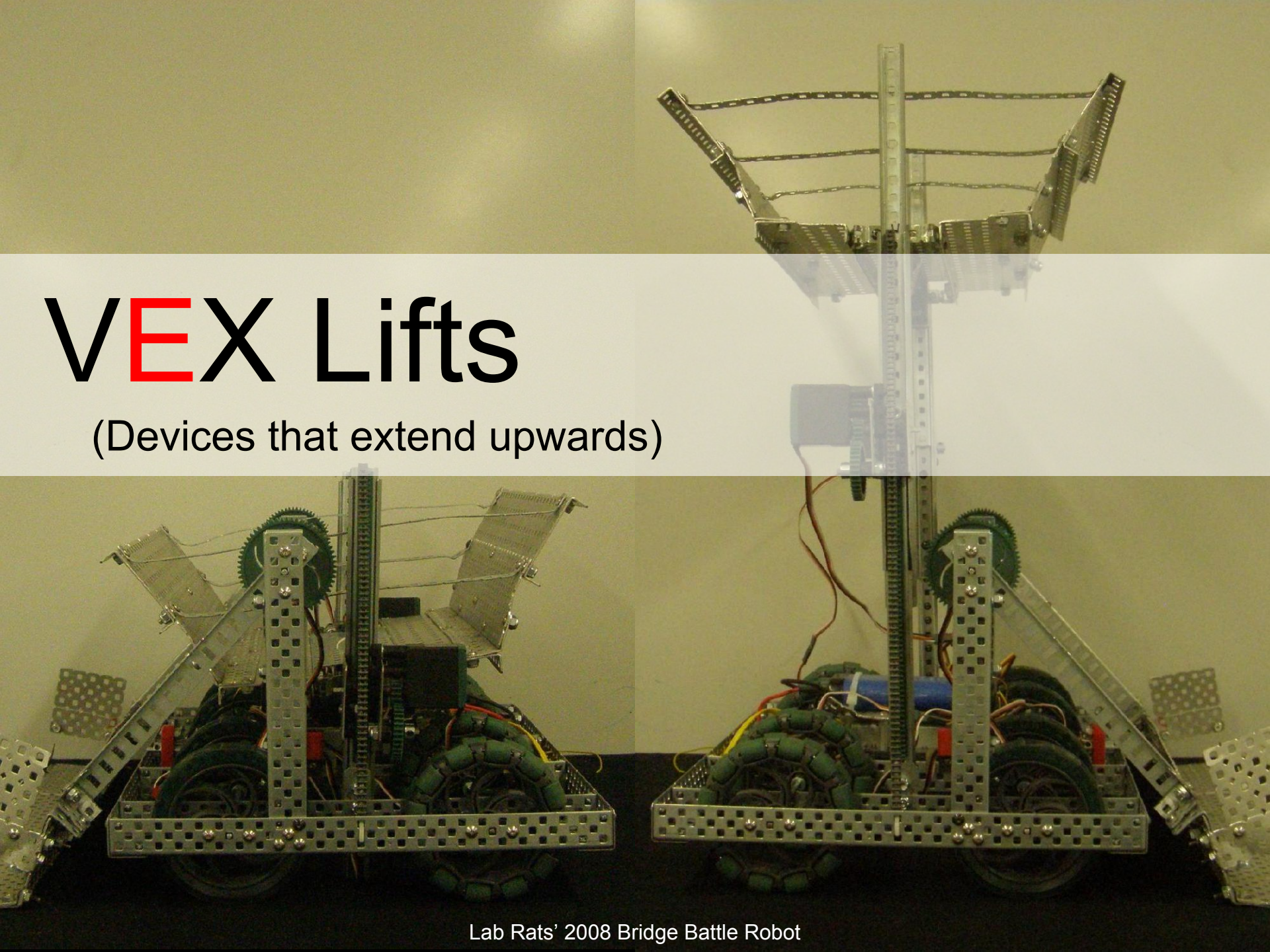
VEX Lifts

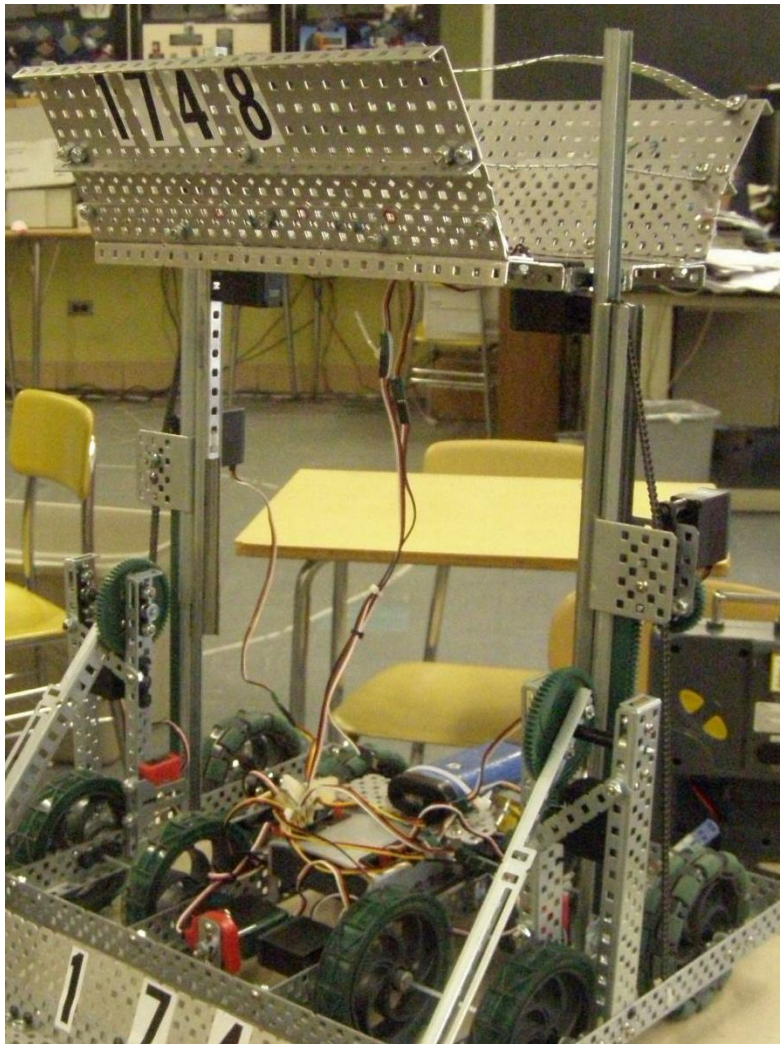
(Devices that extend upwards)



Lab Rats' 2008 Bridge Battle Robot

Outline

- Common Types of Lifts
  - Extension Lifts
    - Rack & Pinion
    - Chain/Cable winch
  - Scissors Lift
- Multi-Stage Lifts
  - Continuous Rigging
  - Continuous Internal Rigging
  - Cascade Rigging
- Challenge
- Advice
  - Limit Switches
- Arms vs. Lifts



