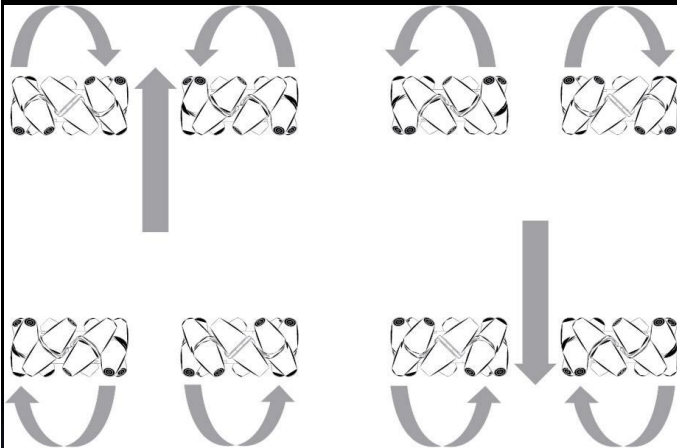
- requires a motor for each drive wheel
- need driver training
- multiple motors draw more current and use up motor ports on controller
- does not climb field obstacles well



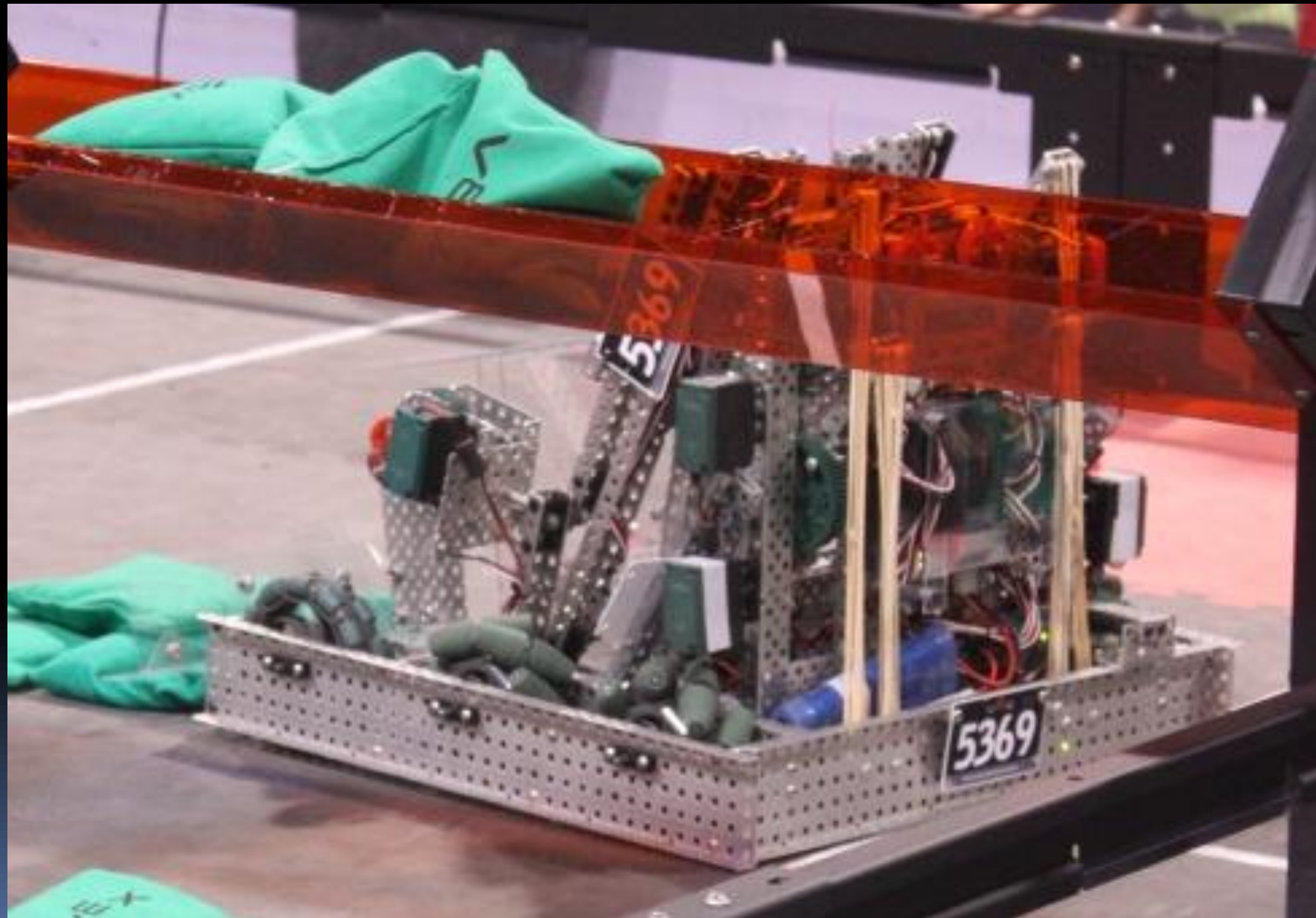
# Holonomic: Mecanum



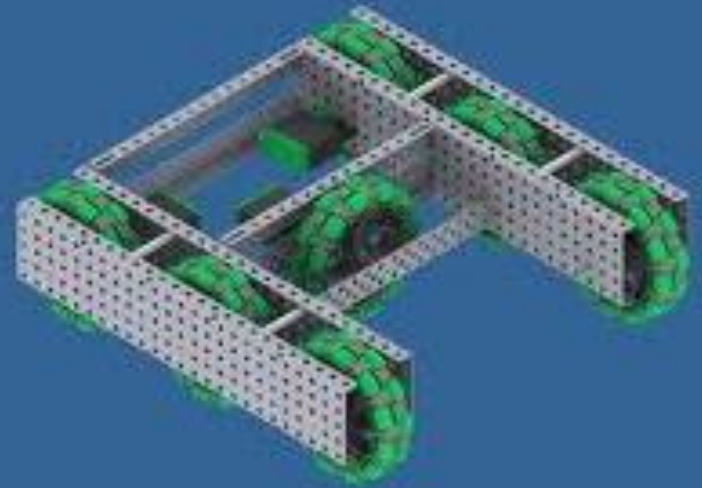
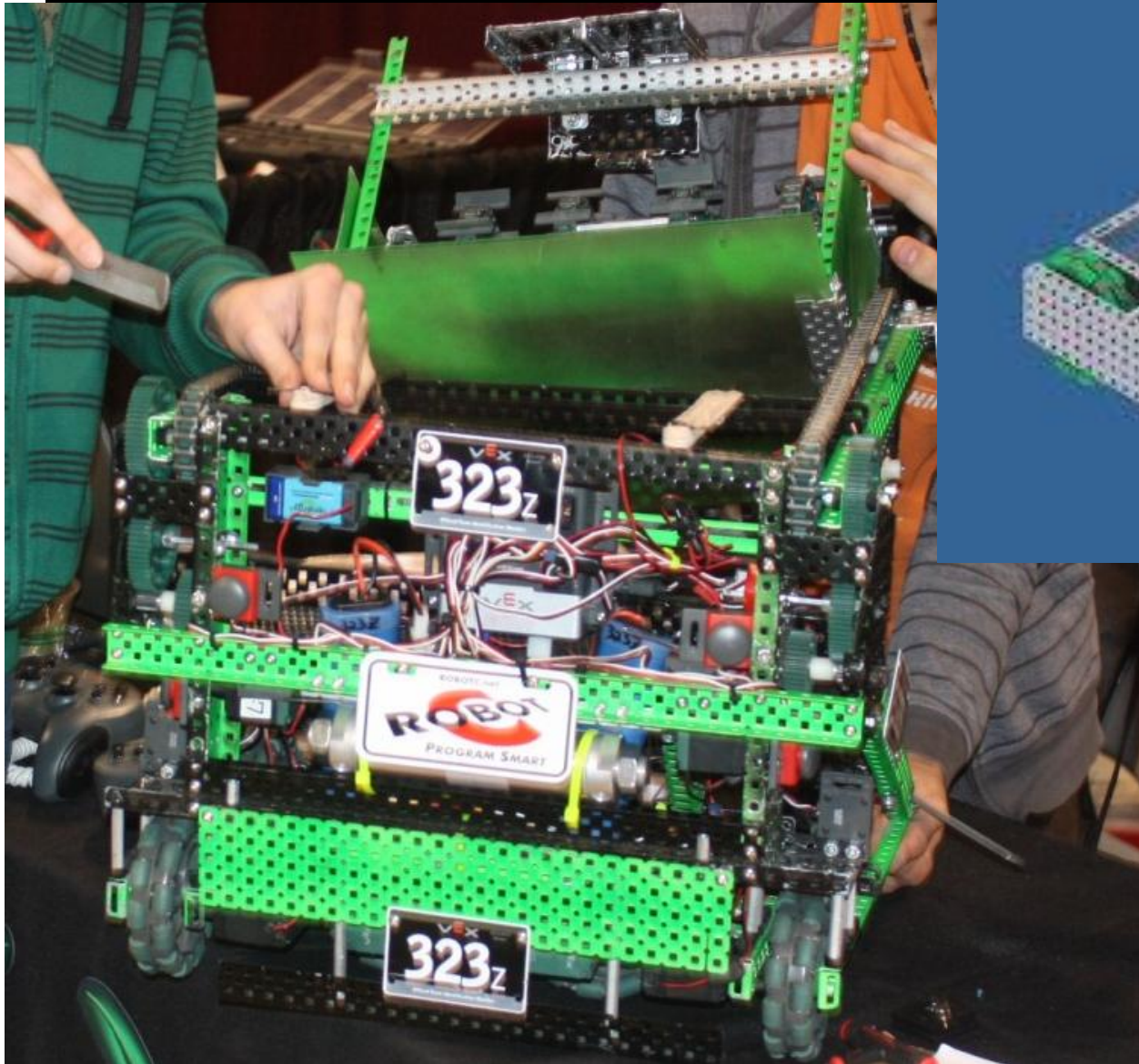
# Holonomic: Mecanum



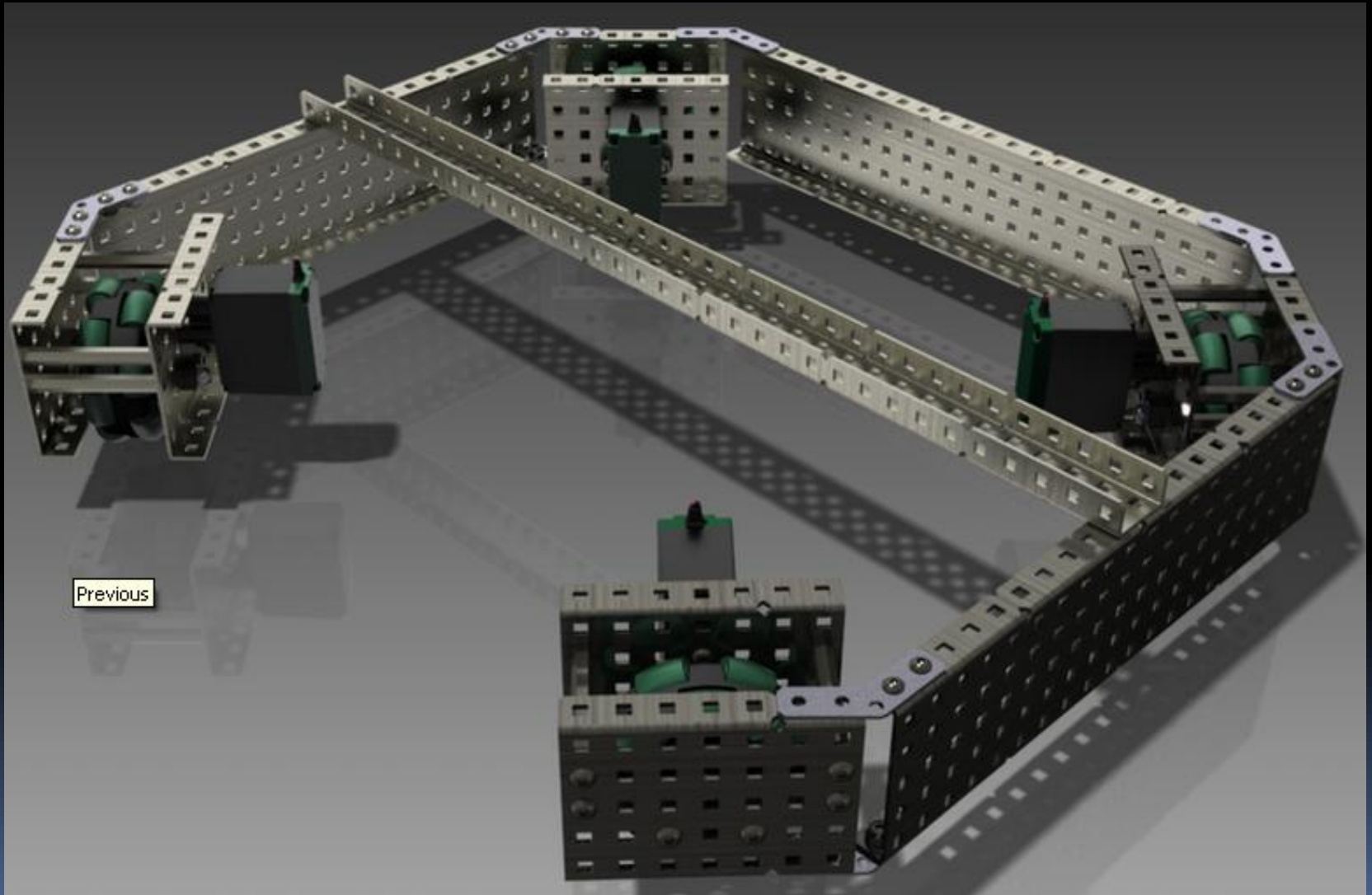
# Holonomic: Mecanums in back, Omni in Front



