



SuperQuest Salem

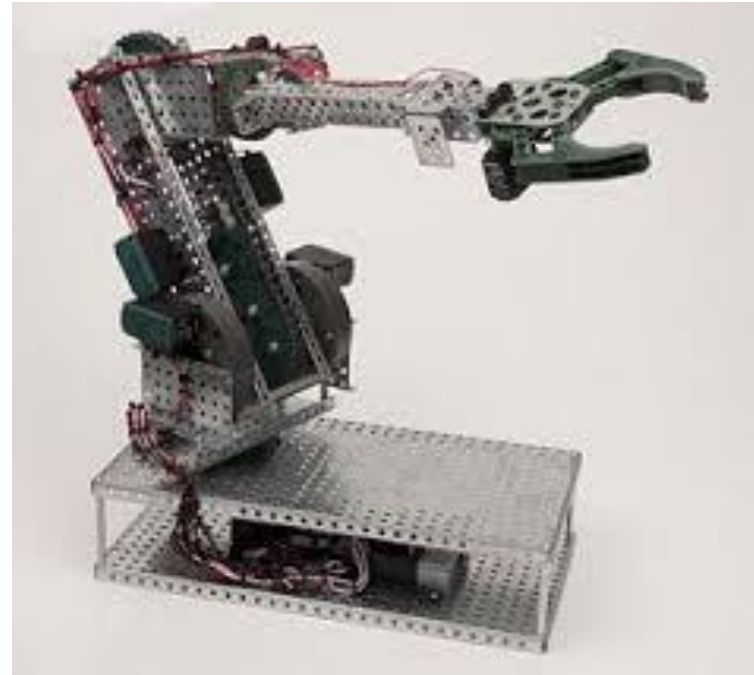
Arms – Best Practices

vEXEDR



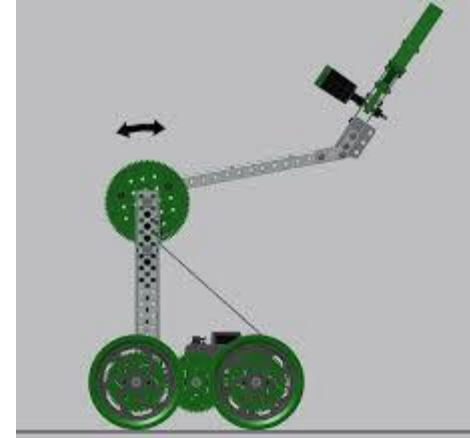
VEX Arm Designs

- Single
- 4-Bar
- 6-Bar
- 8-Bar
- Linear Slide
- Scissor
- Double Reverse 4-Bar

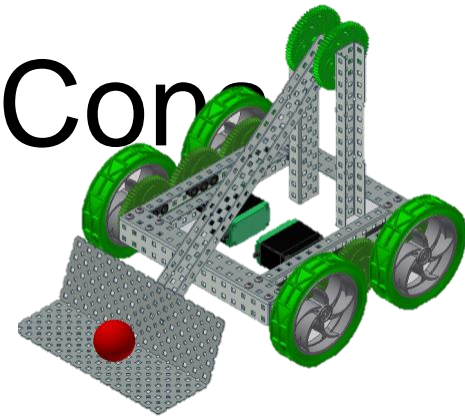


Single Arms

- **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.



Simple Arm Pros and Cons



- **Advantages –**

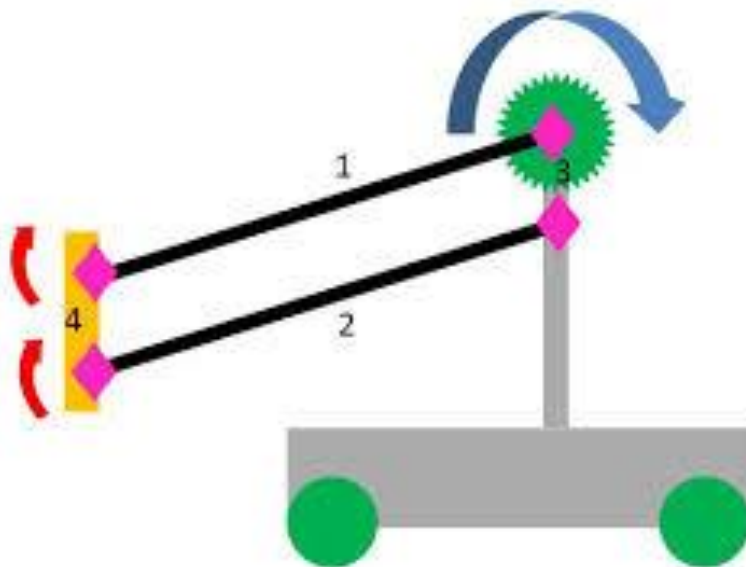
- Lifts an object from the field surface.
- Relatively easy to design and construct.
- Can be designed to pivot from one side of the robot, over the top to the other side of the robot.

- **Disadvantages –**

- Easy to create a design with a high to very high torque situation which can lead to broken drive shafts, stripped gears, broken drive chains, stripped lock plates, etc.
- 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.



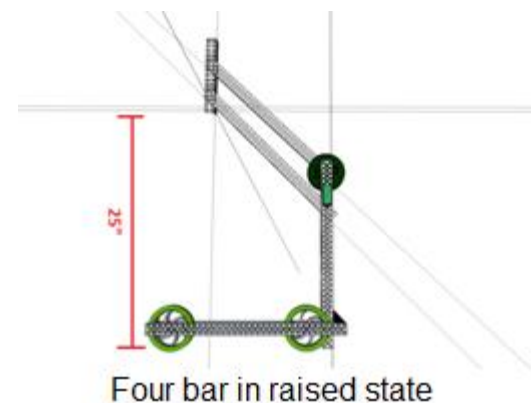
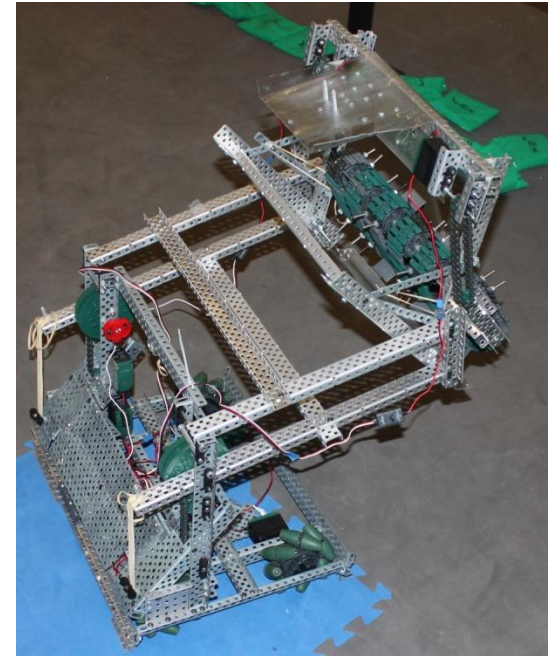
Four-Bar Linkages Pros and Cons