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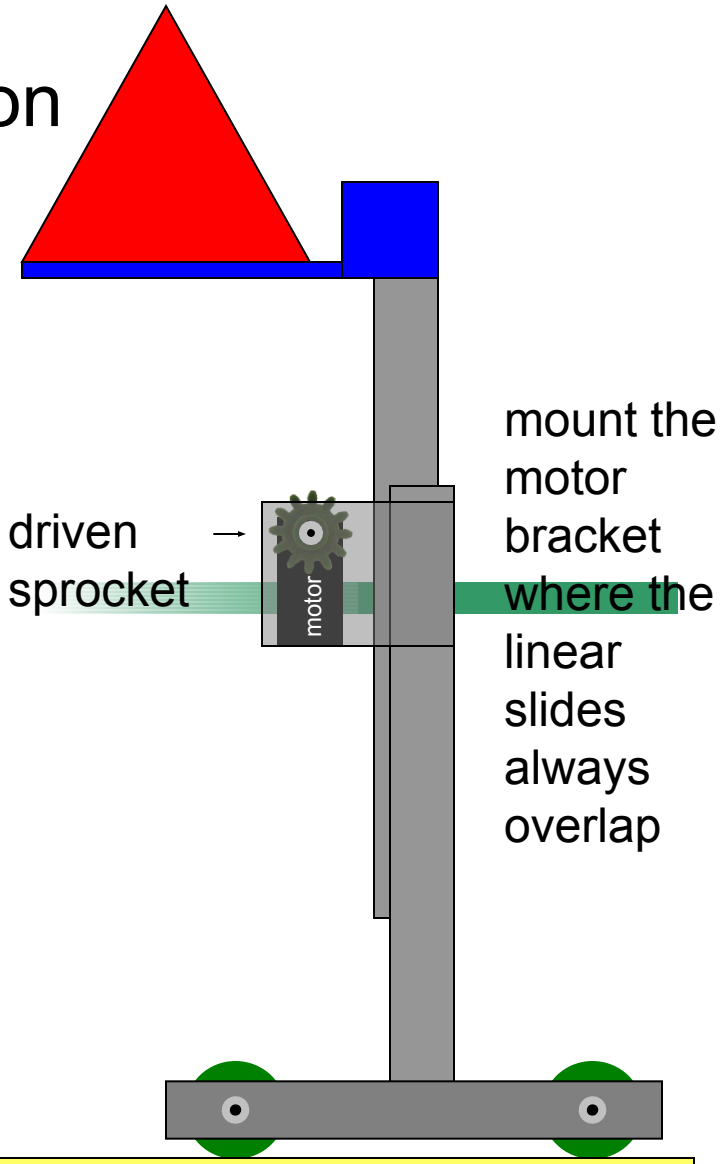
Extension Lifts

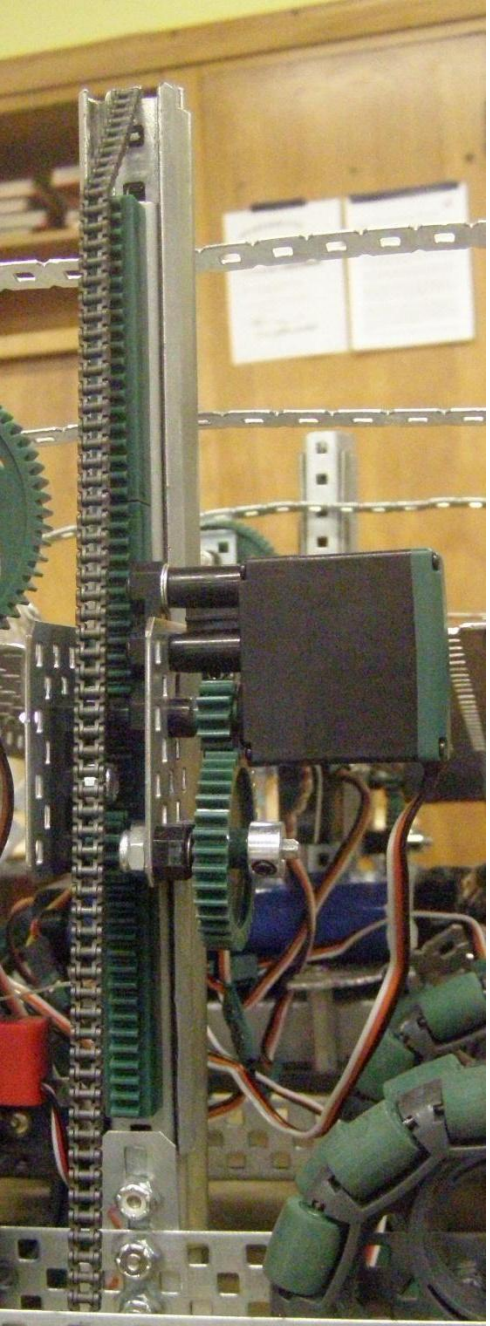
Rack & Pinion

The rack is attached to one linear slide.

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

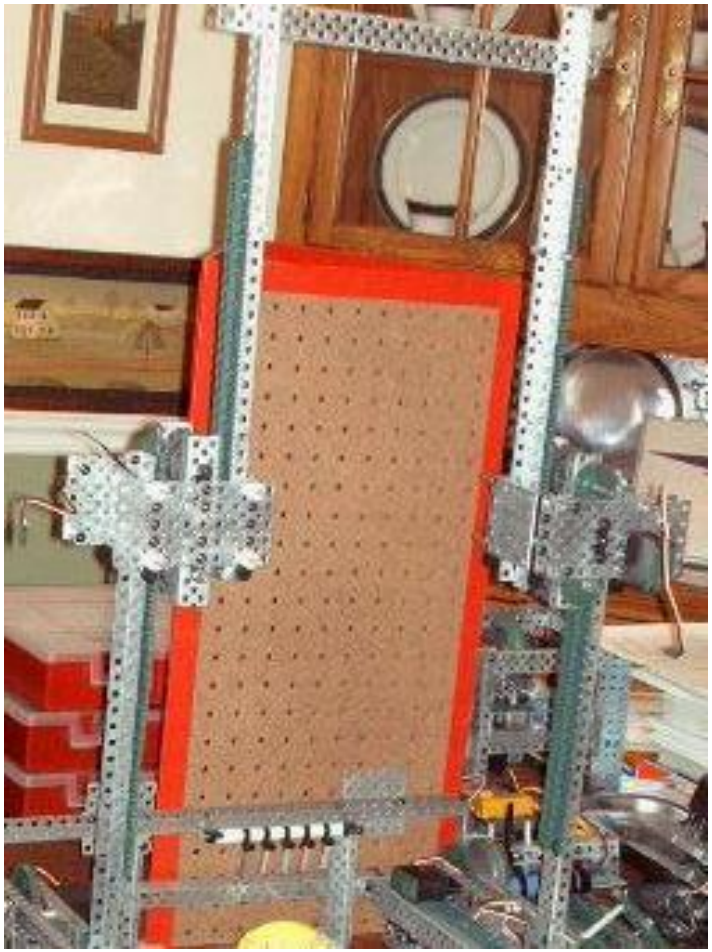
The driven gear must be mounted where the linear slides always overlap.





Lab Rats' 2008 Bridge Battle Robot

Rack & Pinion Lift



posted on www.vexforum.com
by 1885.blake

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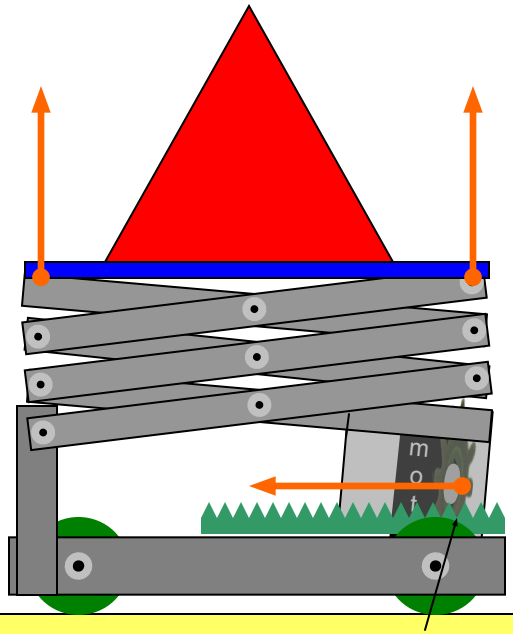
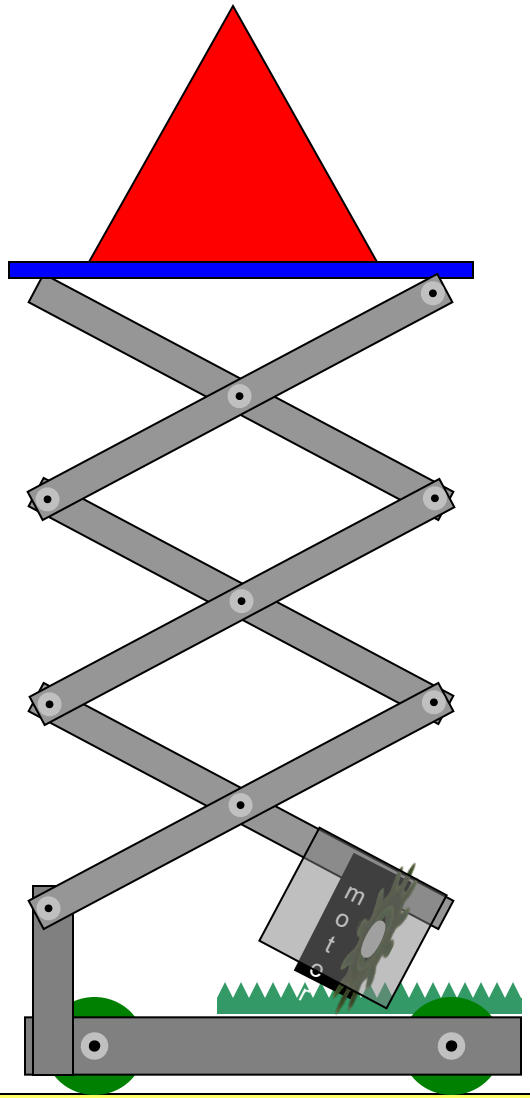
Scissor Lifts