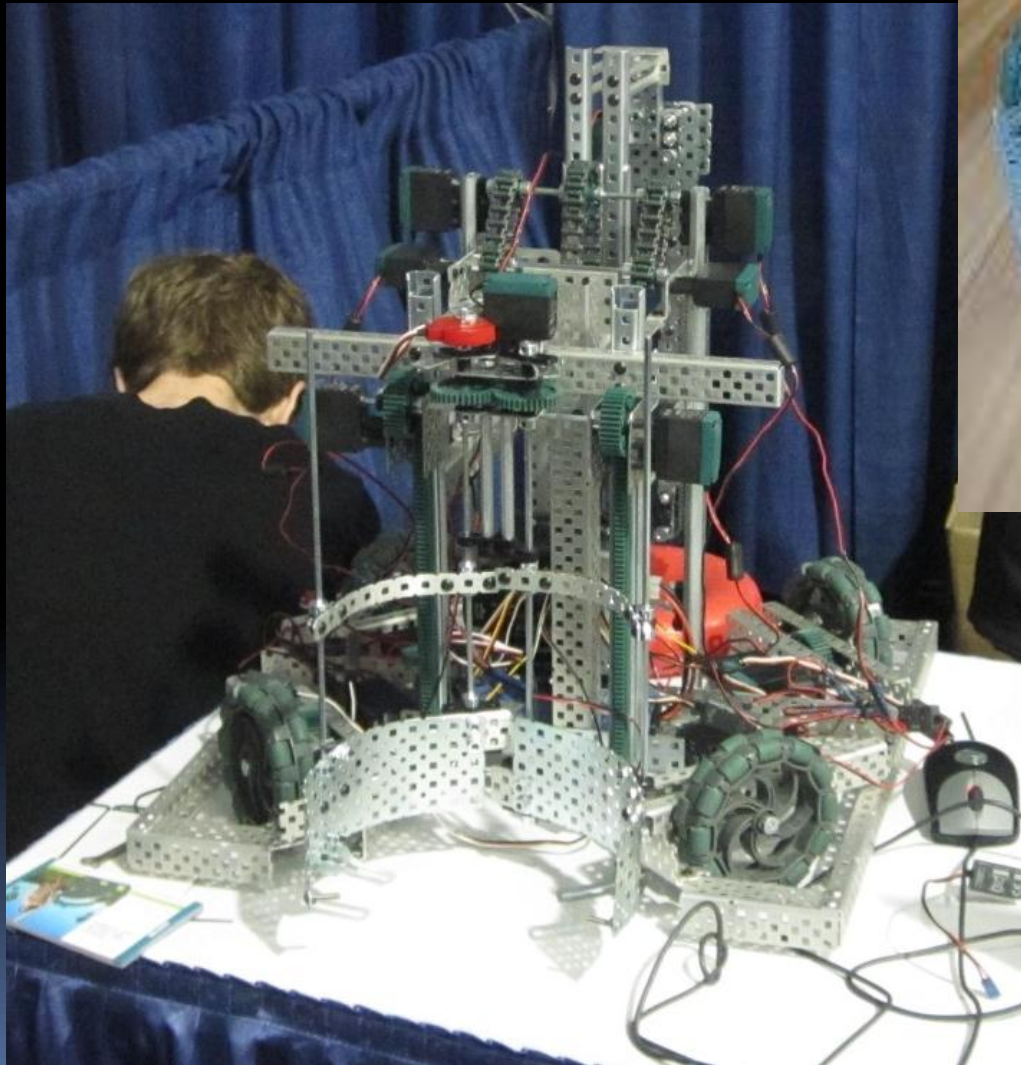
# Holonomic: H-Drive



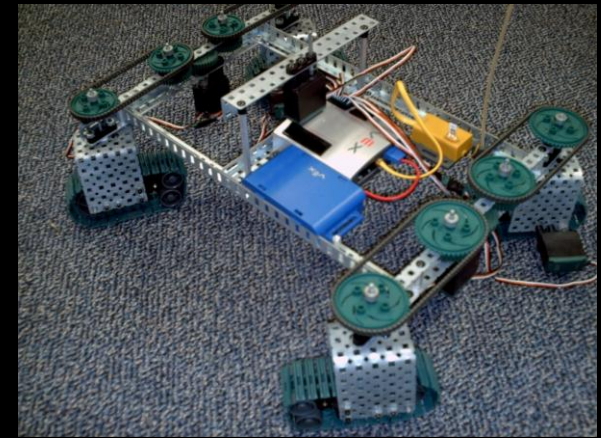
# Holonomic: 4-Omni



# Holonomic: 4-Omni



# Swerve Wheels



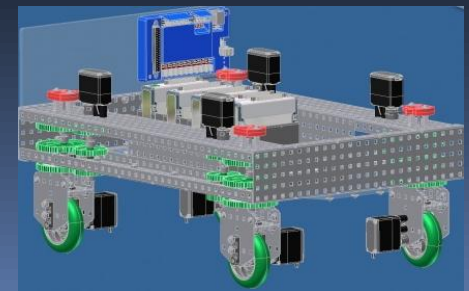
## Pros

- agile!
- can climb field obstacles

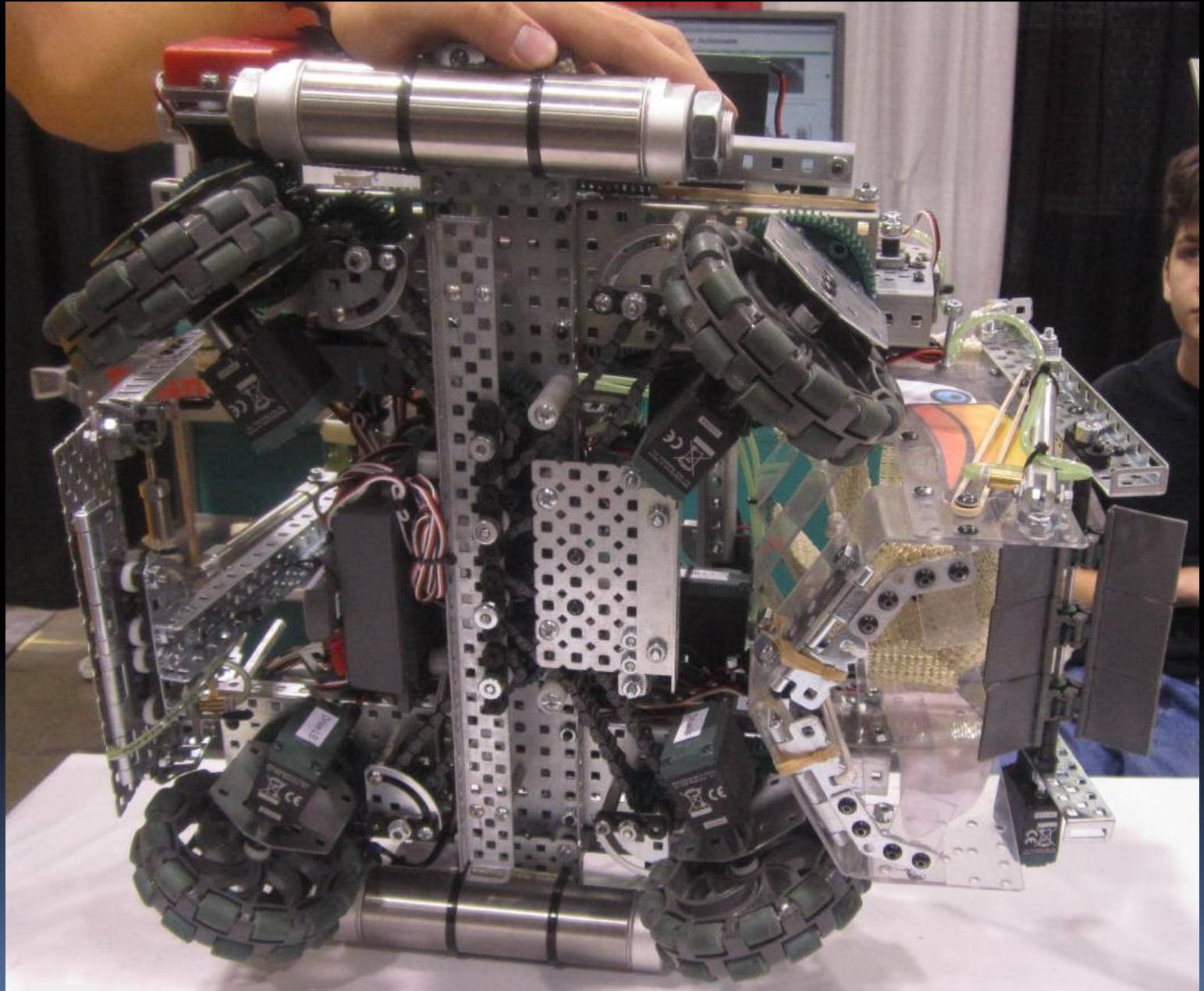
## Cons:

- requires a motor for each wheel and motors to activate the swerve action
- complex
- most designs have a higher center of gravity

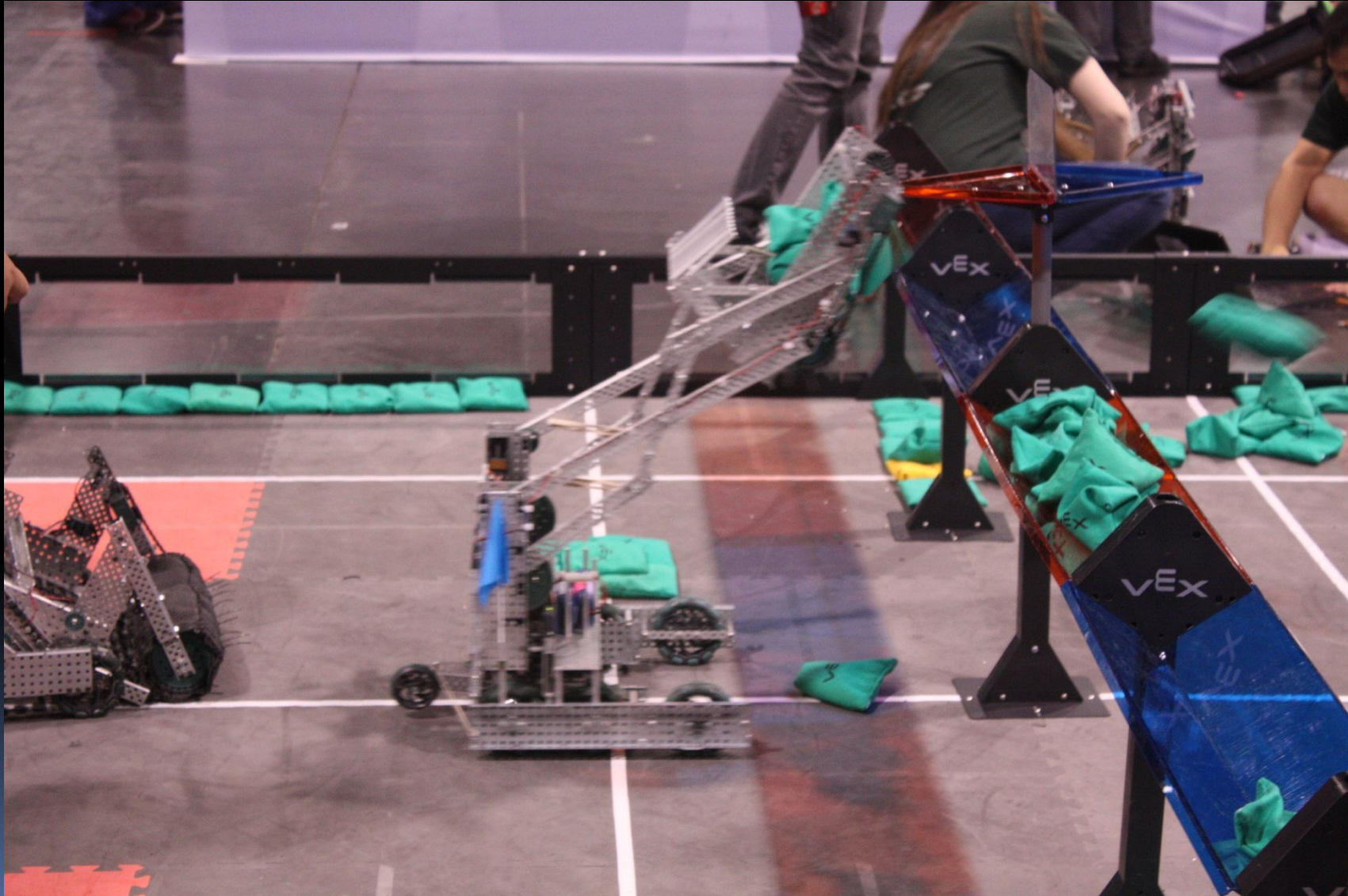
Summary: Very agile, very complex and requires extra parts. Make sure to give yourself time and resources if you are to implement this option.