- **Advantages –**

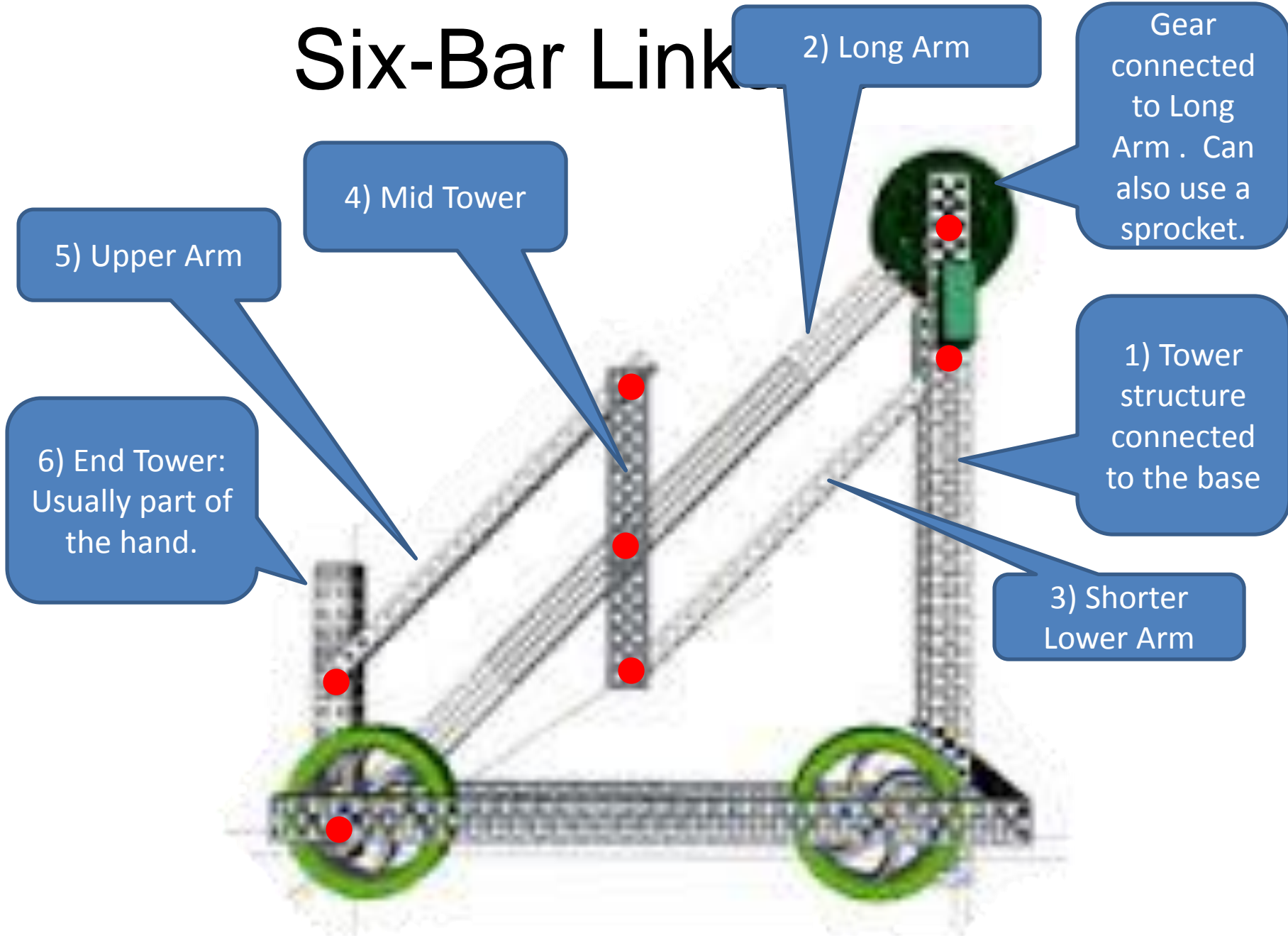
- The orientation of an object can be changed in respect to the arm as it is pivoted up.
- Elastic forces can be added between the linkages to reduce the amount of force the activator needs to apply.

- **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 Link



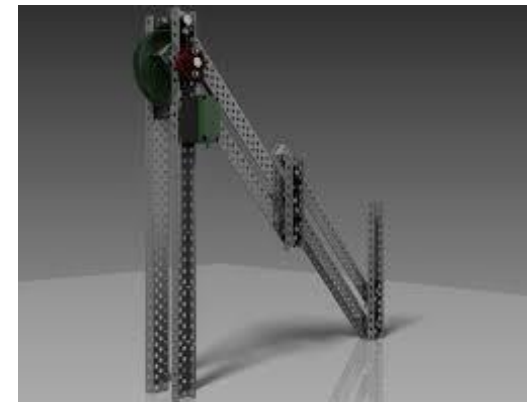
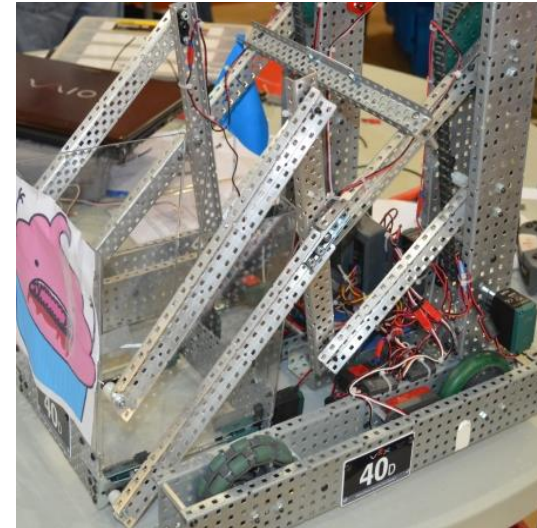
Six-Bar Linkages Pros and Cons

- Advantages –

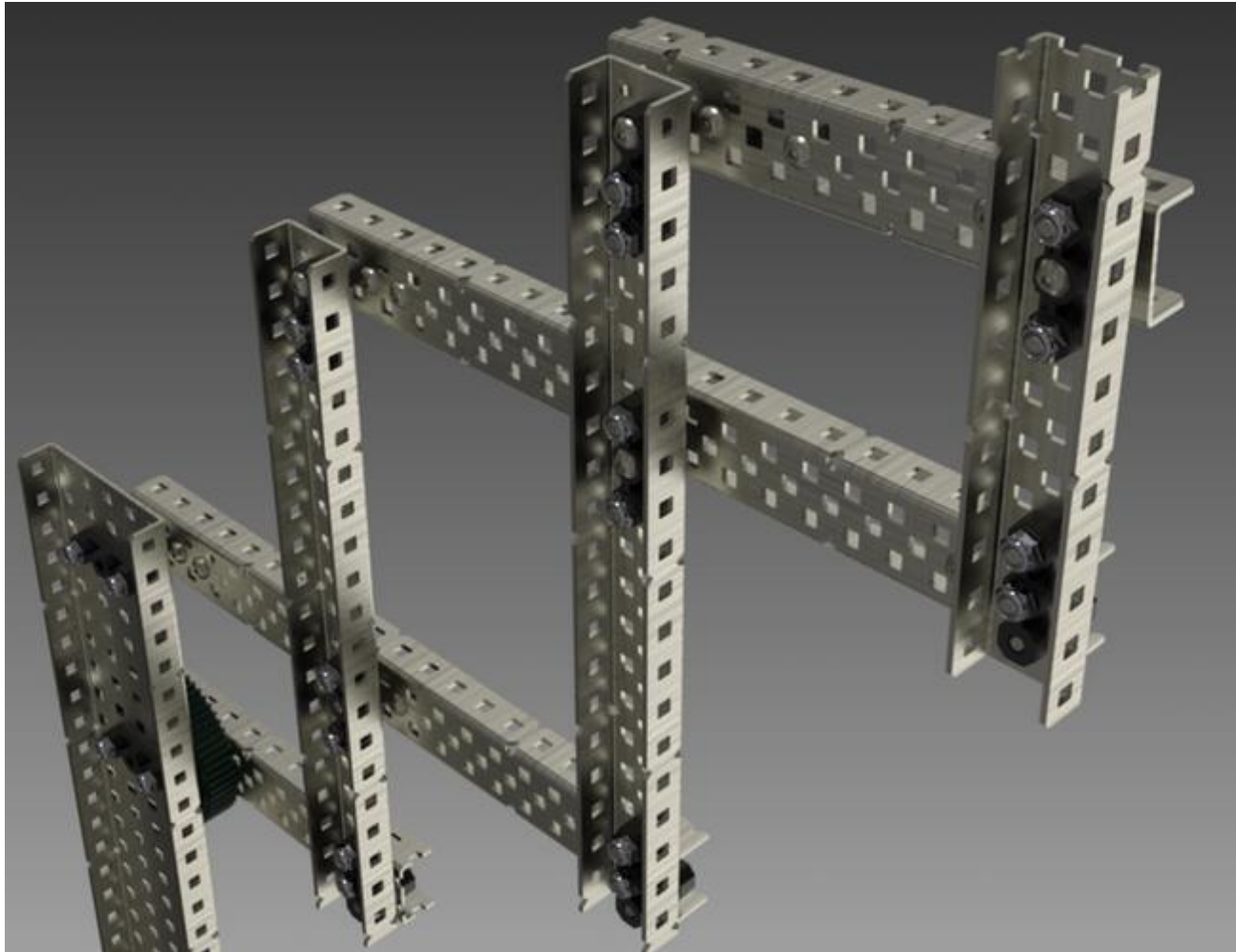
- The orientation of an object can be changed in respect to the arm as it is pivoted up.
- Elastic forces can be added between the linkages to reduce the amount of force the activator needs to apply.