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

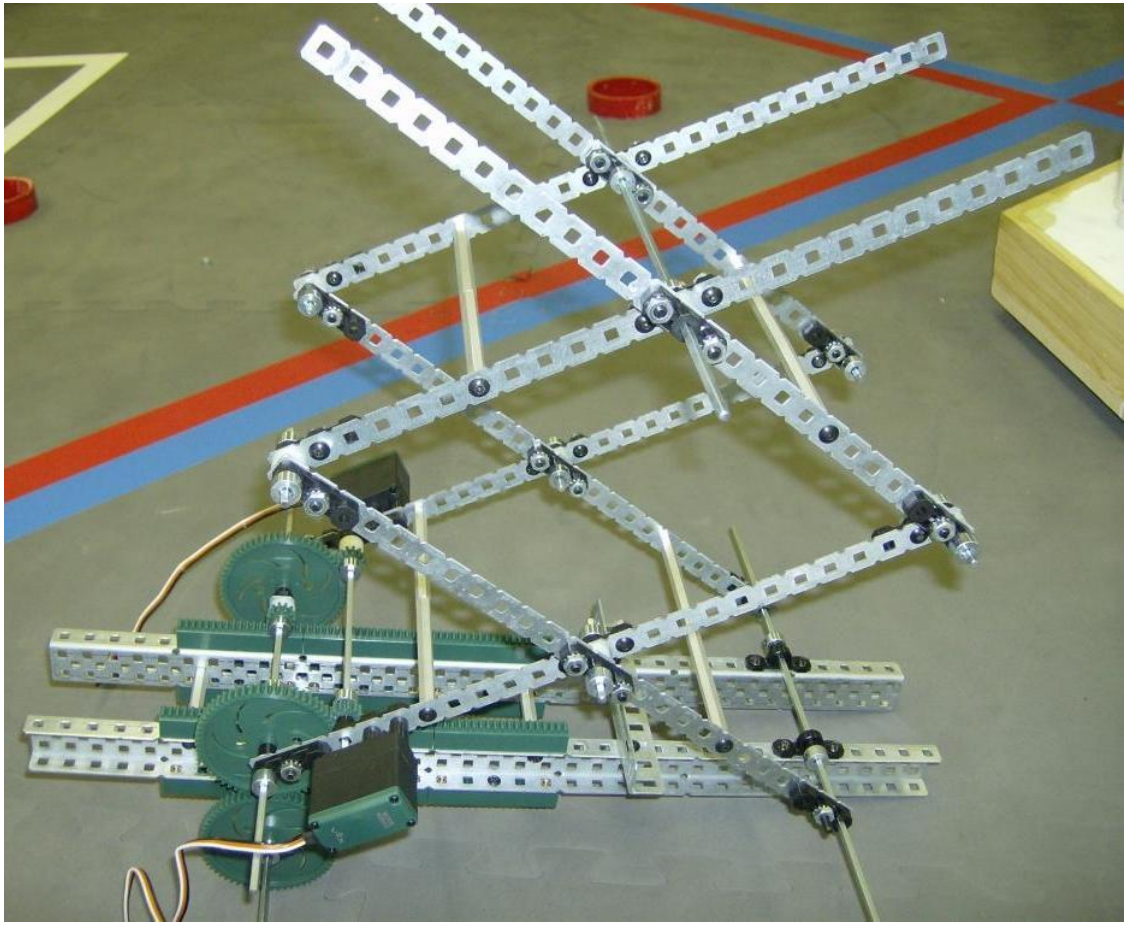
In this example a rack and pinion pulls the bottom of the scissors together.

Scissor lifts work much better with small VEX robots than big FIRST robots.





Scissors Lift



posted on www.vexforum.com
by corpralchee from FVC Team 38

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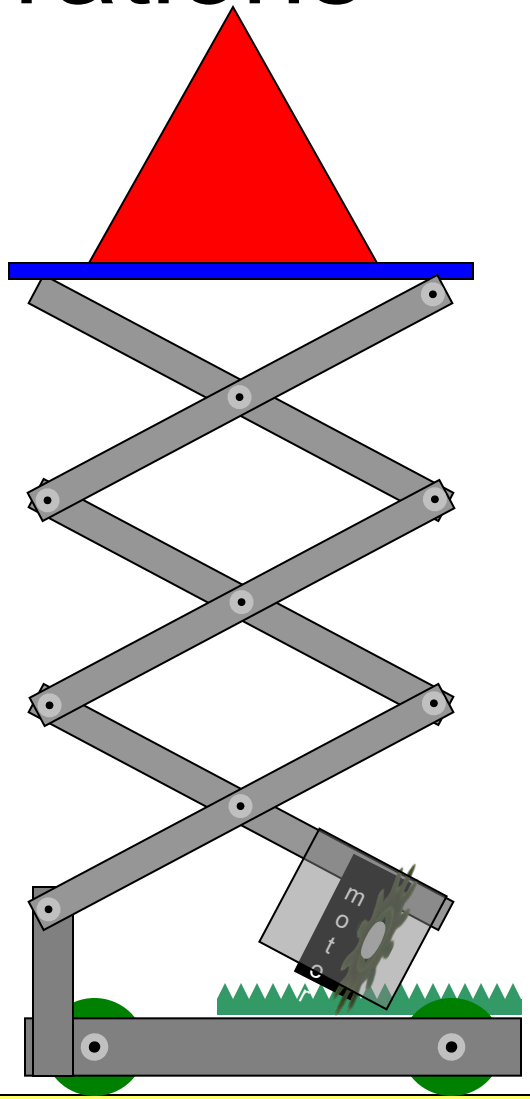
Scissor Lift Considerations