# Swervebot



# Stability Feature: Wheelie Bar



# Tips for Drive Systems


- Always **support drive shafts on two points** (gears, sprockets, track drive sprockets, wheels).
- Always use **Delrin** bearings flats ( **P/N** : 276-1209 ) when placing a drive shaft through a metal structure.
- Always have a **shaft collar** ( **P/N**: 276-2010 ) orientated so as to **hold the drive shaft** into the motor.
- Check that **no** gears, sprockets, drive chains, or wheels are **rubbing** against a surface that will cause additional friction to drive system. This can be tested by spinning the drive system without the motor attached.

# More Tips

- It is a good practice to test the motors before attaching them to the drive system.
- Try to orientate motor screws for easy access because they have a tendency to loosen up after use.
- Use the high strength stainless steel (6-32) motor screws they are less likely to strip.
- When using 6 or 8 wheel drive systems it is advantageous to have the center wheels lower or a slightly larger size than the end wheels



# More Drive Train Tips

- **Large** wheels are **faster** (all else equal) and provide **less torque**
  - Smaller wheels accelerate quicker but have a slower top speed.
  - Smaller wheels can be placed closer to the corners
  - With skid turn designs, short-wide designs are easier to turn than long-narrow
- 

# Referee Training: Human Interaction

- [Human Interaction video](#)



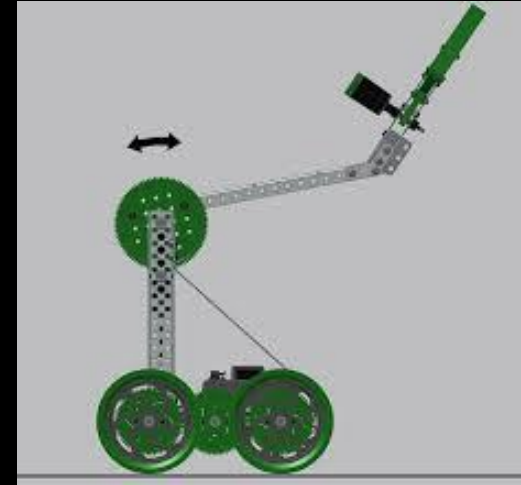
A vertical bar on the left side of the slide, consisting of several colored segments: a thin black line at the top, followed by a thin grey line, a thin yellow line, and a thick pink line at the bottom.

# 10:30 Sample Arms

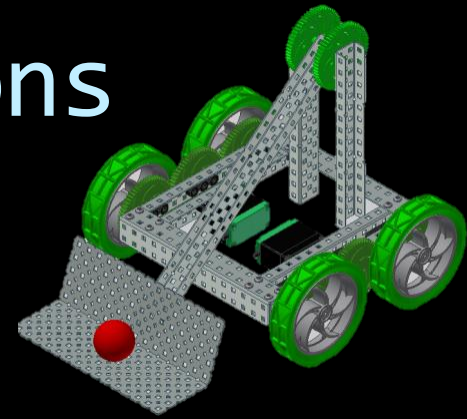
- Look at arms of Robots
- Samples
  - Look at some arms from current robots.

# Single Arms

- **Arms** – These manipulators consist of a pivot point and at least 1 motor.
- Arms can be single and supported on each side by a tower
- Arms are levers, the closer the pivot point is to the end of the arm, the longer the arm, and larger the load the more torque is required to lift it.
- Torque is usually the most difficult thing to overcome when designing an arm.



# Single Arm Pros and Cons



- Advantages –

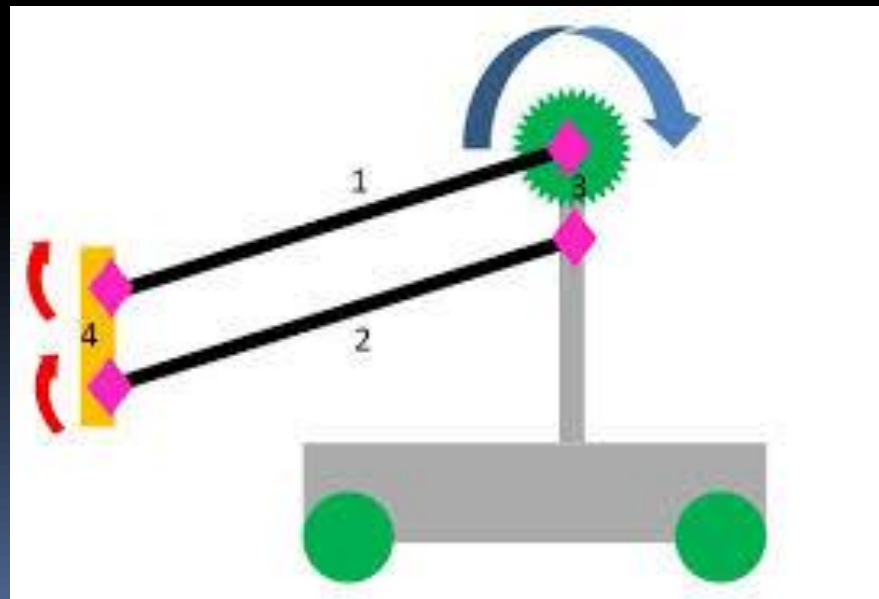
- Lifts an object from the field surface.
- Relatively easy to design and construct.
- Can be designed to pivot from one side of the robot, over the top to the other side of the robot.

- Disadvantages –

- High to very high torque situation which can lead to broken drive shafts, stripped gears, broken drive chains, ...
- **Back dive** when not powered
- Creates a **higher center of gravity** when lifted.
- The object being picked up maintains its orientation with the arm as it arcs up and may not be aligned with the final manipulation goal.
- Summary: A great first arm that can be enhanced with gatherers.

# Four-Bar Linkage

- Usually the four structures consist of a tower, two arms, and a hand.
- Creates a parallelogram
- The closer the linkages are to one another the less they can pivot.



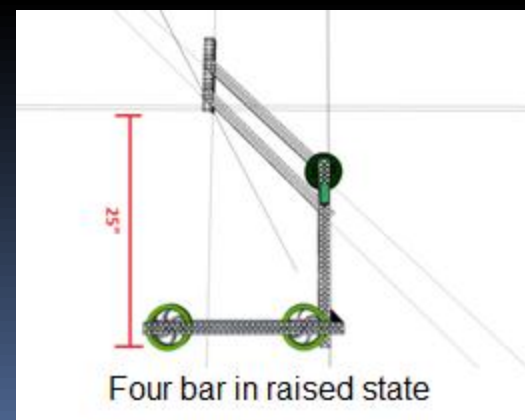
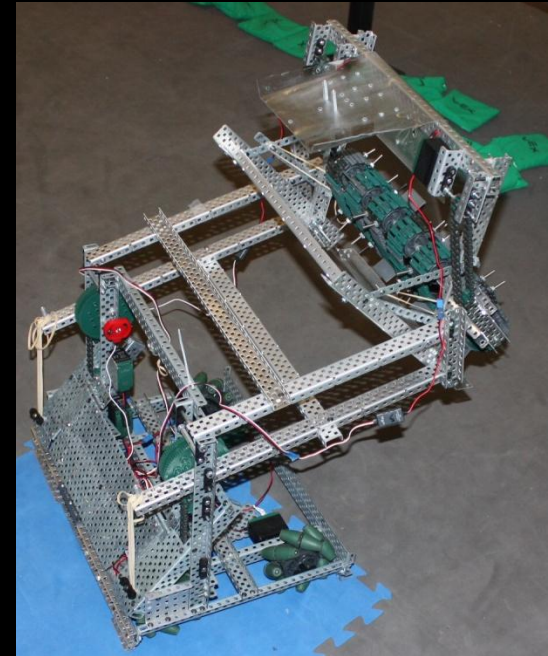
# Four-Bar Linkages Pros and Cons

## ▪ Advantages –

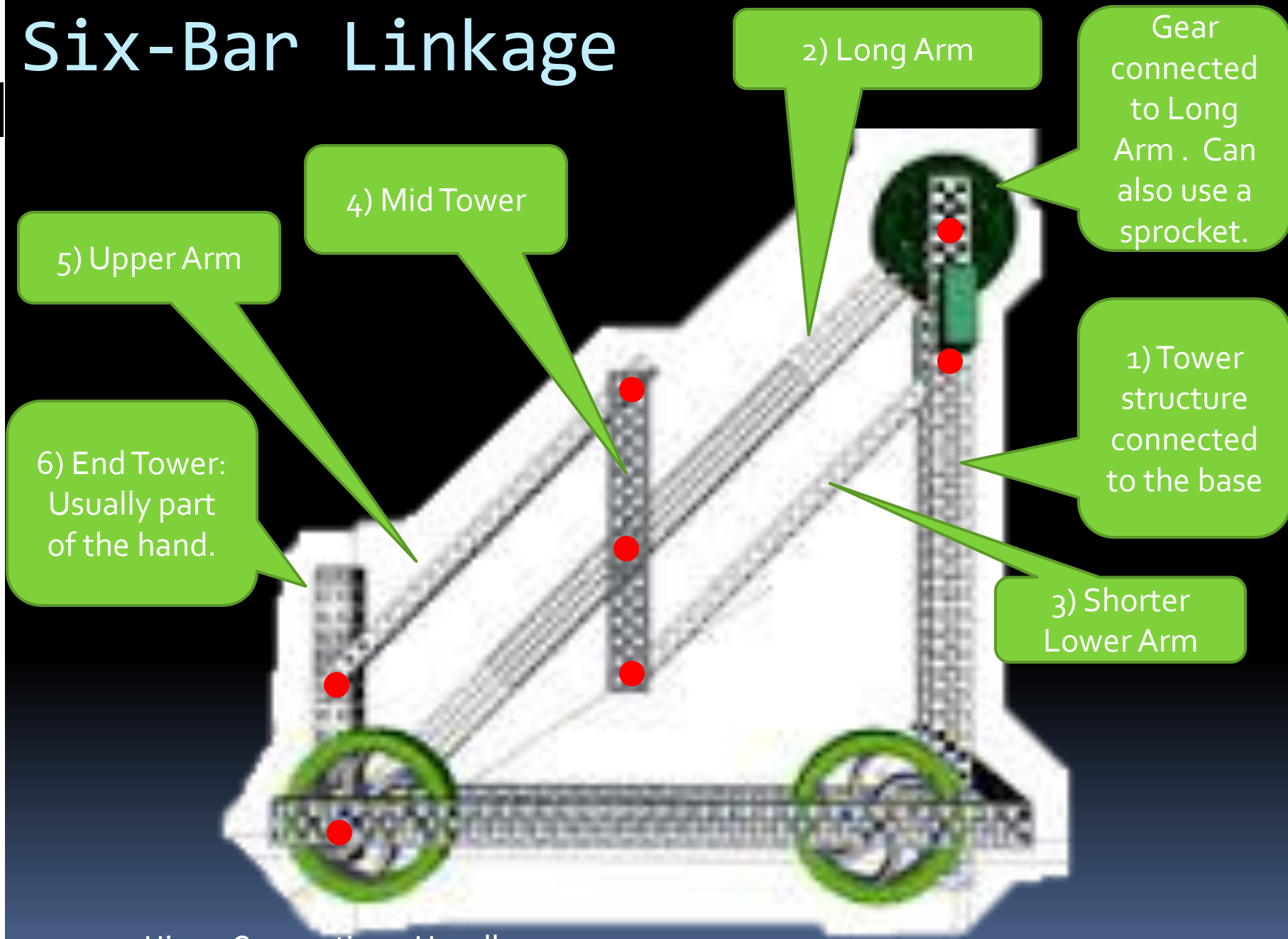
- The orientation of an object can be changed in respect to the arm as it is pivoted up.
- Elastic forces can be added between the linkages to reduce the amount of force the activator needs to apply.