- Disadvantages –

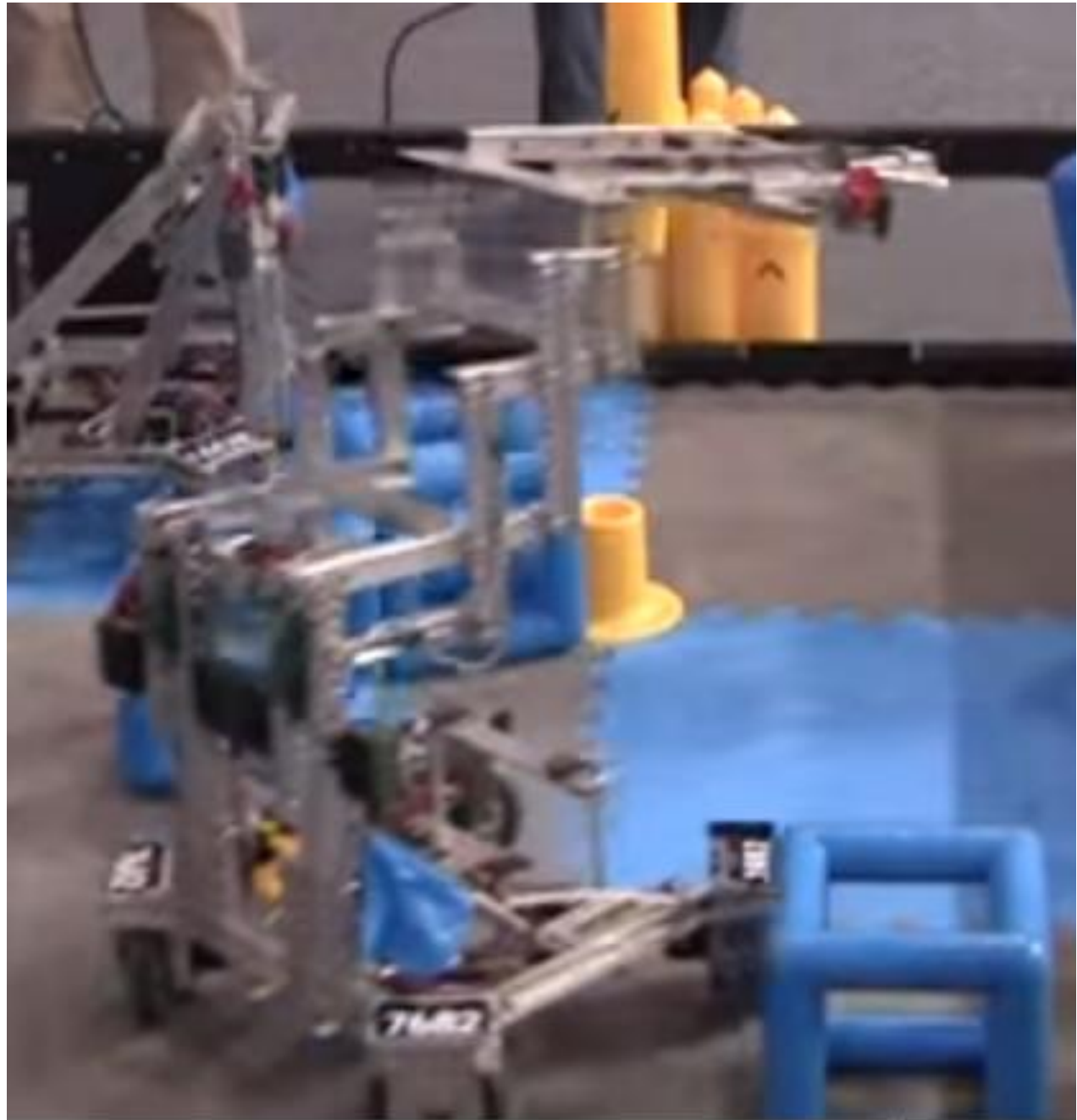
- Easy to create a design with a high to very high torque situation
- Back dive.
- The amount of pivot is limited by the distance between the arms. Can not rotate from one side of the robot over to the other side.
- Creates a changing and higher center of gravity when lifted
- Summary: A four-bar linkage on steroids. You can lift higher, but it is a bit more complex to build



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

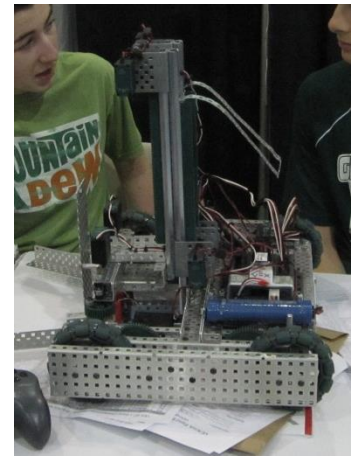


8-Bar Sample



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

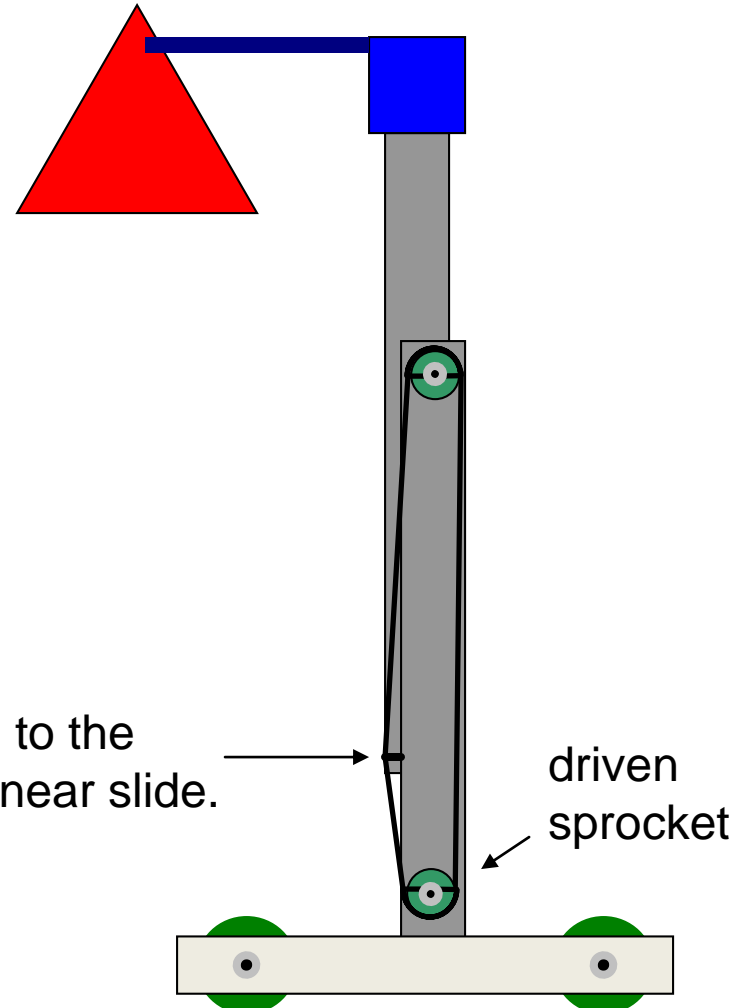
The motor rotates the chain.

The linear slide is attached to the chain.