- 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



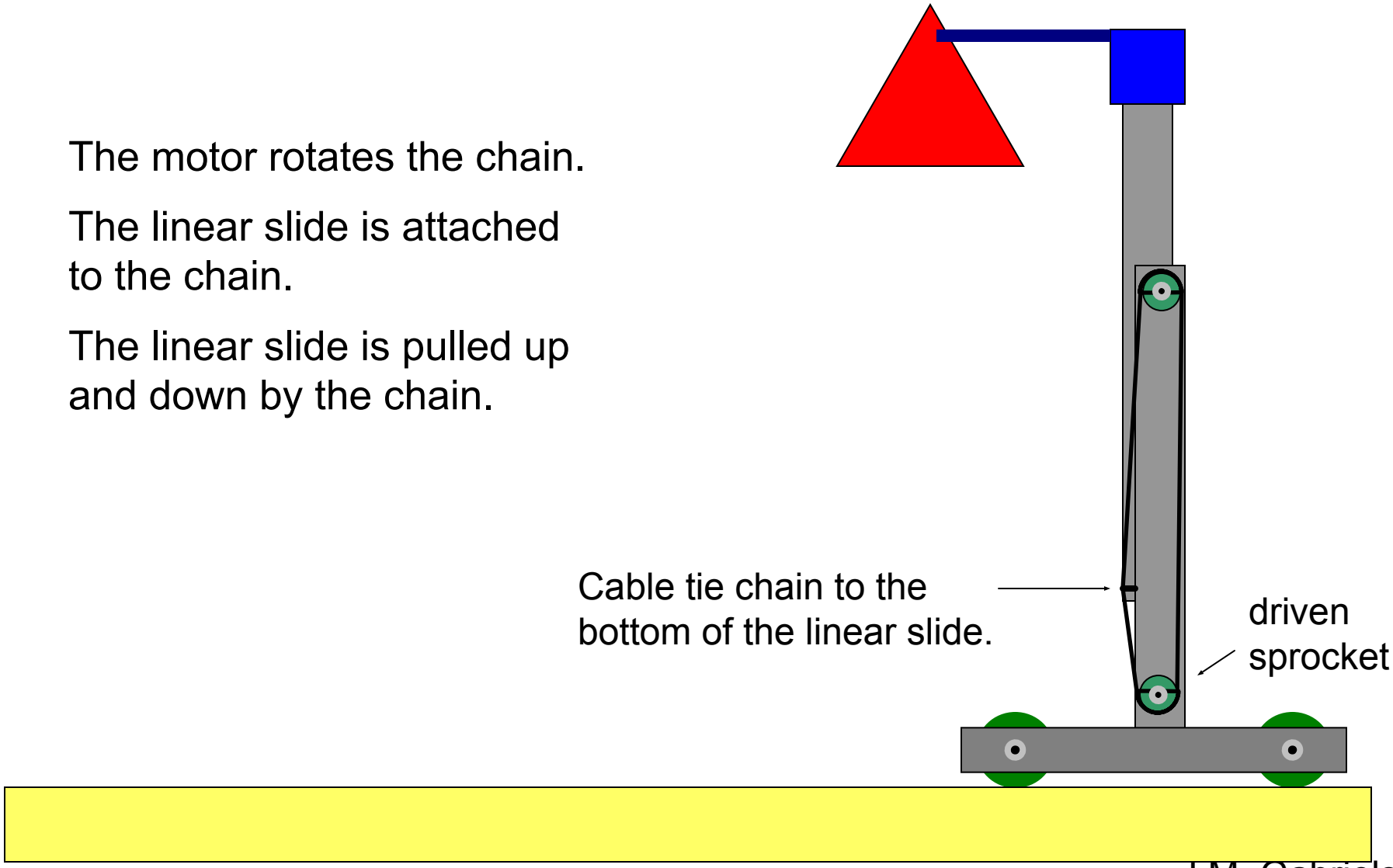
Extension Lifts

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.

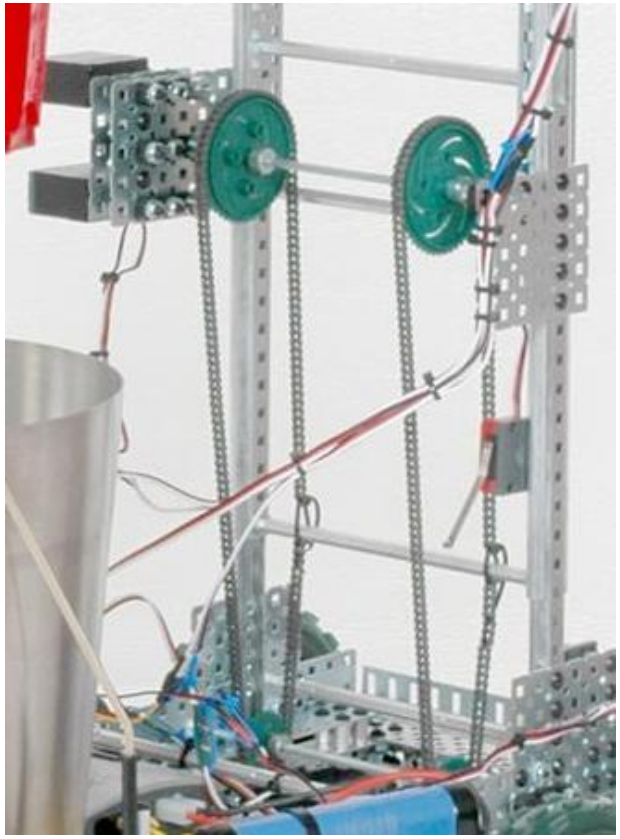


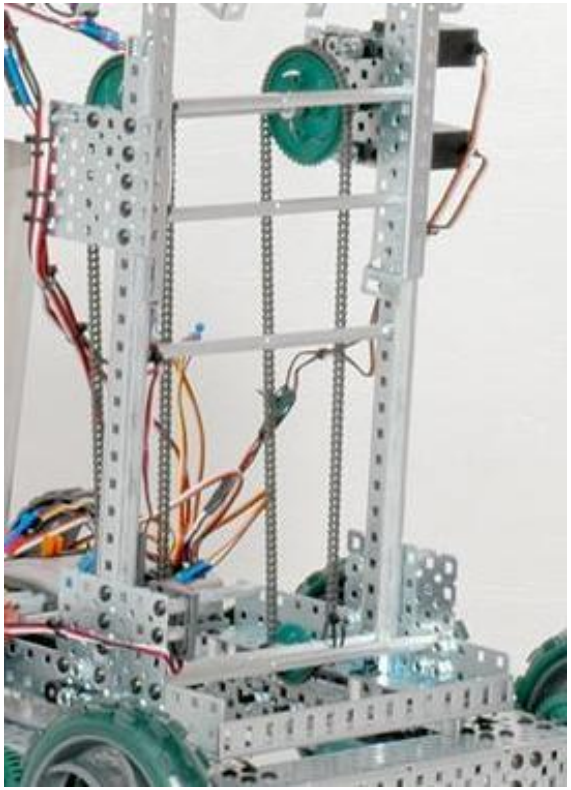
Single Stage Chain Lift

The motors are attached to the robot.

The chain is zip-tied to the lift.

The lift goes up and down with the chain.





CanBot posted on www.vexforum.com by VexLABS

Extension Lifts: Winches

Winches are motorized spools.

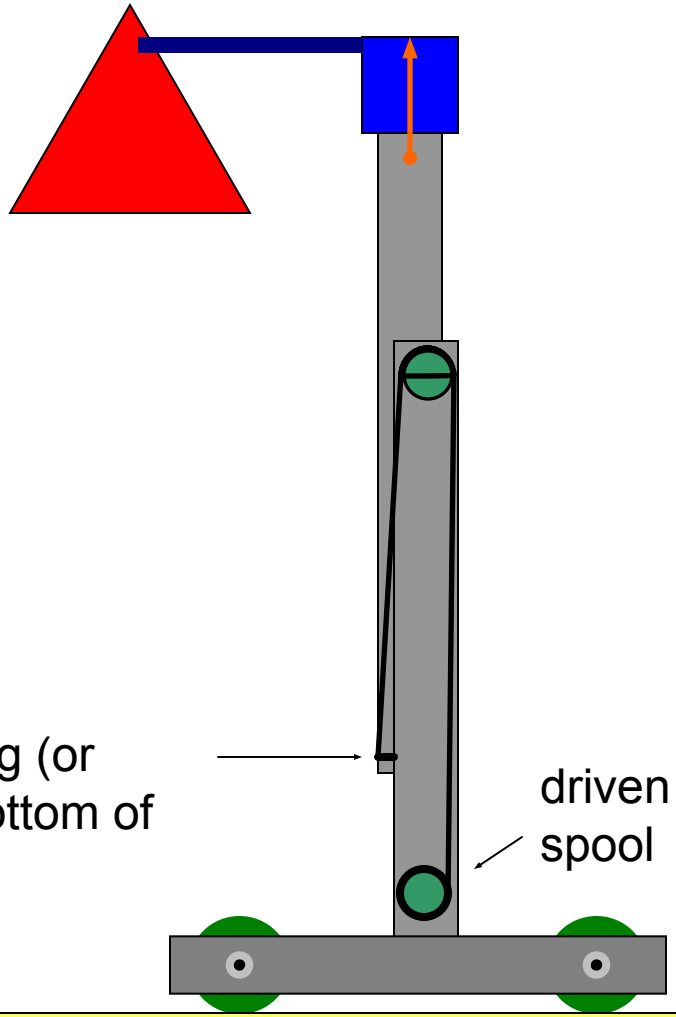
The motor pulls the string by winding it around the spool.