## ▪ Disadvantages –

- Easy to create a design with a high to very high torque situation
- Back dive when not powered
- Can not rotate from one side of the robot over to the other side.
- Creates a higher center of gravity when lifted
- Summary: A good option that keeps the orientation of the hand, but limited by how high you can reach.



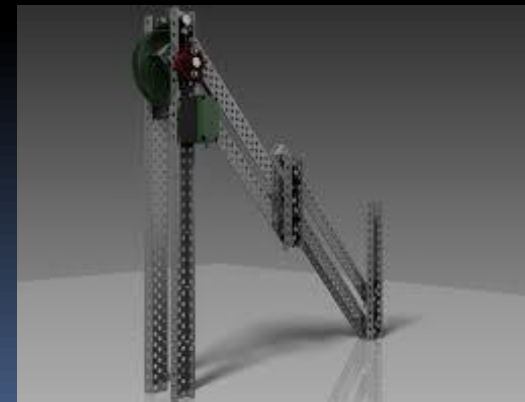
# Six-Bar Linkage



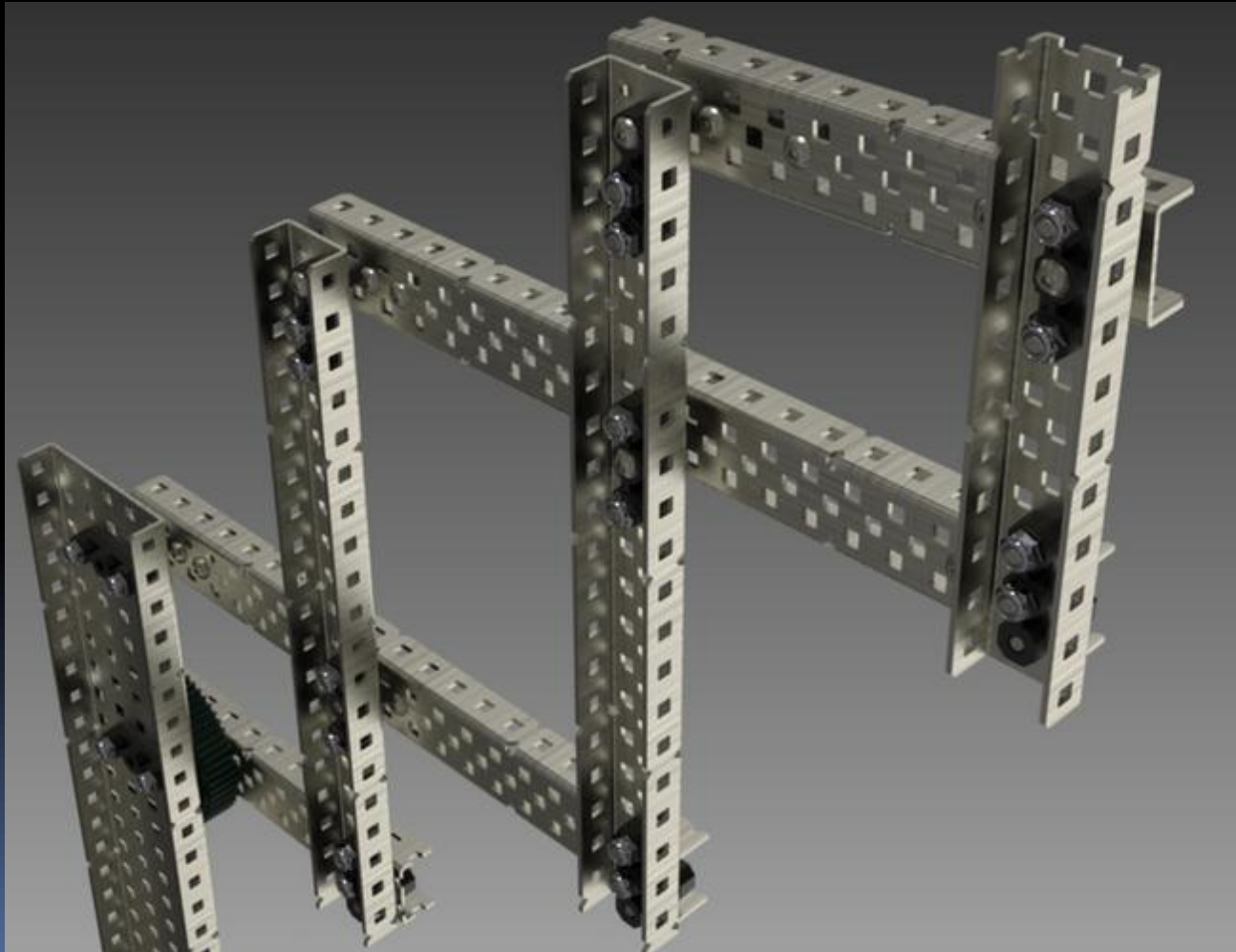
● Hinge Connection. Usually with axle or loose screw.

# Six-Bar Linkages Pros and Cons

- Advantages –
- The orientation of an object can be changed in respect to the arm as it is pivoted up.
- Elastic forces can be added between the linkages to reduce the amount of force the activator needs to apply.
- Disadvantages –
- Easy to create a design with a high to very high torque situation
- Back dive.
- The amount of pivot is limited by the distance between the arms. Can not rotate from one side of the robot over to the other side.
- Creates a changing and higher center of gravity when lifted
- Summary: A four-bar linkage on steroids. You can lift higher, but it is a bit more complex to build



# 8-Bar Linkage .. A Six-Bar Linkage on Steroids

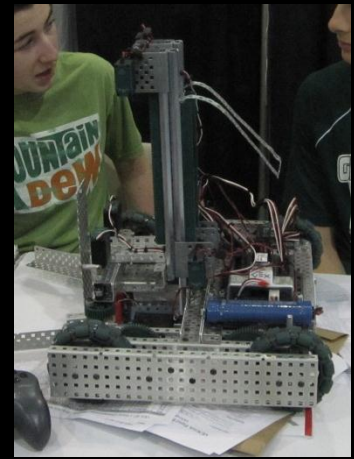


# 8-Bar Sample



# Linear Slide

- **Linear slides** – The VEX design system provides two types of linear slides in the linear motion kit .
  - The linear motion kit provides inside and outside Delrin slide trucks which can slide up and down the linear slide track.
  - The old linear slides are two metal slide members (an outside and an inside) which slide over one another. Both make excellent linear lifts.
- You can use a motor with rack and pinion, or chain or rope to move the slide.



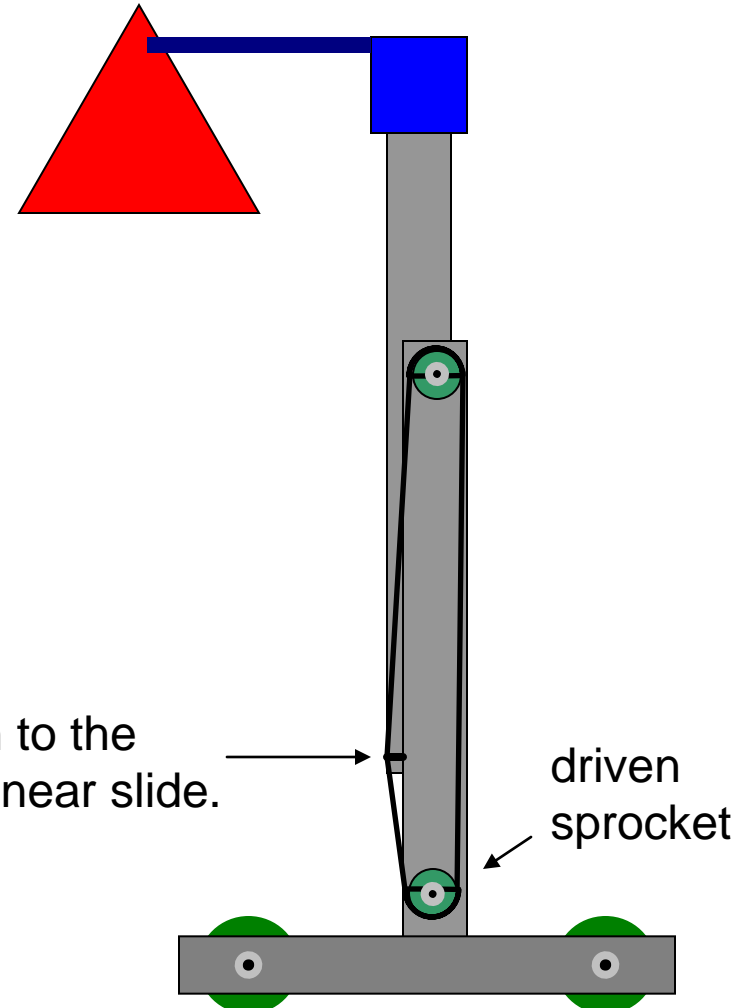
# Linear Slide Extension Lifts

## Single Stage Chain Lift

The motor rotates the chain.

The linear slide is attached to the chain.

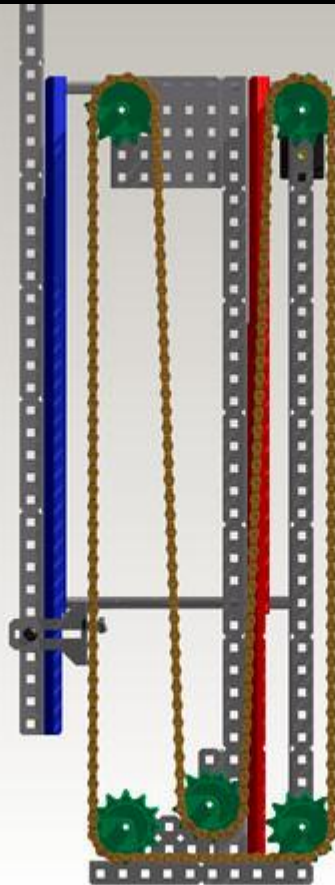
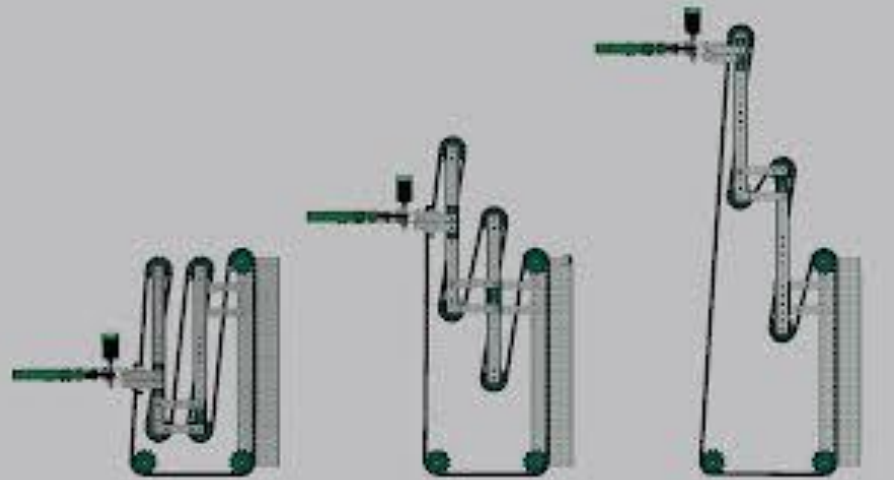
The linear slide is pulled up and down by the chain.



Cable tie chain to the bottom of the linear slide.