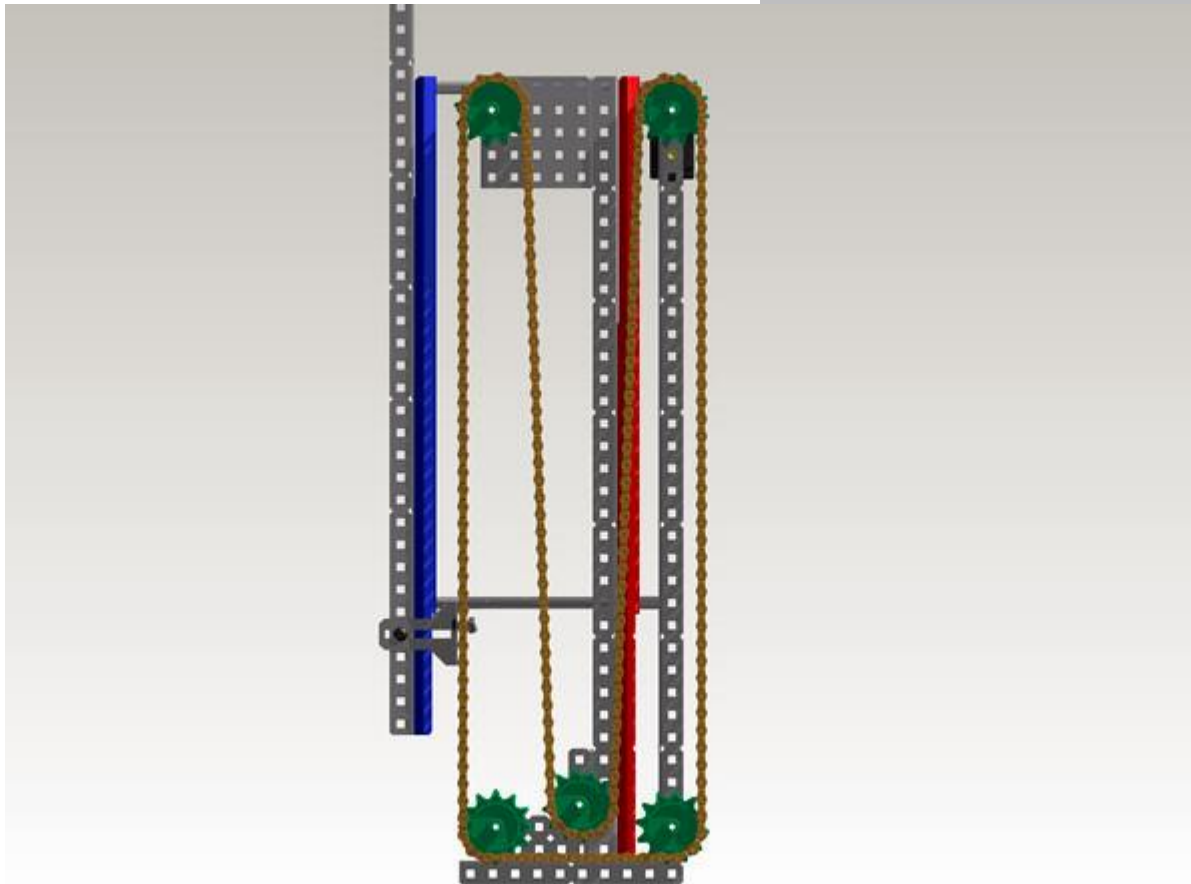
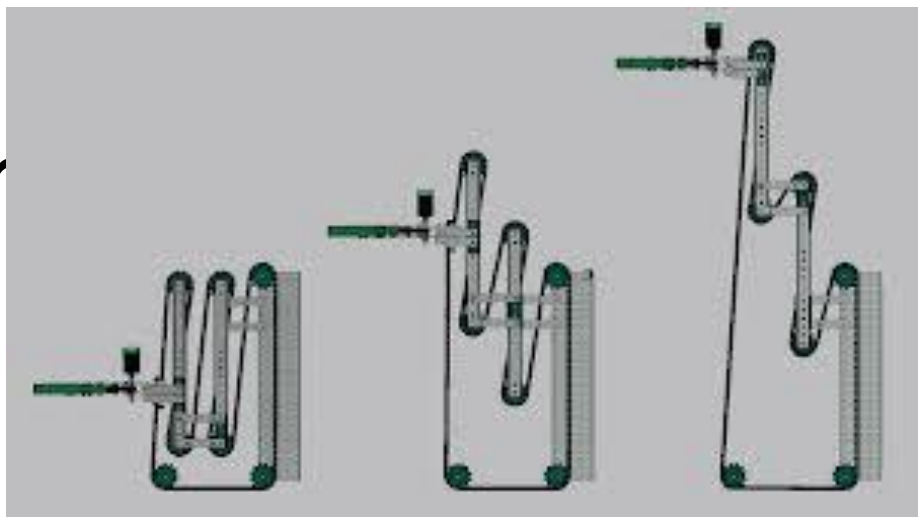
The linear slide is pulled up and down by the chain.

Cable tie chain to the bottom of the linear slide.

driven sprocket

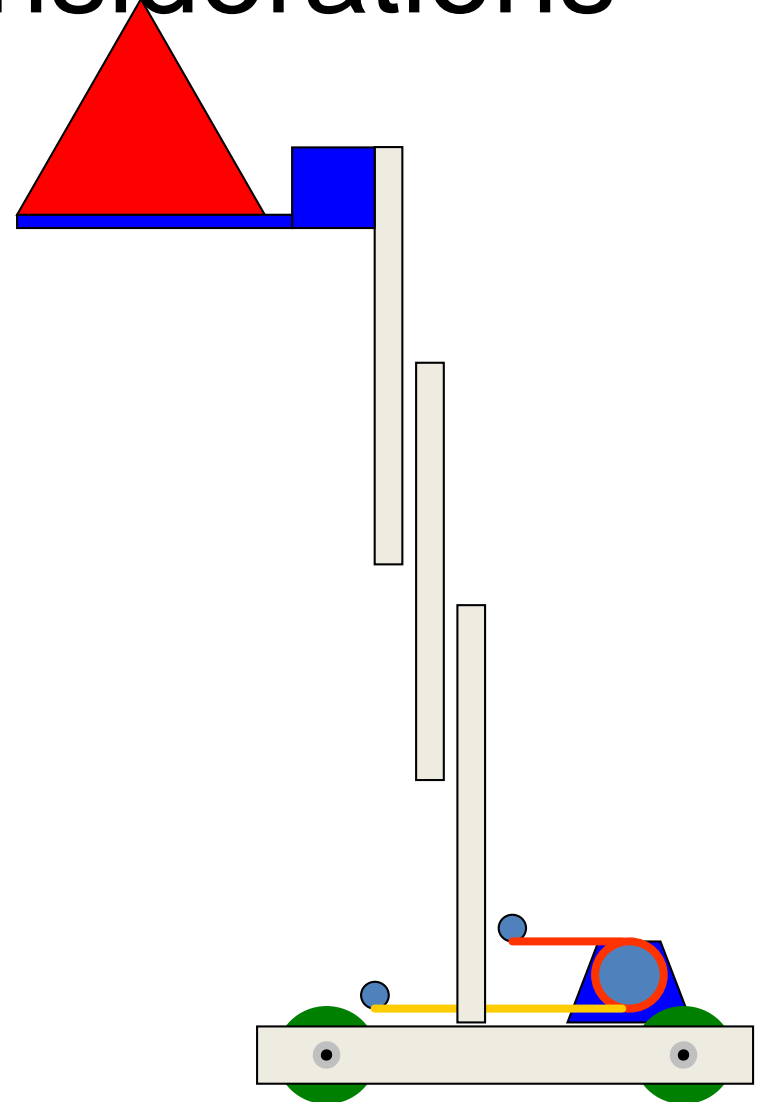


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Extension Lift Considerations

- 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



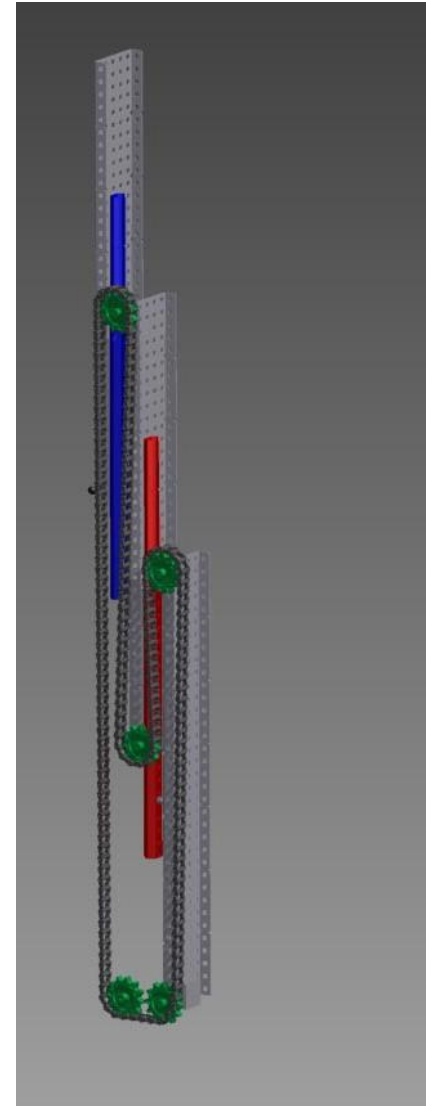
Linear Slide Pros and Cons

- Advantages –

- Very effective linear lift from floor surface.
- Linear motion kit has very little sliding friction.
- 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.