The string is wrapped over a pulley so it pulls up on the linear slide.

Gravity pulls the linear slide back down.

Winding string or chain is very difficult.

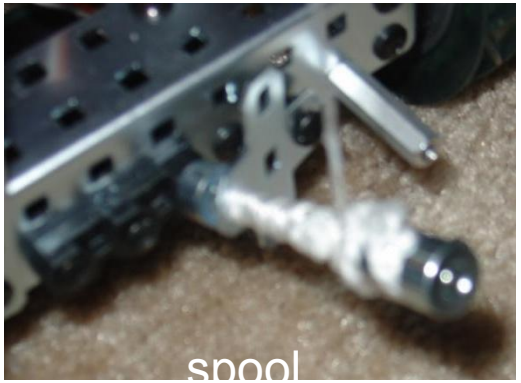
Friction and tangles often make these lifts unreliable.



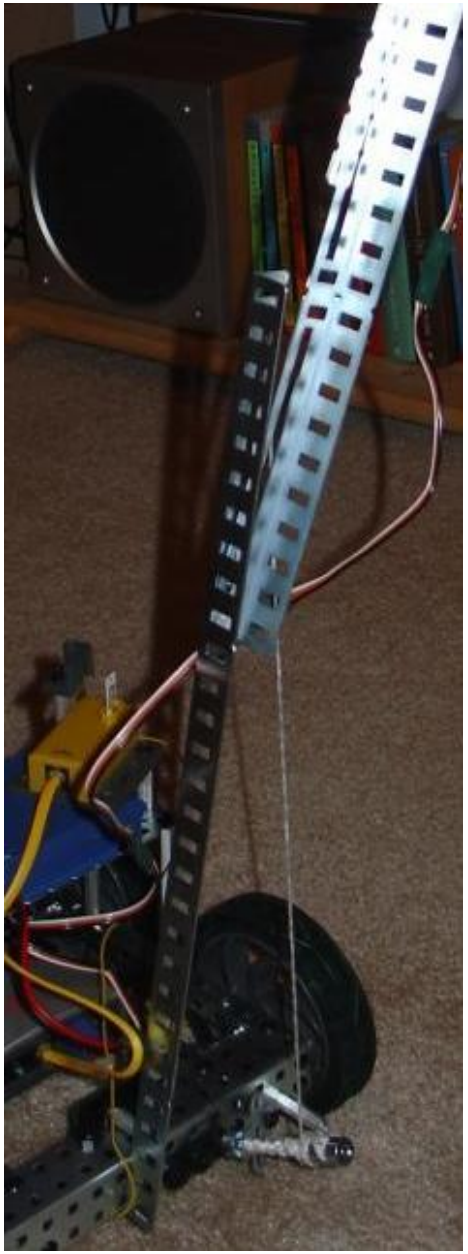
Winch

A motor wraps string around a spool.

The string is looped over the top of the tower so it pulls up on the extension.



posted on www.vexforum.com
by Stonebot



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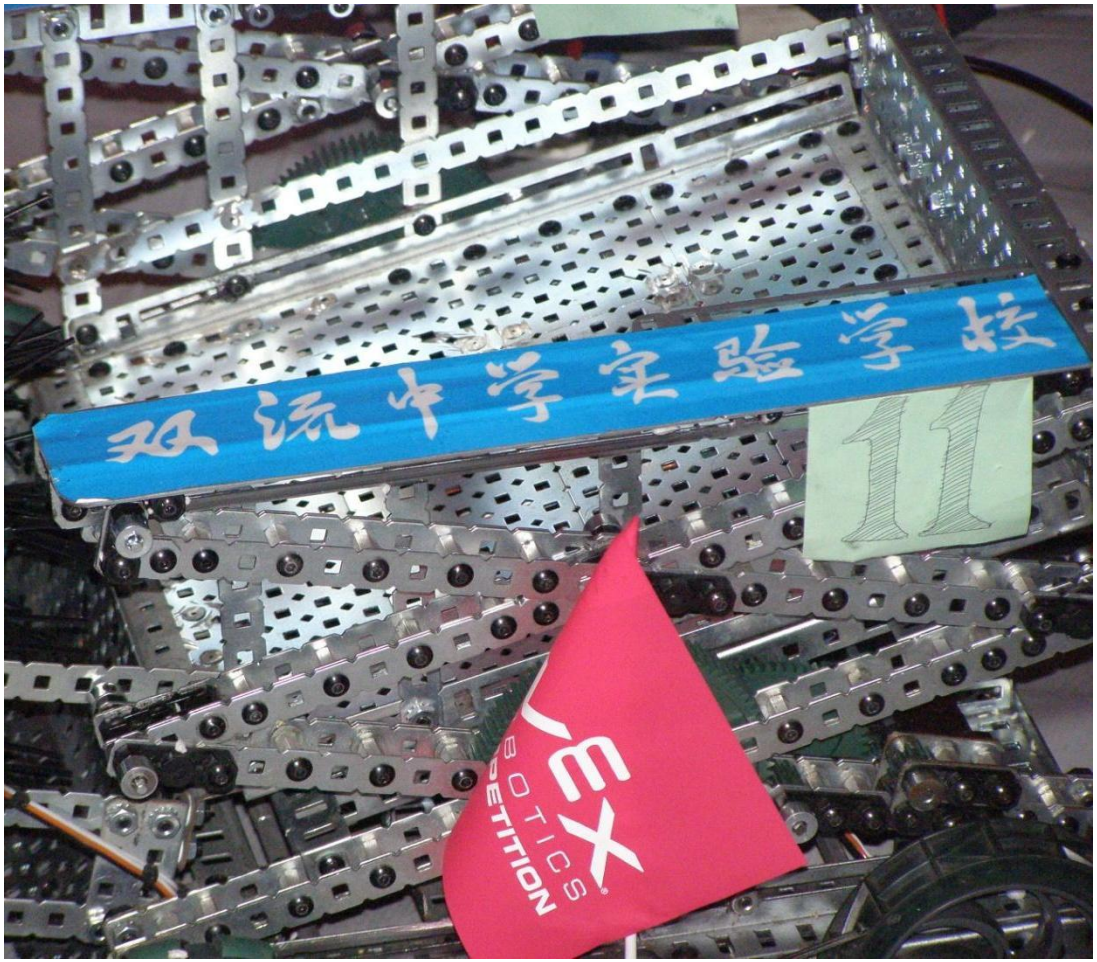
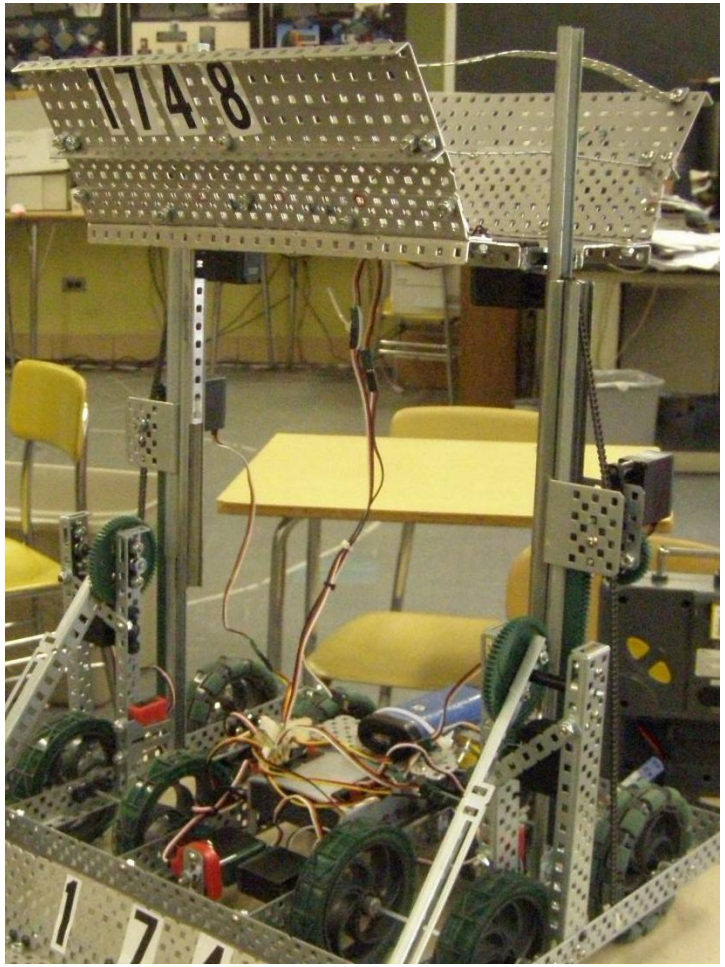
Multi-Stage Lifts