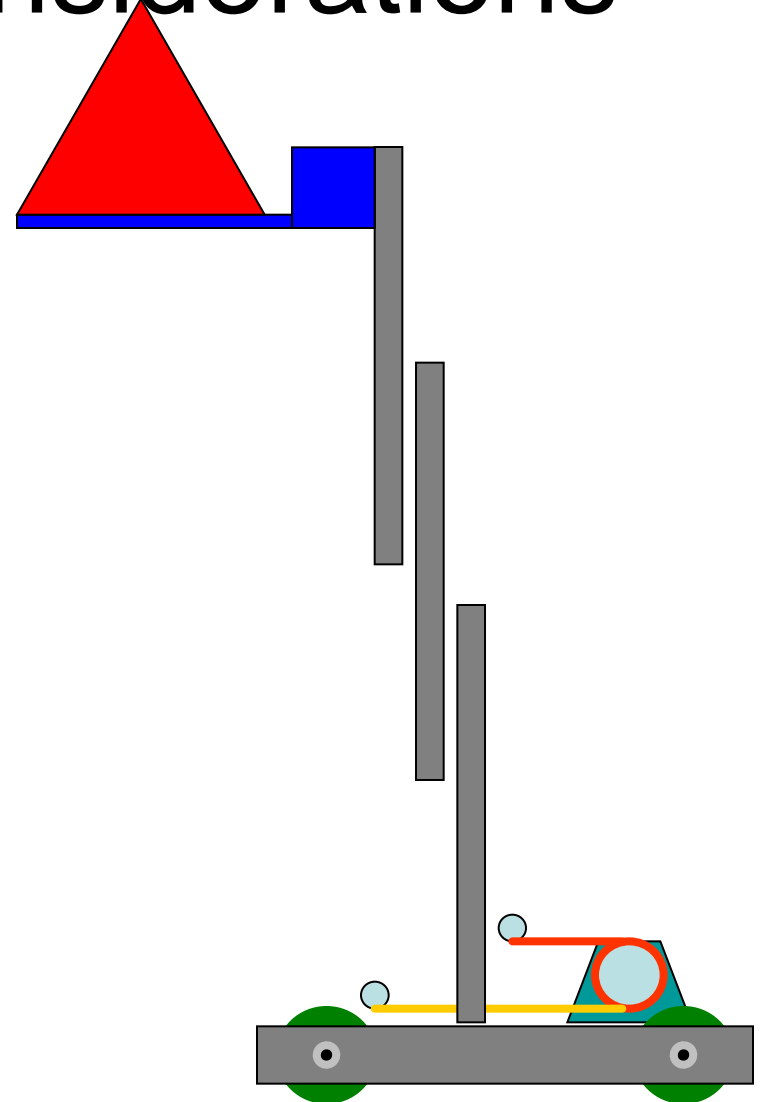
driven sprocket

# Animation



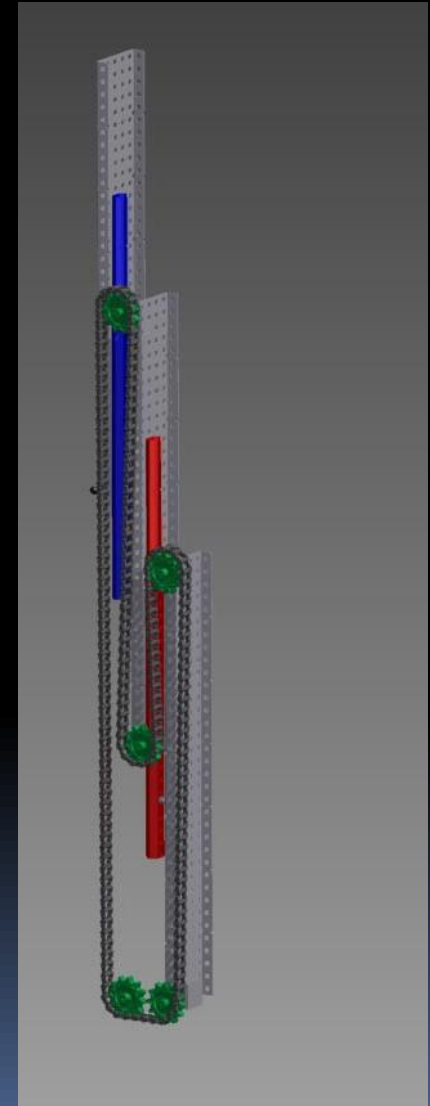
# Extension Lift Considerations

- Best if powered up AND down
  - If not, make sure to add a device to take up the slack if it jams
- Segments need to move freely
- Need to be able to adjust chain/cable lengths.
- Minimize slop/ free-play
- Maximize segment overlap
  - 20% minimum
  - more for bottom, less for top
- Stiffness is as important as strength
- Minimize weight, especially at the top



# Linear Slide Pros and Cons

- Advantages –
- Very effective linear lift from floor surface.
- Takes up little volume on the robot.
- You can add 'stages' to increase the distance the slide can travel.
- Disadvantages –
- The gear teeth on plastic racks can strip.
- Creates a higher center of gravity when lifted
- Difficult to build and keep friction down.
- Summary: Can be tricky to limit the friction, but gives the advantage of lifting straight up and taking up little room.



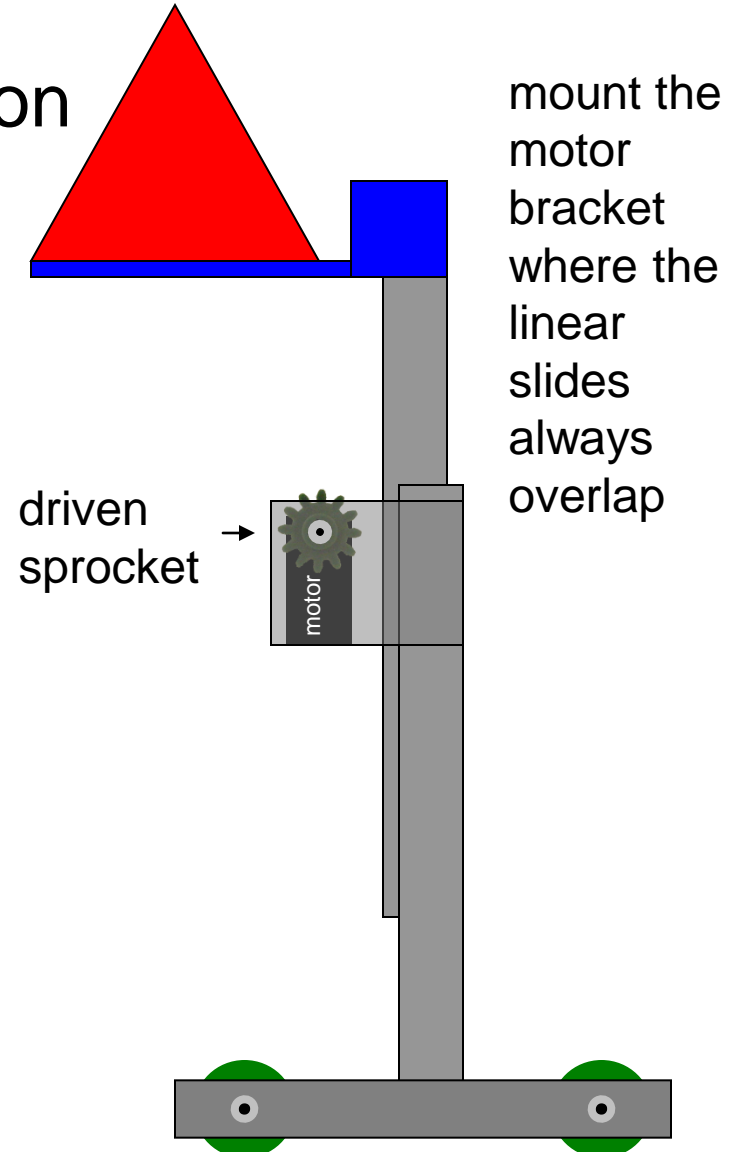
# Extension Lifts

## Rack & Pinion

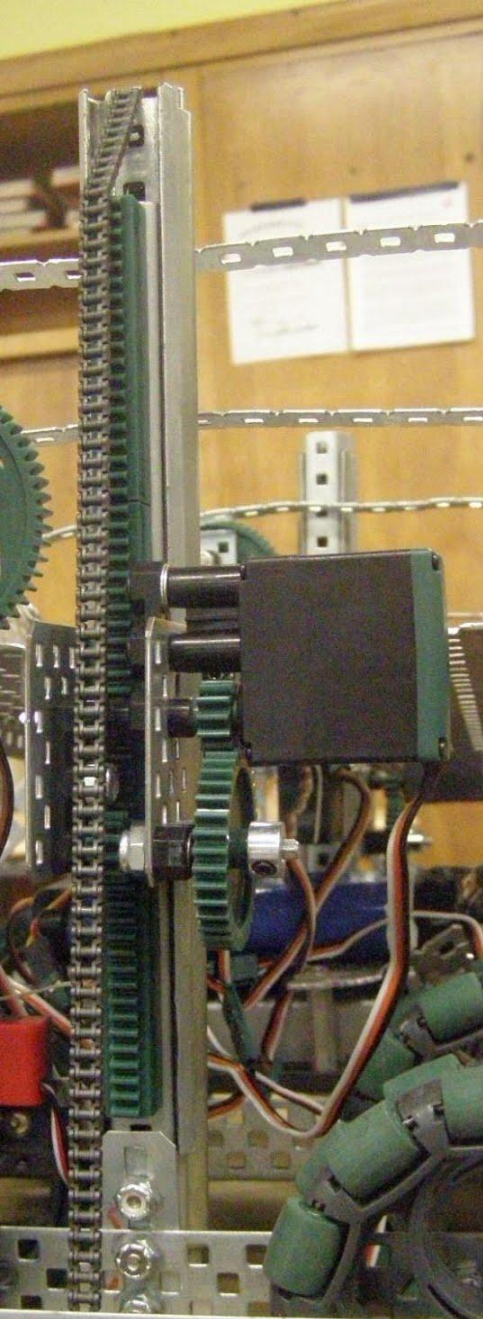
The rack is attached to one linear slide.

The pinion (driven gear) is attached to the other slide

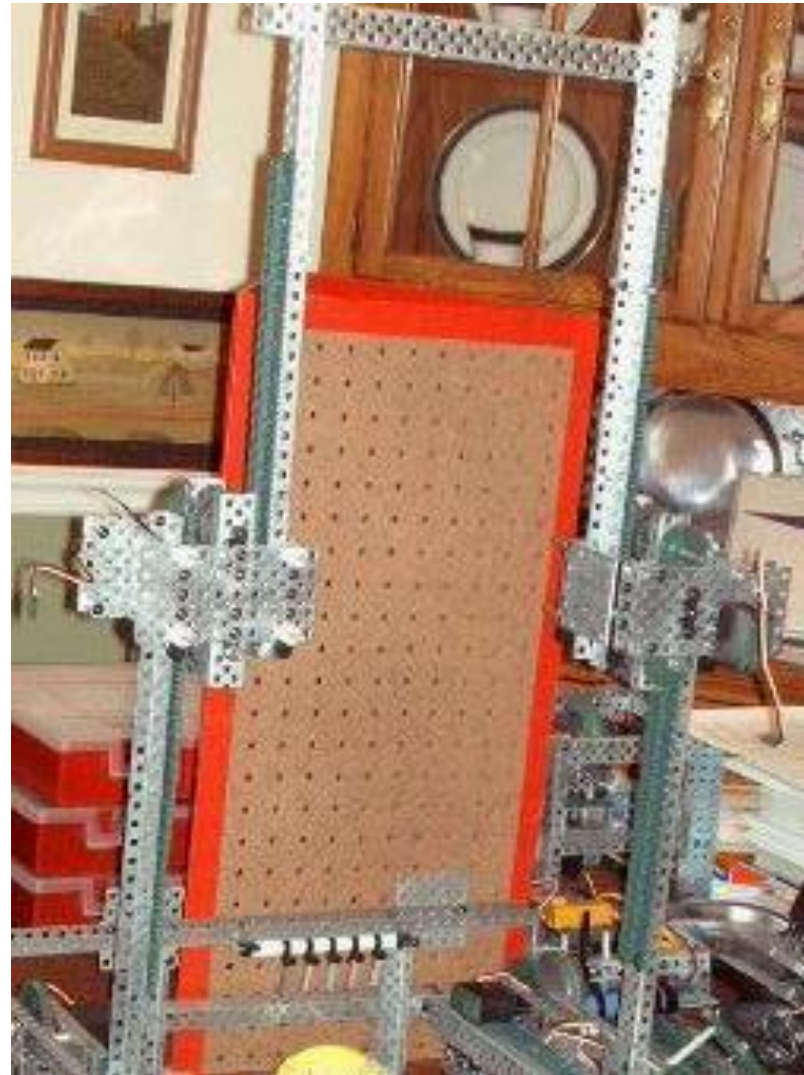
The driven gear must be mounted where the linear slides always overlap.