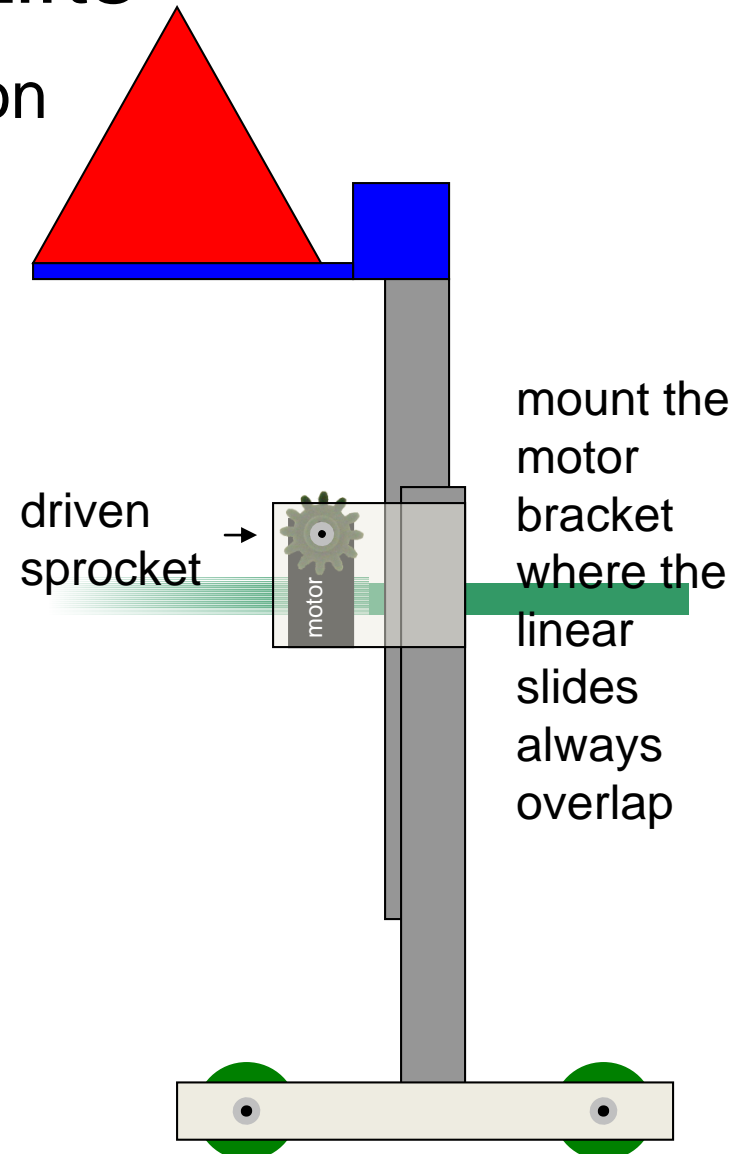
Extension Lifts

Rack & Pinion

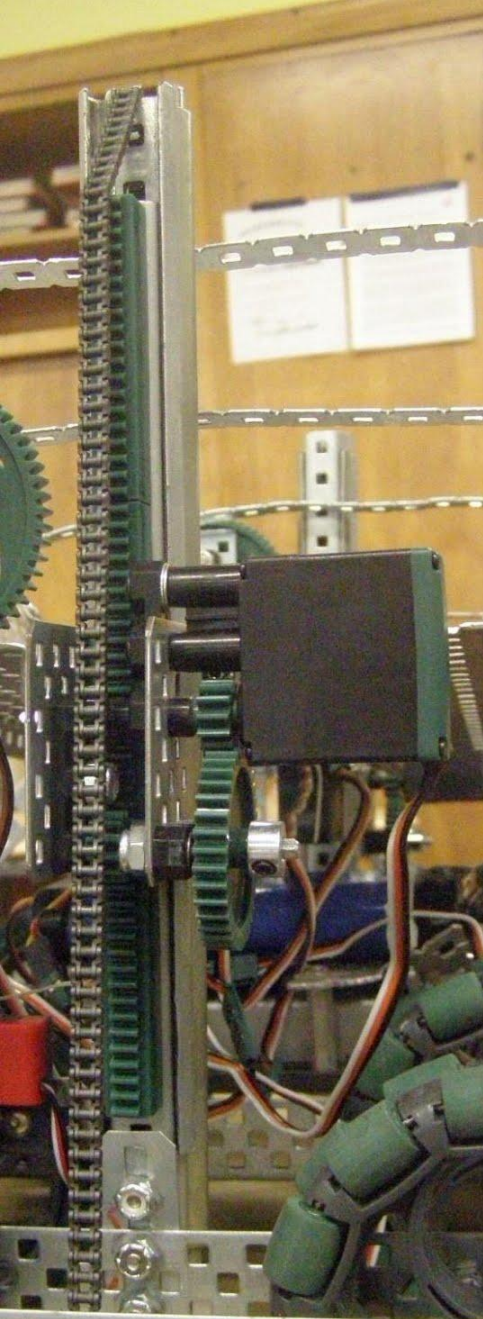
The rack is attached to one linear slide.

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

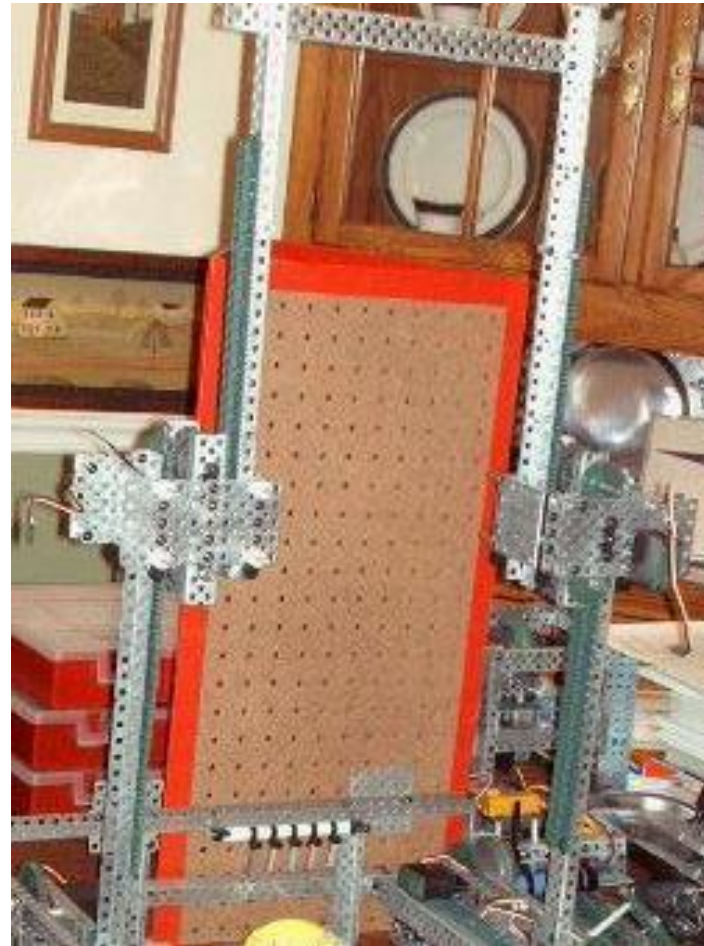
The driven gear must be mounted where the linear slides always overlap.