Put multiple lifts together to extend even higher.



Team 11



Team 1748

2008 Vex World Championship

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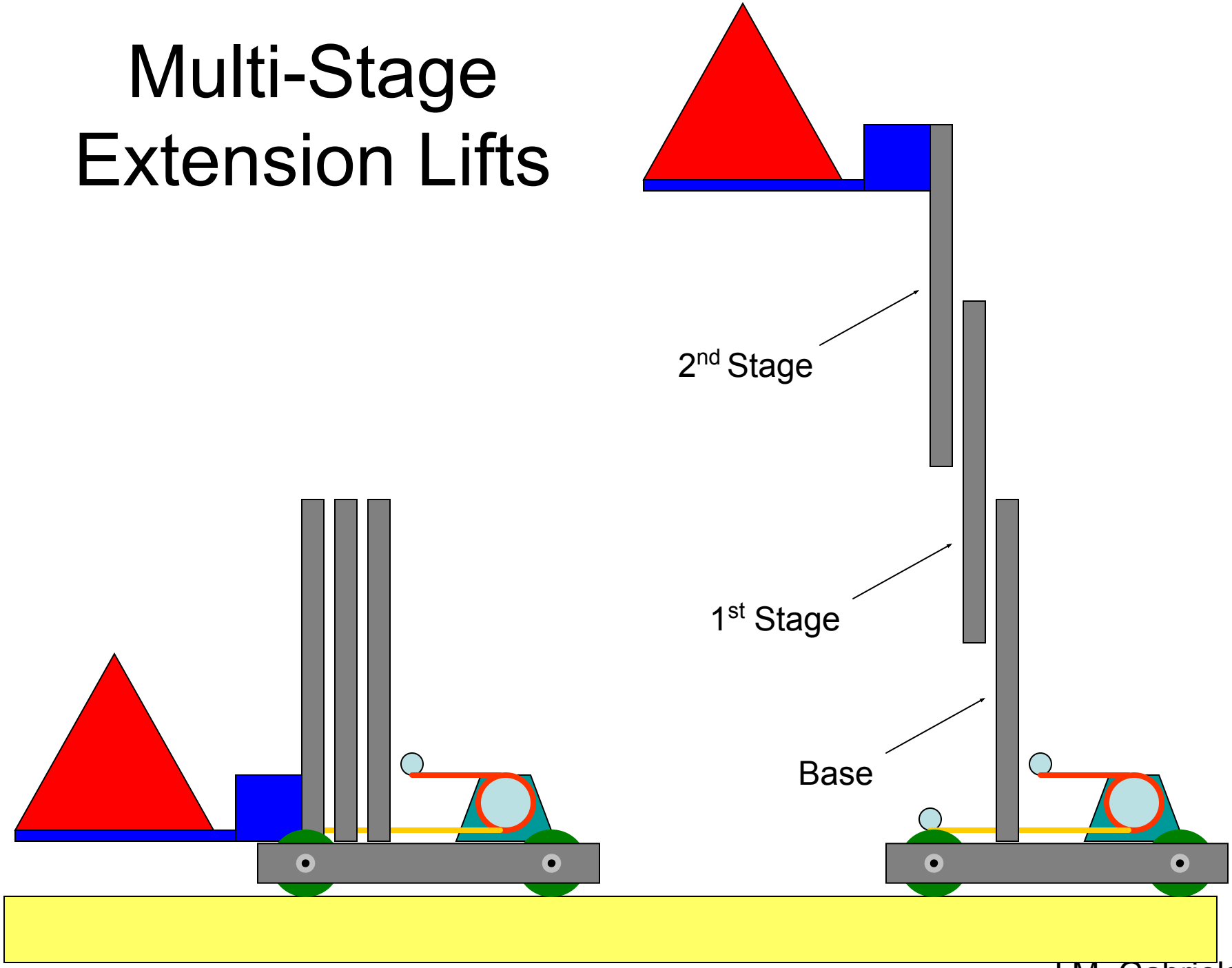
Multi-Stage Extension Lifts



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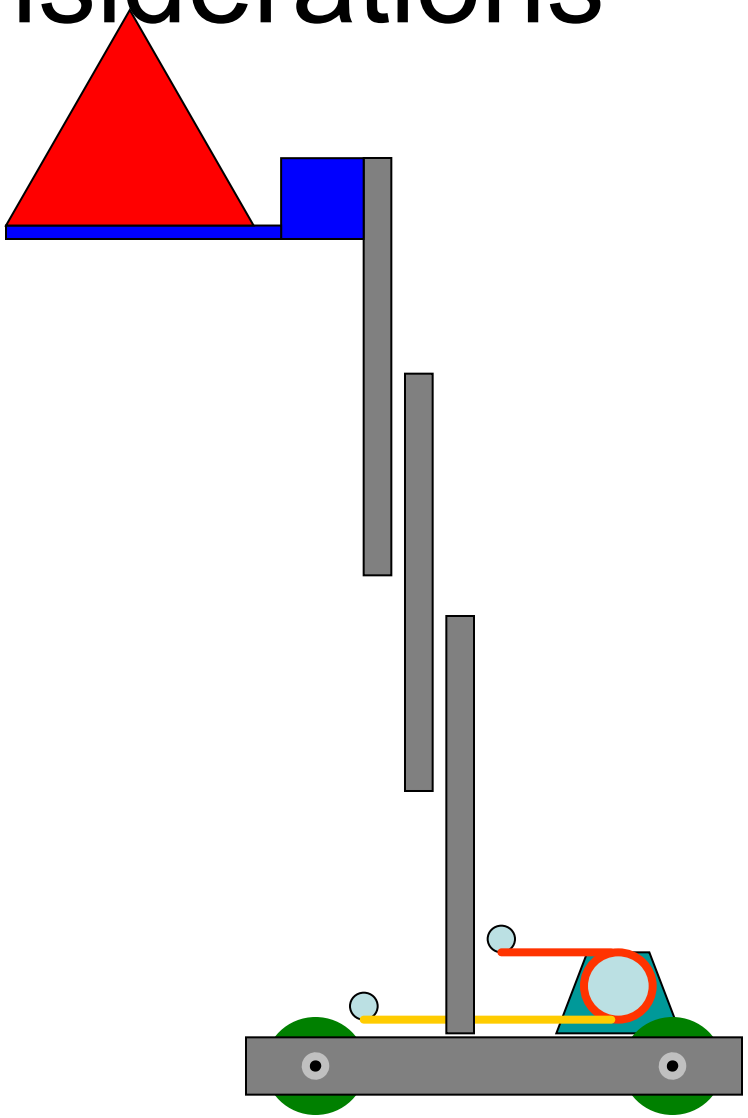
Extension Lift Considerations