# Rack & Pinion Lift



Lab Rats' 2008 Bridge  
Battle Robot



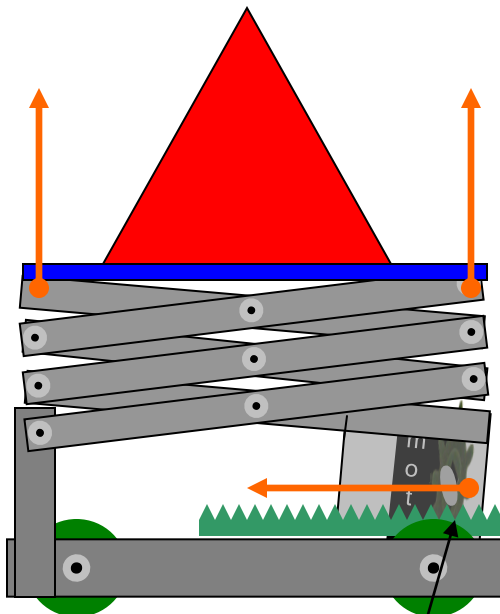
posted on [www.vexforum.com](http://www.vexforum.com)  
by 1885.blake

J.M. Gabrielse

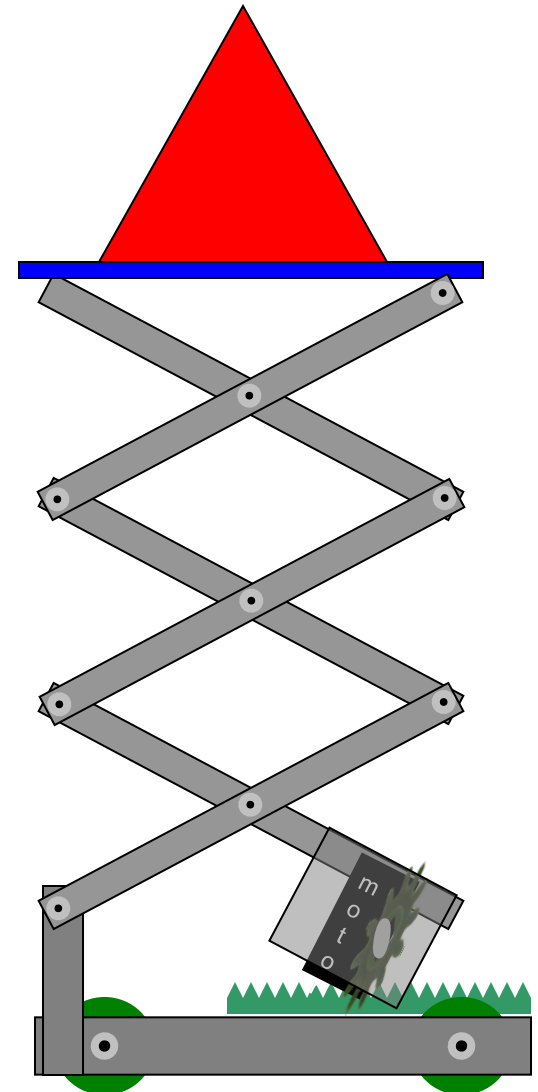
# Scissor Lifts

When the bottom of the scissors is pulled together it extends upwards.

In this example a rack and pinion pulls the bottom of the scissors together.

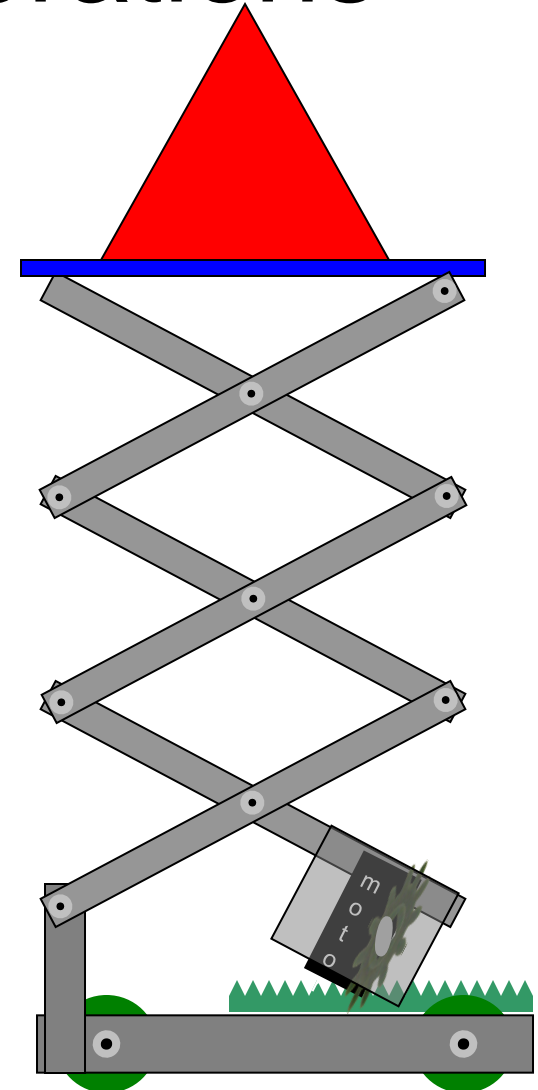


driven gear



# Scissor Lift Considerations

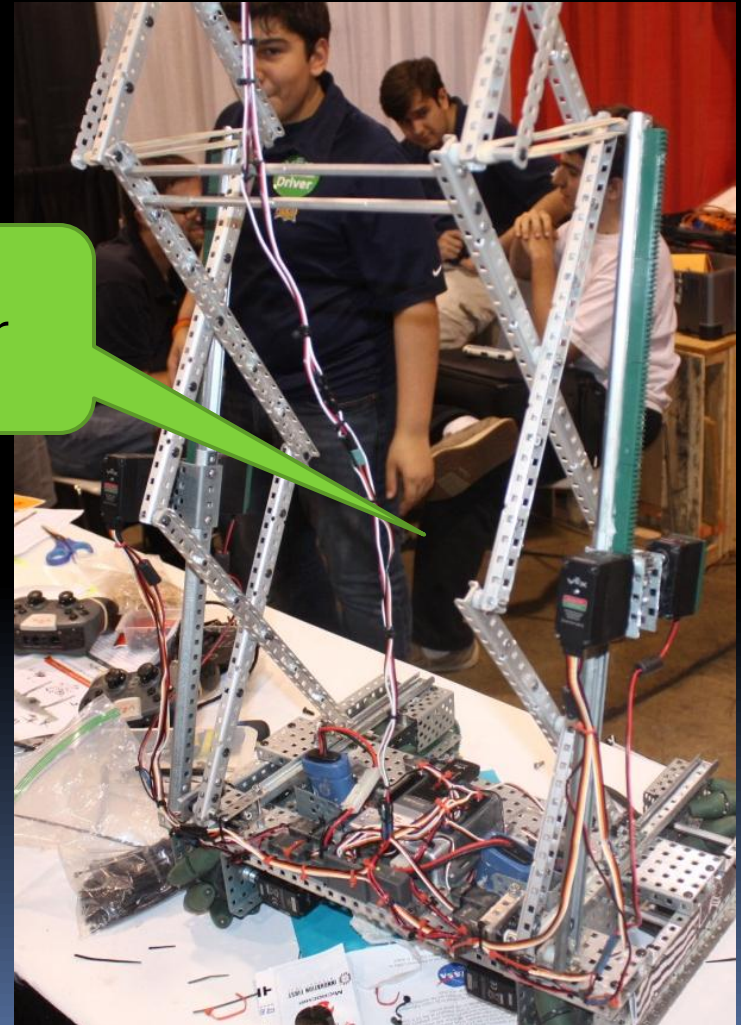
- Advantages
  - Minimum retracted height - can go under field barriers
- Disadvantages
  - Tends to be heavy to be stable enough
  - Doesn't deal well with side loads
  - Must be built very precisely
  - Stability decreases as height increases
  - Loads very high to raise at beginning of travel



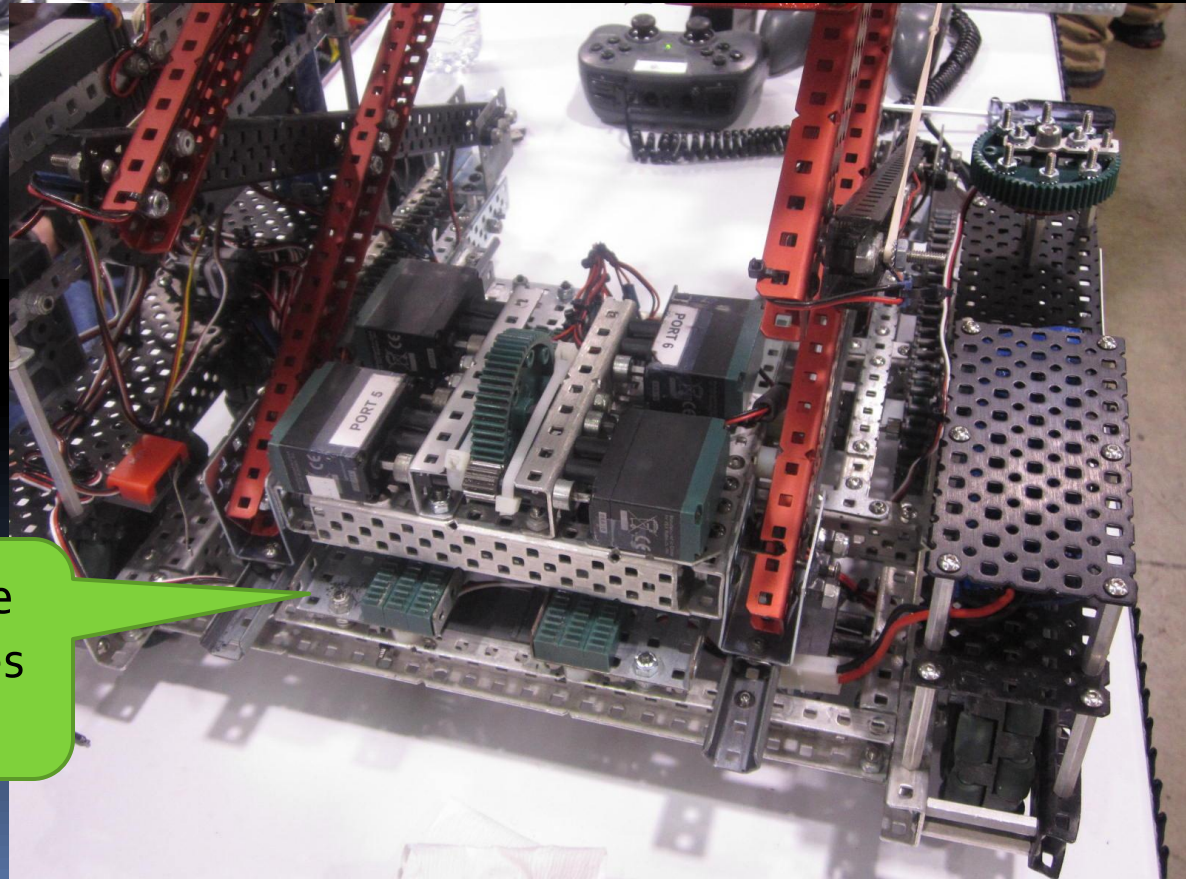
# Scissor Lift Example



Rack and  
Pinion for  
lifting

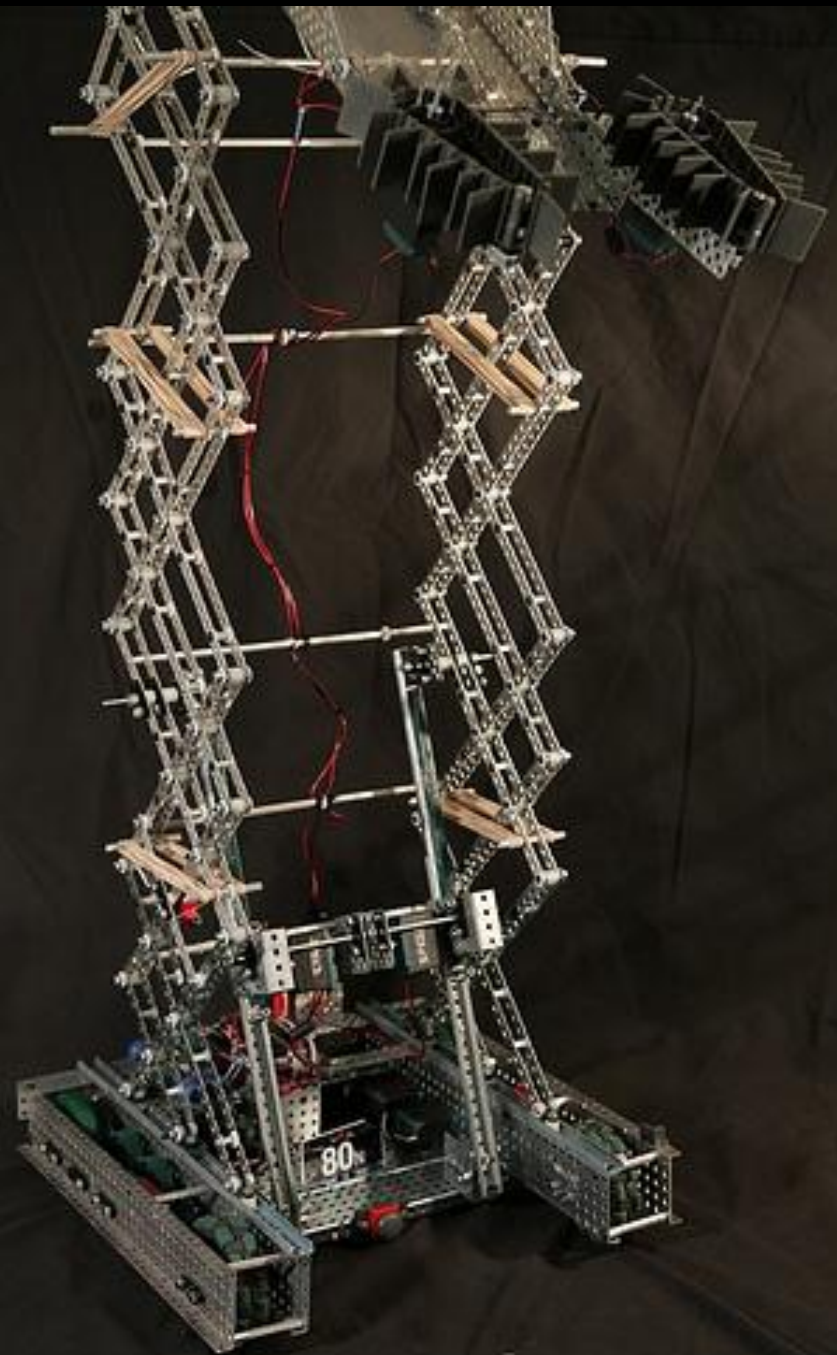
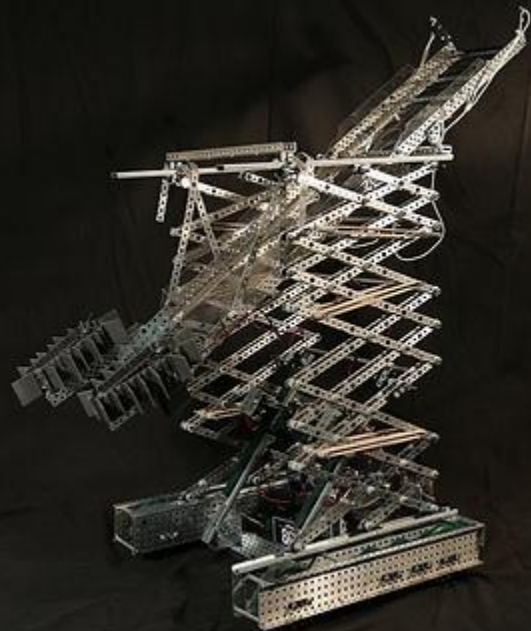