Rack & Pinion Lift



Lab Rats' 2008 Bridge
Battle Robot

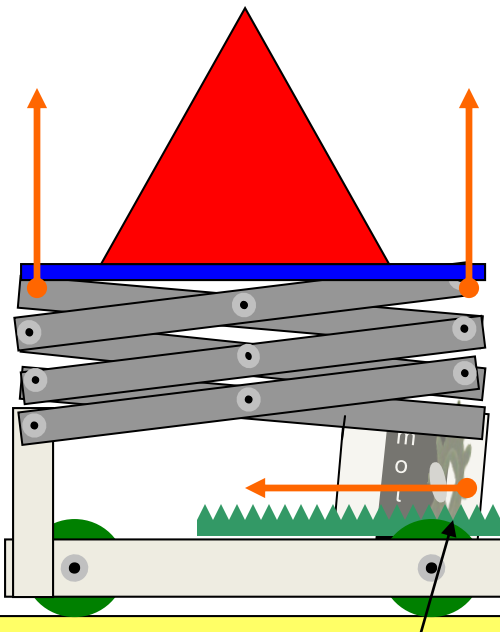


posted on www.vexforum.com
by 1885.blake

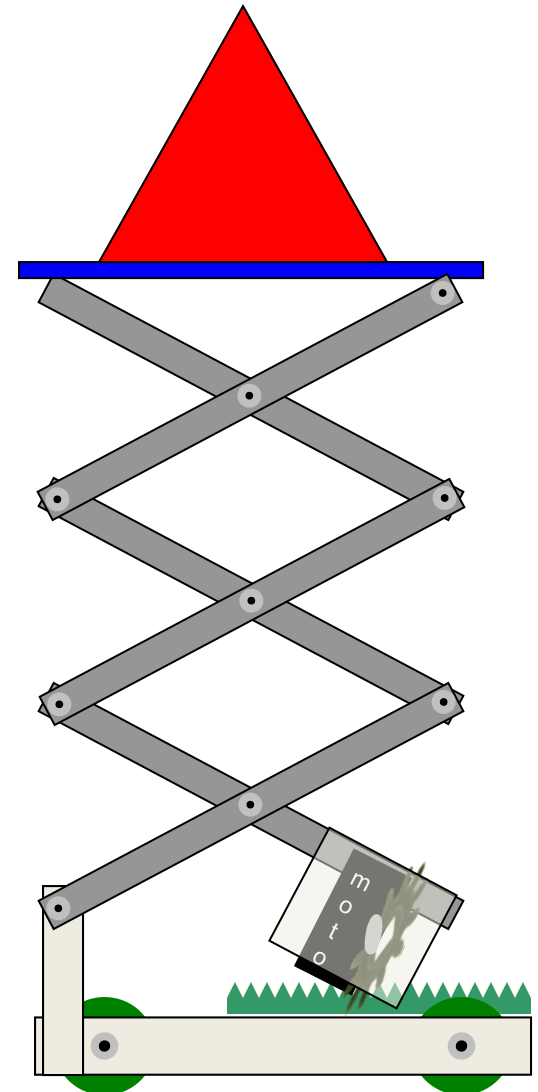
Scissor Lifts

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

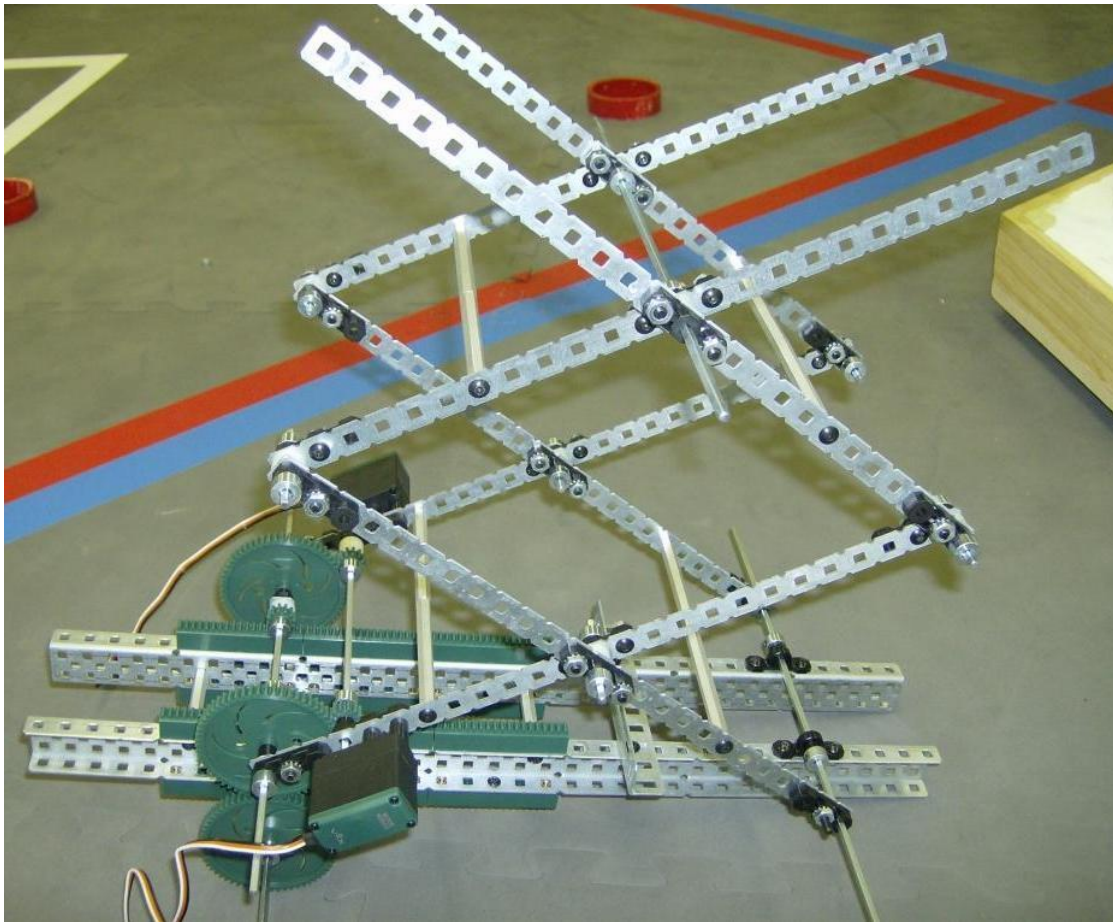
In this example a rack and pinion pulls the bottom of the scissors together.



driven gear



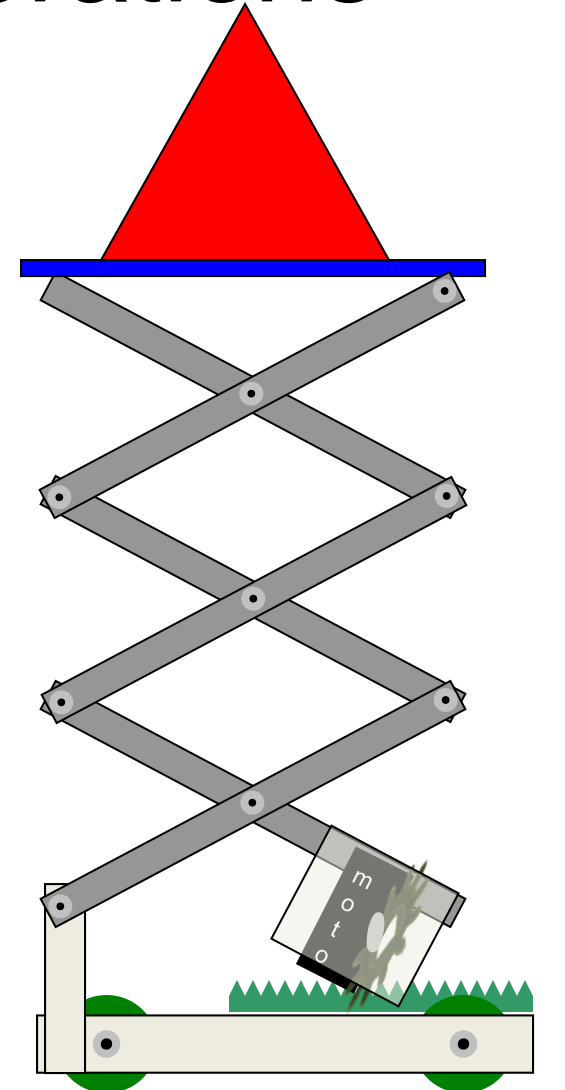
Scissors Lift



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by corpralchee from FVC Team 38