- 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



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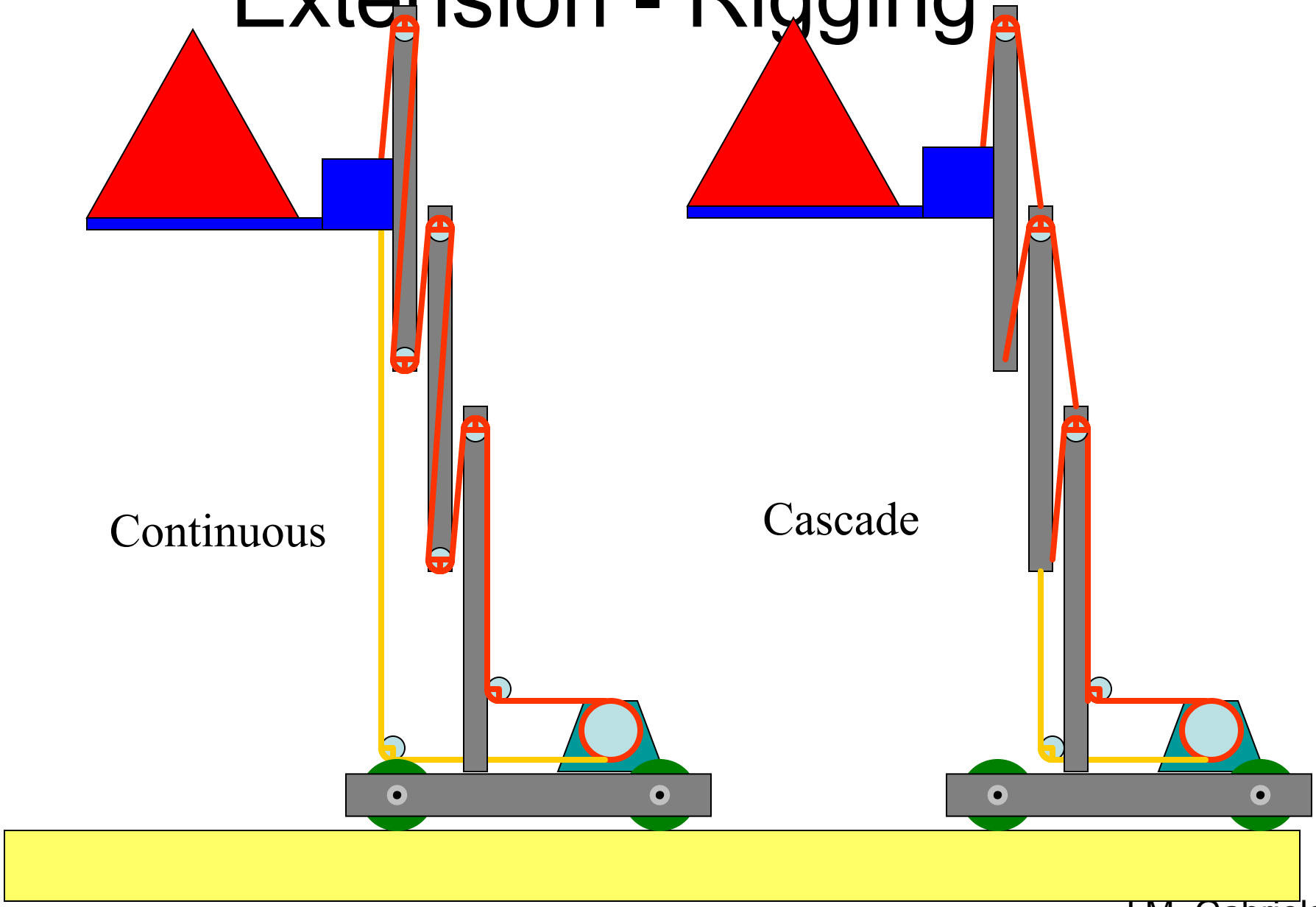
Extension - Rigging



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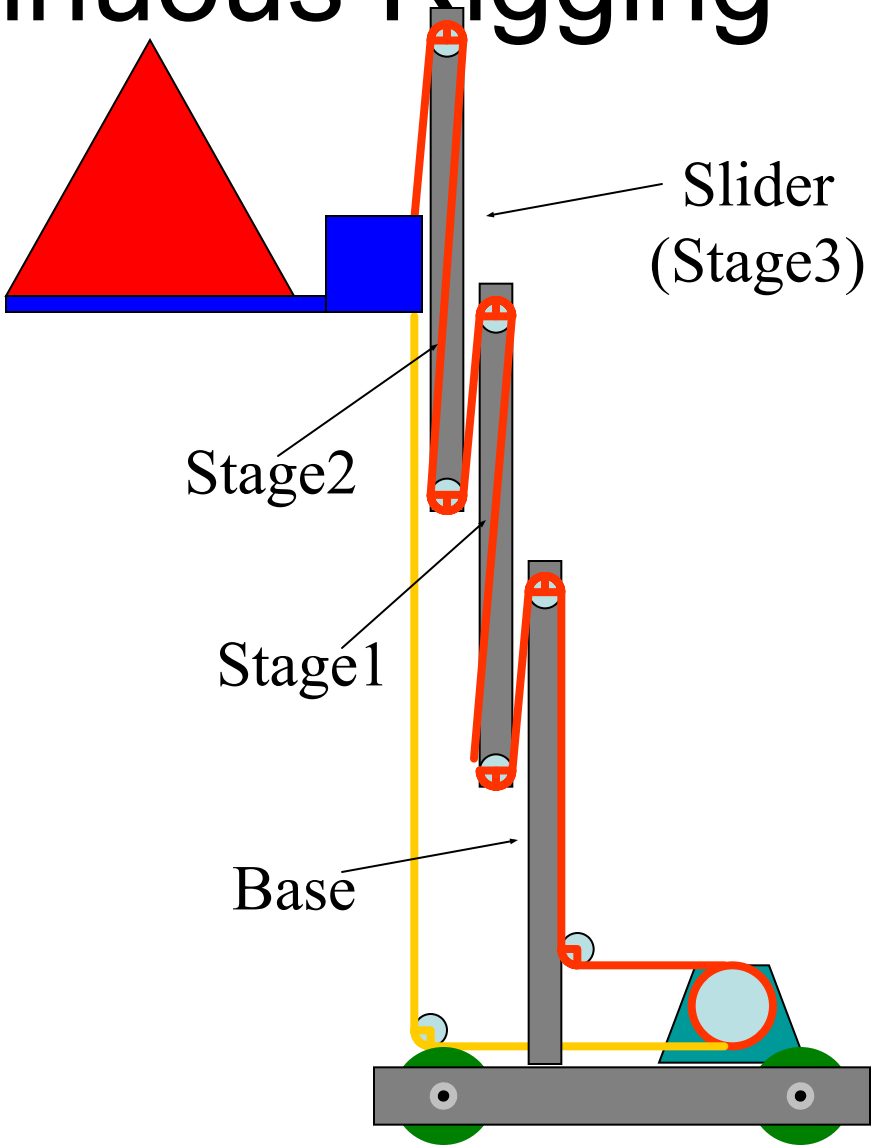
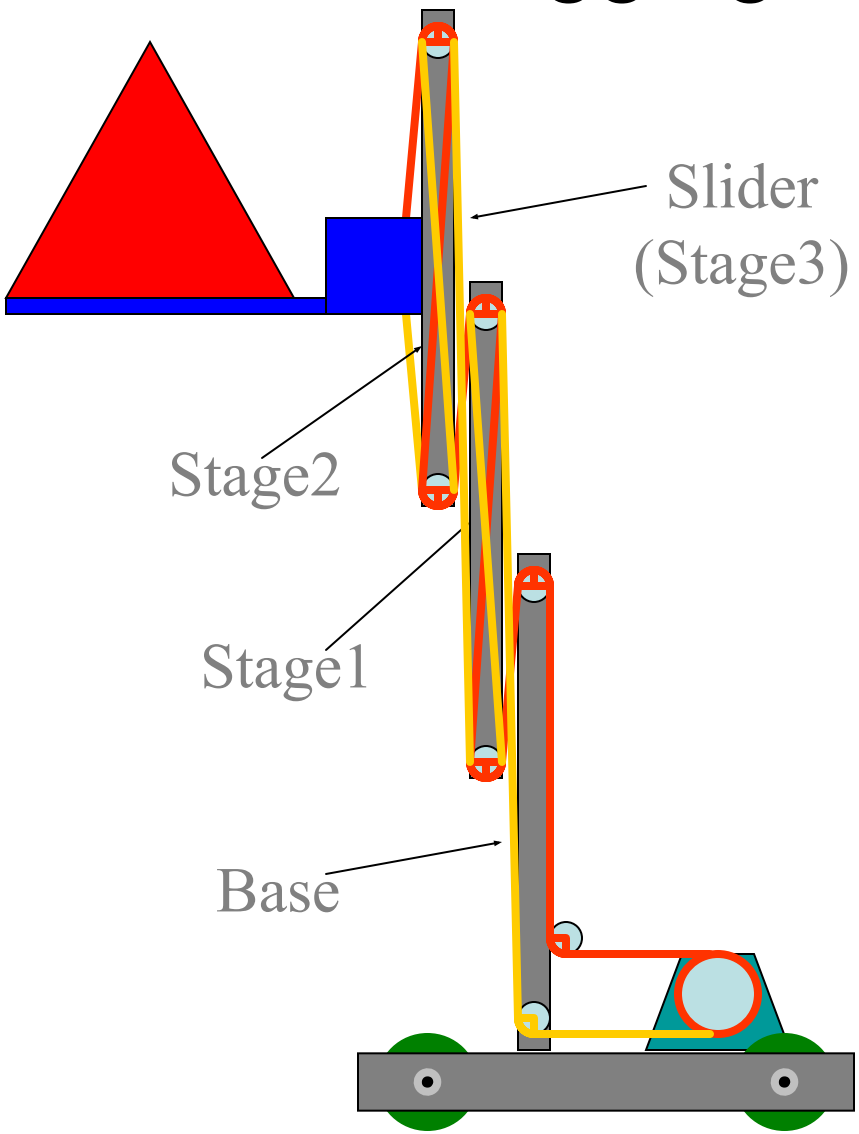
Extension: Continuous Rigging