# Scissor Lift Example



Motors move the base which moves the arms.

# Scissor Lift



# Scissor Lift Pros and Cons

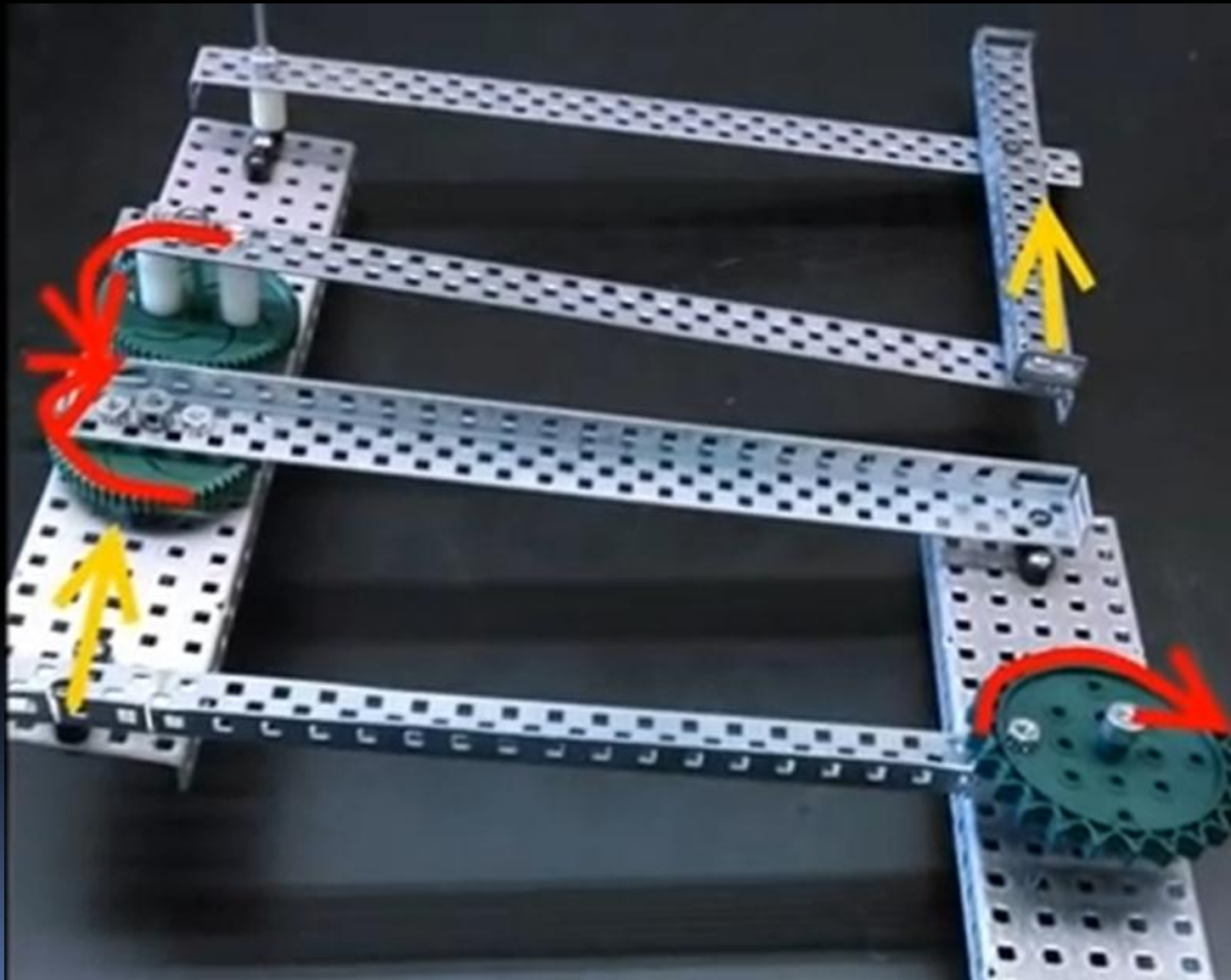
## ▪ Advantages –

- Can expand a great distance for very little linear motion.
- Can be expanded horizontally as well as vertically.
- Elastic forces can be used to expand the lift.

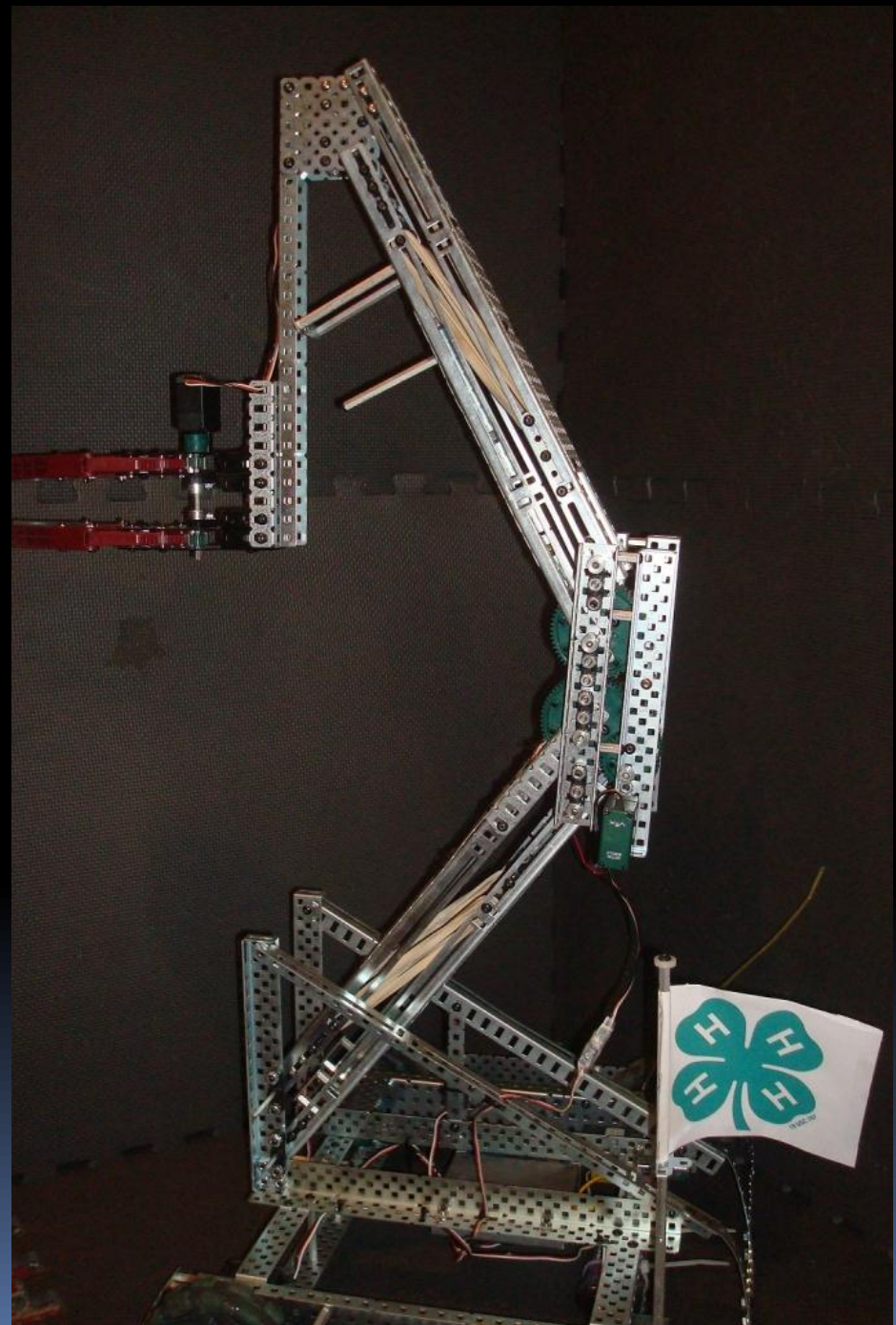
## ▪ Disadvantages –

- Complex
- The further apart the legs and the lower the center hinge point, the more force is required to lift the structure.
- Scissor lift systems must be well designed or they will bind. Scissor lifts take up a great deal of volume on a robot.
- Creates a higher center of gravity when lifted.
- Summary: The Great Tormentor! Great on paper, can be difficult to implement with multiple stages.

# Reverse Four-Bar



# Reverse Four-Bar Examples

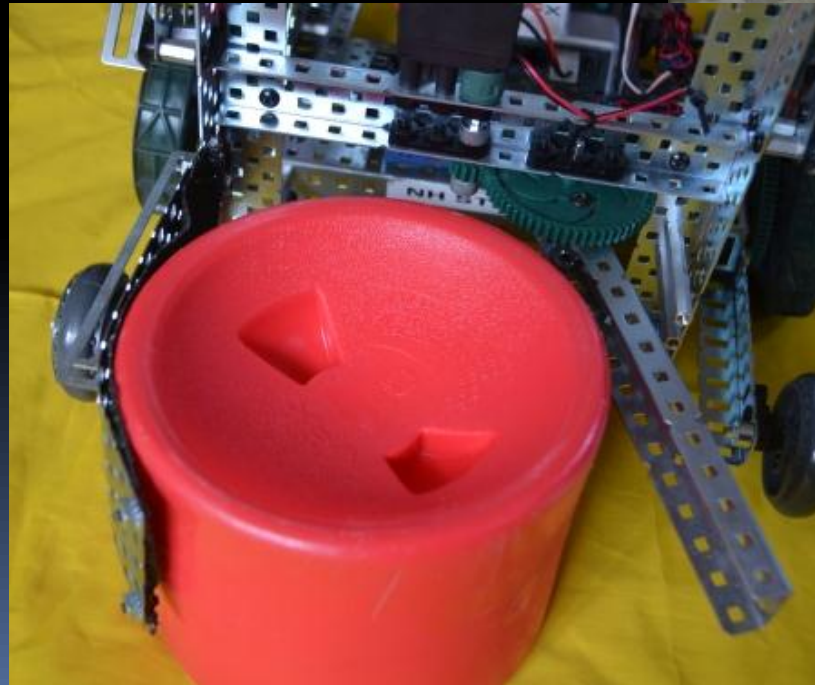
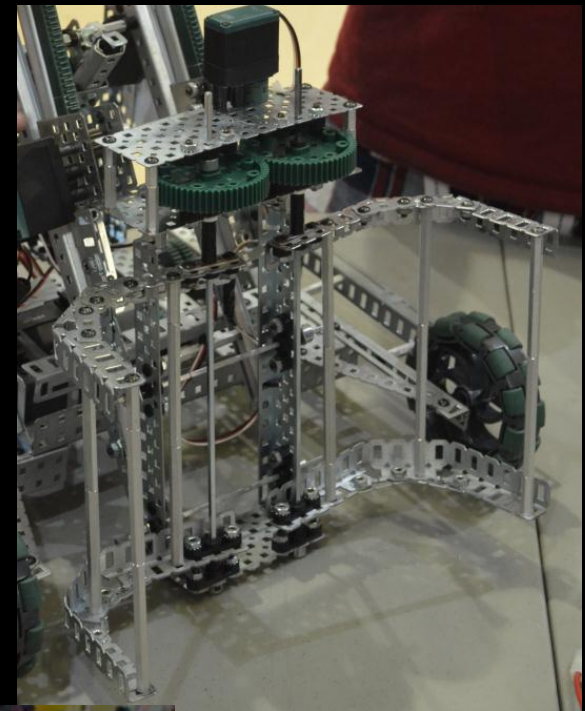