Scissor Lift Considerations

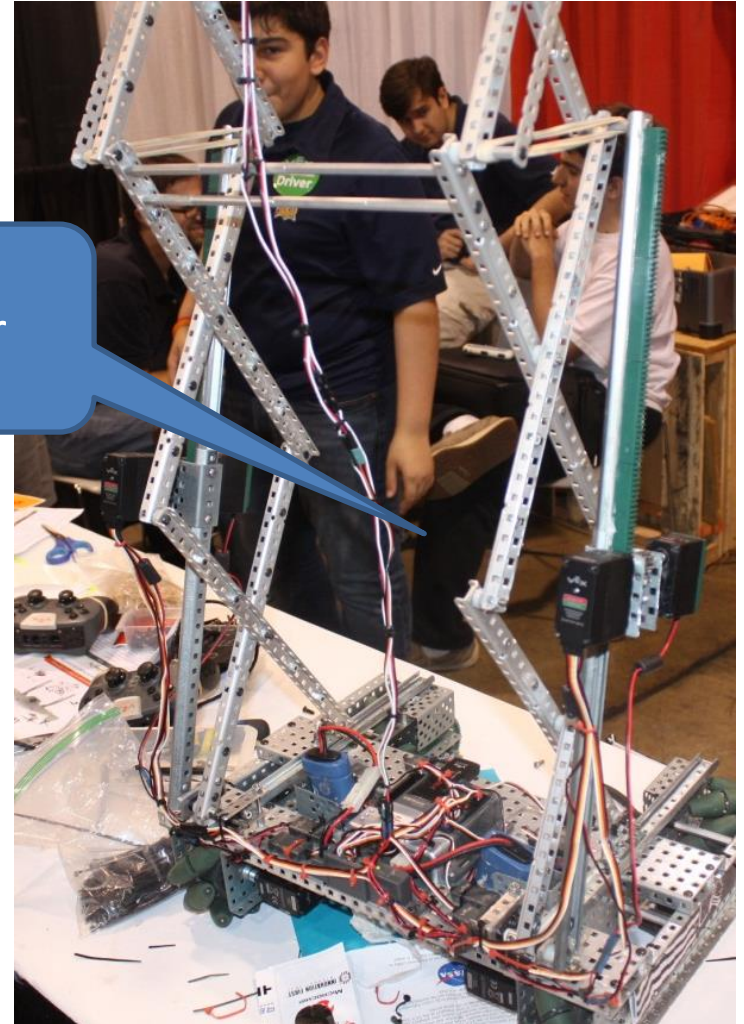
- Advantages
 - Minimum retracted height - can go under field barriers
- Disadvantages
 - Tends to be heavy to be stable enough
 - Doesn't deal well with side loads
 - Must be built very precisely
 - Stability decreases as height increases
 - Loads very high to raise at beginning of travel



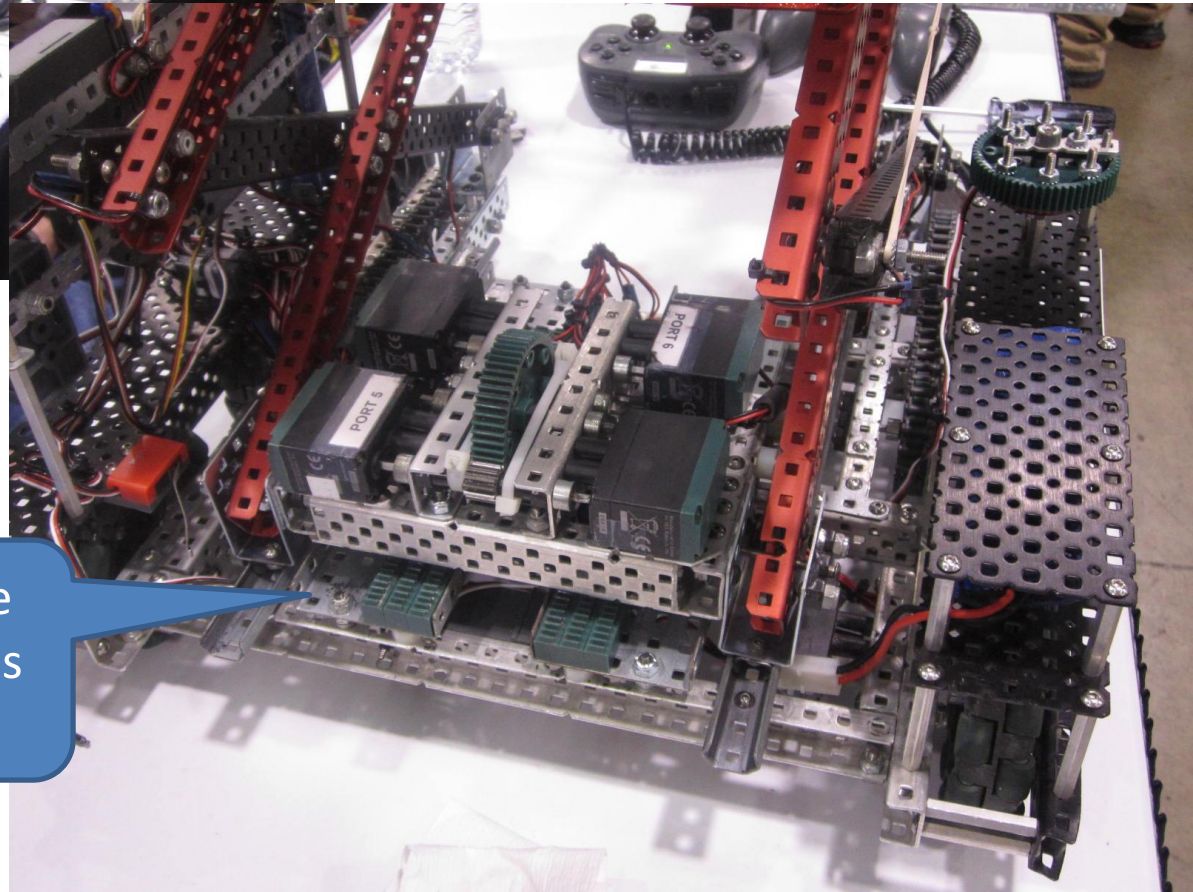
Scissor Lift Example



Rack and
Pinion for
lifting

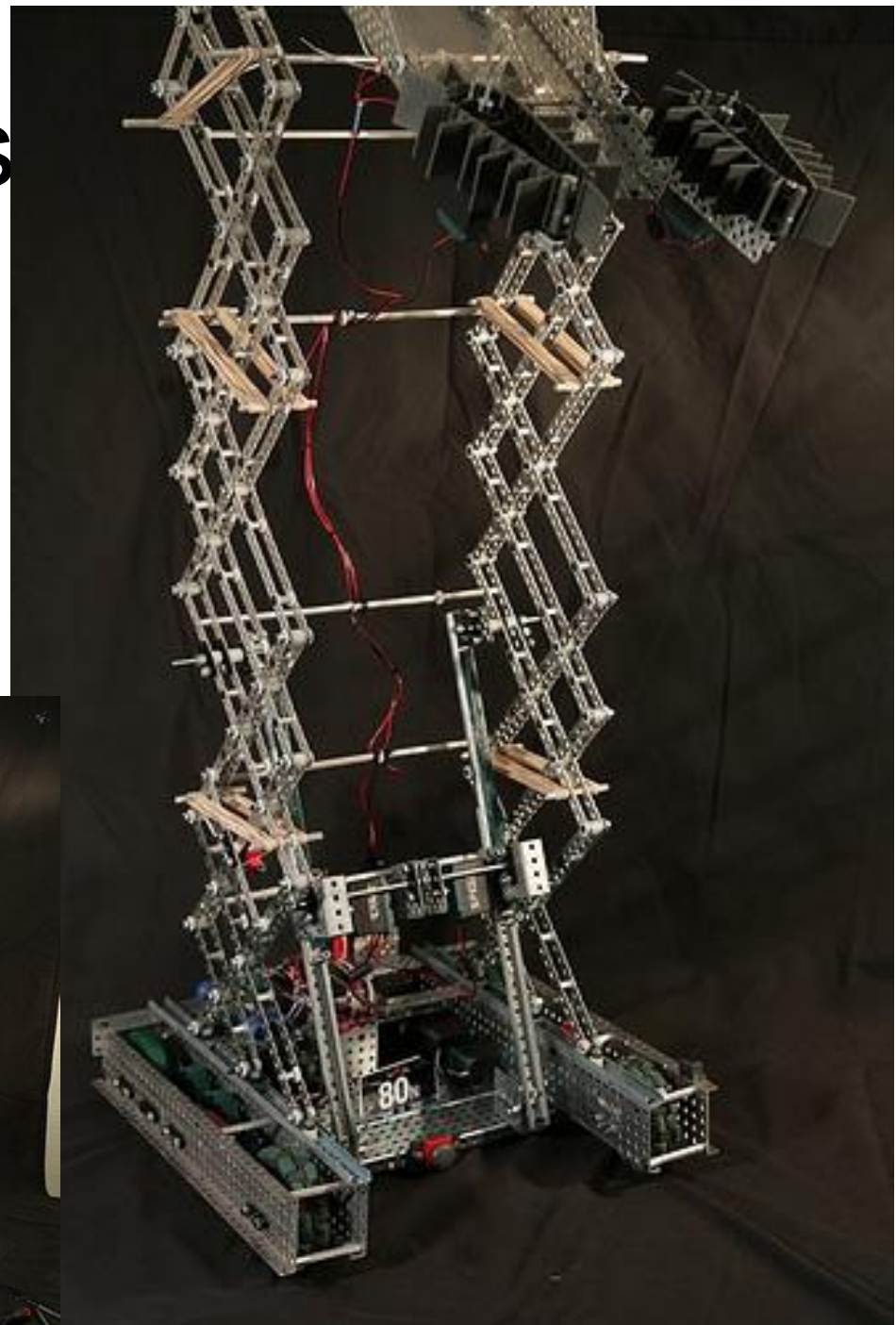


Scissor Lift Example



Motors move the base which moves the arms.

Scissors



Scissor Lift Pros and Cons

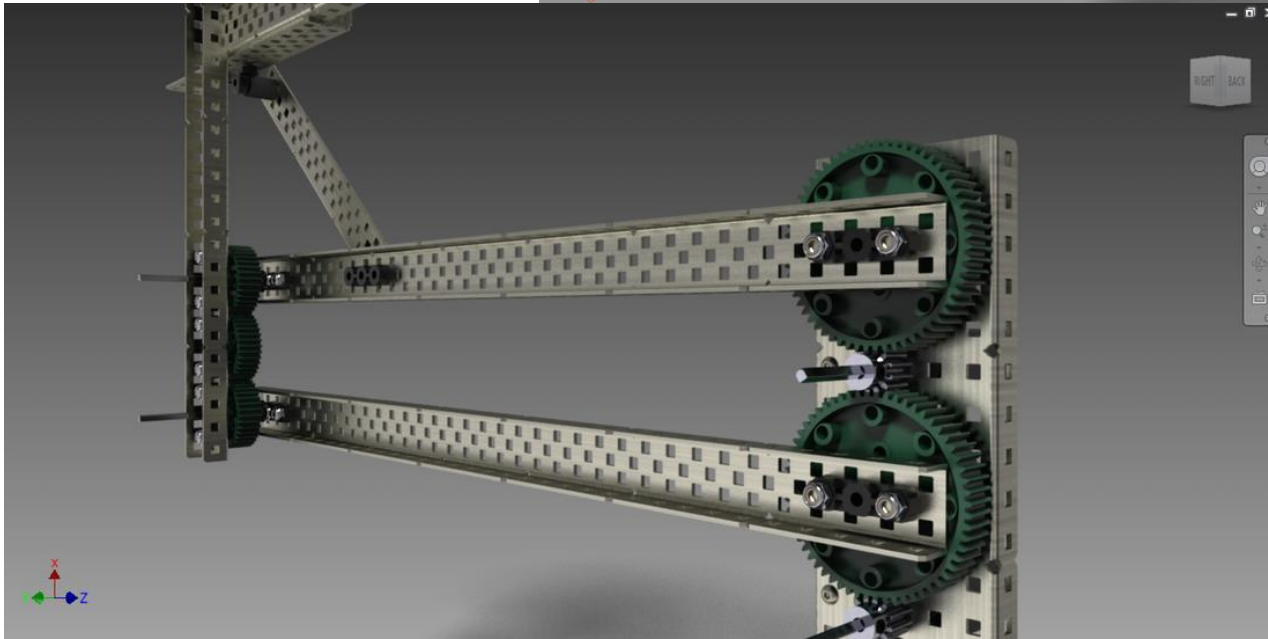
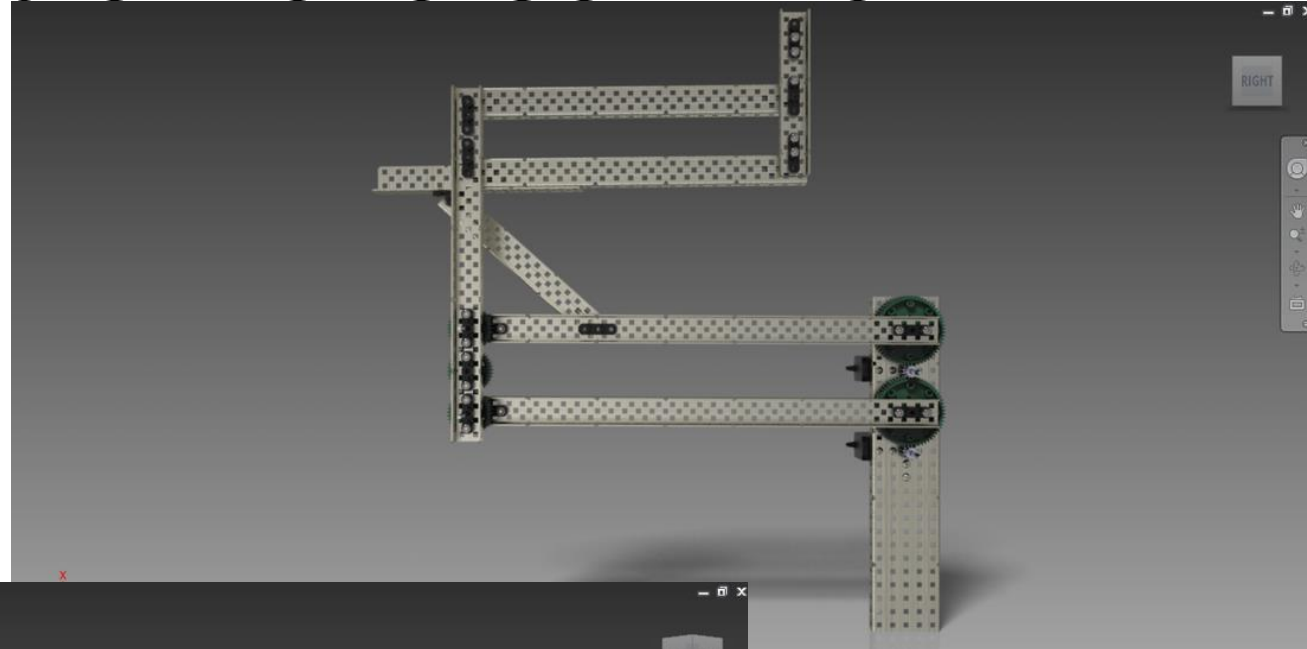
- **Advantages –**

- 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.**

Double Reverse 4-Bar



Double Reverse 4-Bar