# 11:00 Hands/ Manipulators

- Referee Training: Scoring
- Referee Training: Skyrise Building




# Hands :



# Claws Pros and Cons

- *Advantages –*
- Relatively simple to build
- Requires a low to medium torque application.
- *Disadvantages-*
- Usually can only hold one item at a time
- **Summary: Great start and good for manipulating one item at a time.**



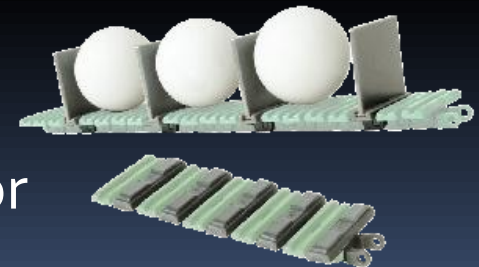
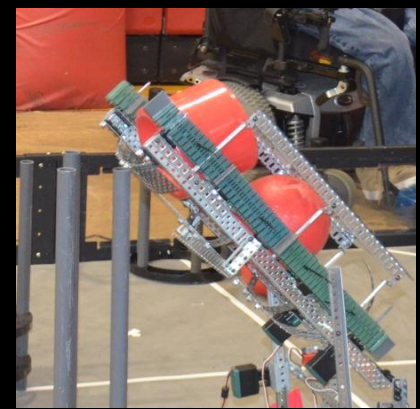
# Referee Training: DQ and Disable

- [Referee Training Video Disqualification and Disablement](#)



# Conveyor Belts

- **Conveyer belts**- These manipulators can be used to lift objects or move them horizontally.
- They consist of the tank tread kit or chain from the high strength or regular sprocket sets.
- Can combine with Tank Tread Upgrade kit for flaps.
- Many times the conveyer belt is integrated into a roller claw.
- All conveyer belts require at least one motor to activate

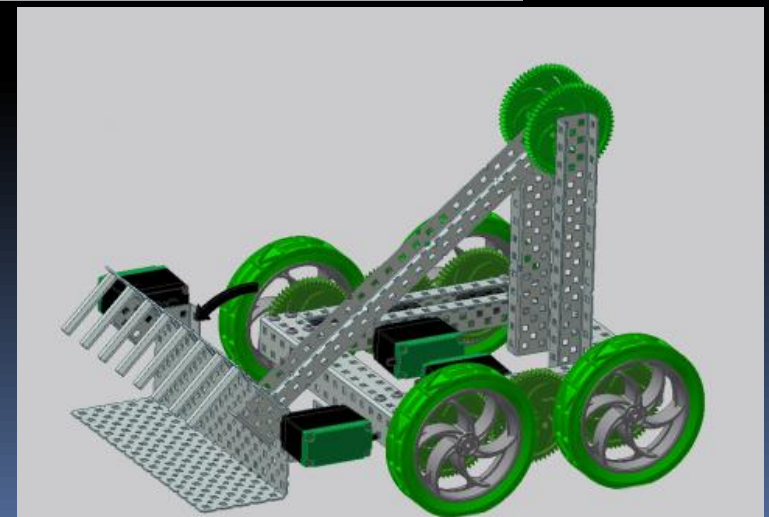
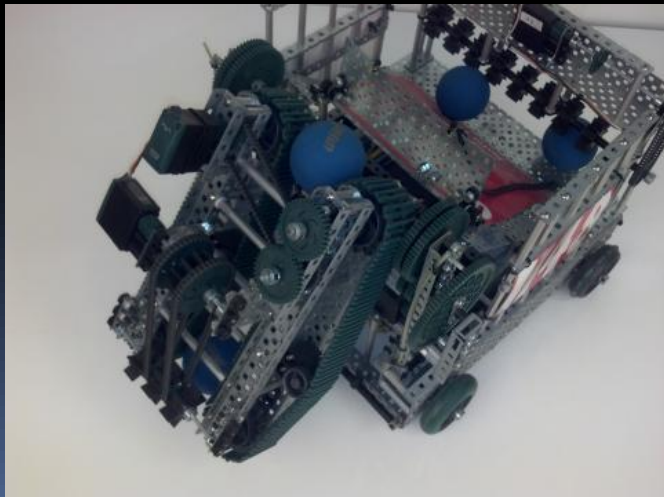
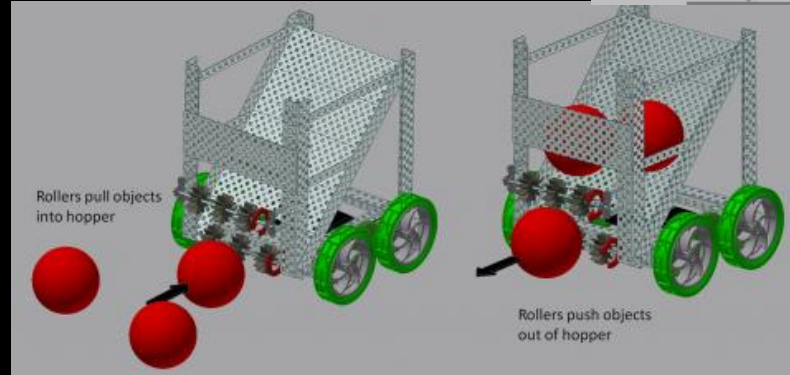
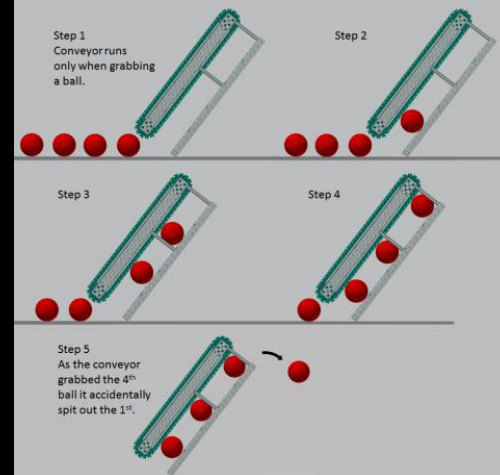
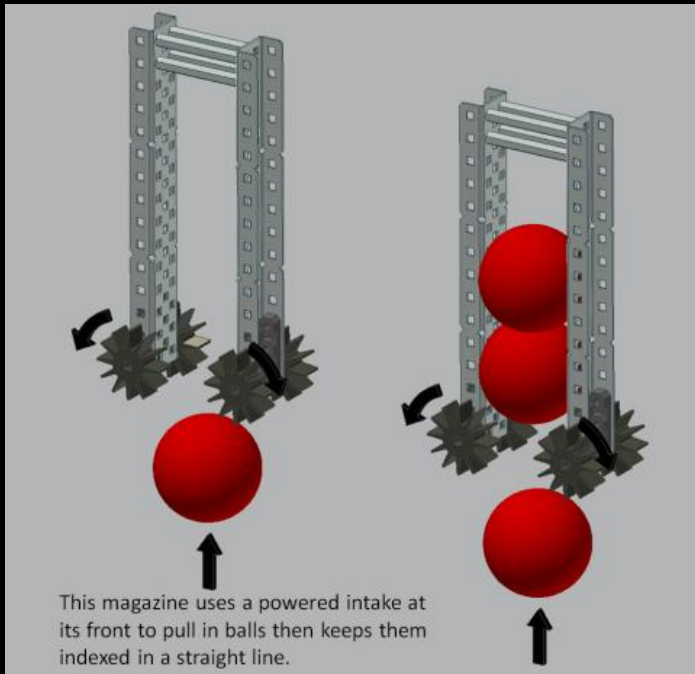


# Conveyor Belts Pros and Cons

- Advantages –
- Can move objects horizontally or lift them vertically.
- Requires a low to medium torque application.
- Disadvantages-
- Takes up a large volume on the robot, can raise the center of gravity of the robot
- Summary: More complex than a claw, but lets you control more than one scoring element at a time.



# Accumulators



# Side Gatherer



# Referee Training Break

- The Protected Area
- Causing Opponents to Violate a Rule

# 11:30 Programming Autonomous

- Programming Autonomous Discussion
- Modify an autonomous programs on the field.
- Open in RobotC
  - Training Samples
  - Moving Forward

# Simple Sample Autonomous

- task main()
- {
- bMotorReflected[port2] = 1;
- motor[port3] = 127;
- motor[port2] = 127;
- wait10Msec(10);
- }

# Go forward until the touch sensor is touched.

Plug a touch sensor into port 1.

```
#pragma config(Sensor, in1, touchSensor, sensorTouch)

task main()
{
    wait1Msec(2000); //Robot waits for 2000 milliseconds
    bMotorReflected[port2] = 1; //Reflects the direction of the motor on port2
    while(SensorValue(touchSensor) == 0)
    {
        motor[port2] = 63; //Motor on port2 is run at half (63) power forward
        motor[port3] = 63; //Motor on port3 is run at half (63) power forward
    }
    motor[port2] = 0;
    motor[port3] = 0;
}
```

# 12:00 Lunch

- Thank you  
Oregon  
Computer  
Science  
Teachers  
Association!!





# 1:00 pm Programming Driver Controlled Period

- Test
  - Scoring a match
- 

# Simple Sample Joystick

- task main()
- {
- bMotorFlippedMode[port2] = true;     //Port 2 Motor Direction Flipped
- blfiAutonomousMode = false; //Can leave off on Cortex
- while (1 == 1)                     //Creates and infinite loop
- {
- motor[port2] = vexRT(Ch2);     //The right motor is set to  
  //equal the value transmitted by  
  //Ch2 (y-axis of the right joystick)
- motor[port3] = vexRT(Ch3);     //The left motor is set to equal  
  //the value transmitted by Ch3  
  //(y-axis of the left joystick)
- }
- }

# Dual Joystick

- task main()
  - {
    - bMotorFlippedMode[port2] = true; //Port 2 Motor Direction Flipped
    - blfiAutonomousMode = false; //Can leave off on Cortex
    - while (true)
      - {
        - motor[port1] = vexRT(Ch2);
        - motor[port2] = vexRT(Ch3);
        - motor[port3] = vexRT(Ch2Xmtr2);
        - motor[port4] = vexRT(Ch3Xmtr2);
      - }
    - }

# 1:30 Competition Template


- Open Competition Template
  - File -> New -> Competition Template
  - Copy Autonomous code into Template
  - Copy Driver Controlled Code into Template
- Test
  - Templates\Competition Template
  - Modify Autonomous Duration to 15
  - Modify userControlDuration to 105

# 2:00 Technical Inspection/ Practice Matches

- Technical Inspection/ Practice Matches
- [Referee Training Video: Scoring a Match](#)
- Robot Skills
  - One robot, all elements, one minute
- Practice 2v2 Matches
  - 2v2, 15 Second Autonomous. 1:45 Driver Controlled
- Programming Skills?
  - One robot, all elements, one minute



# 3:15 Clean up

- Thanks for coming
  - 3:30 Closing
- 

# VEX Schedule for Oregon

- 11/15/2014 VEX Tournament Phoenix, High School
- 12/6/2014 VEX Tournament at West Salem
- 12/13/2014 VEX Skills Challenge Event at North Marion
- 1/10/2015 VEX Tournament at Evergreen Space Museum
- 1/24/2015 VEX Tournament at West Salem
- 2/7/2015 VEX Tournament at Dallas High School
- 2/14/2015 VEX Tournament at Sandy High School
- 2/21/2015 VEX Tournament at Redmond High School
- 2/28/2015 VEX Tournament at Dallas HS
- **3/6-3/7/2015 VEX State Championship: North Marion High**
  - **Winning Alliance, Excellence and Robot Design Advance to Worlds**
  - **Middle School Excellence Winner advances to Worlds**
- 4/15-4/18/2015 VEX World Championship Louisville, KY



# References

- [www.simplerobotics.org](http://www.simplerobotics.org)
  - <http://curriculum.vexrobotics.com/curriculum>
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