- Cable moves at the same speed for up and down
- Intermediate sections sometimes jam
- Low cable tension
- More complex cable routing
- The final stage moves up first and down last



Extension: Continuous Internal Rigging

- very complex cable routing
- clean
- protected cables
- linear slides don't have room for internal rigging



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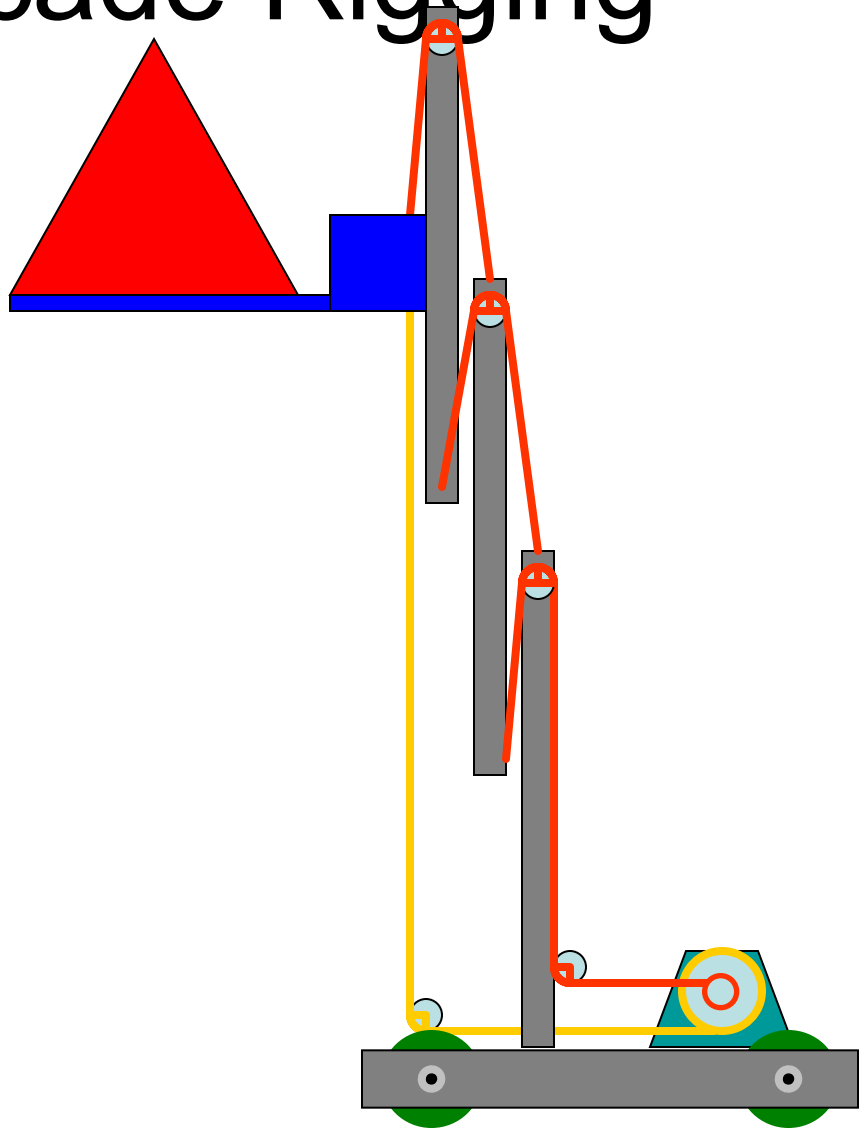
Extension: Cascade Rigging

- Up-going and Down-going Cables Have Different Speeds
- Different Cable Speeds Can be Handled with Different Drum Diameters or Multiple Pulleys
- Intermediate Sections Don't Jam
- Much More Tension on the lower stage cables
  - Needs lower gearing to deal with higher forces

- I do not prefer this one!



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Lift Challenge

Vex Challenge #5

Lifts

Due Date: Friday

Vex Inventor's Guide: Stability & Center of Gravity in the Structure section (p. 231)
Forums: www.vexforums.com: Search the forum or post questions
Chief Delphi Forum: www.chiefdelphi.com: Search the forum or post questions

C Level Challenge (70 points):

- Build a robot that uses a single stage lift to extend at least 6 inches upwards
- Make a design drawing of your lift

B Level Hardware Challenge (85 points):

- Build a robot that uses a single stage lift to raise a soda can 10 inches
- Make a design drawing of your lift

A Level Hardware Challenge (100 points):

- Build a robot that uses a two stage lift to raise a soda can 16 inches
- Make a design drawing of your lift

A Level Software Challenge (100 points):

- Complete the C Level Challenge
- Implement limit switches to limit the range of motion in software

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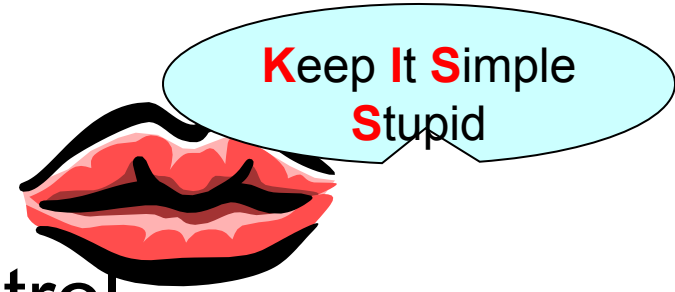
Advice

- Be original
- Simple doesn't mean bad
  - **KISS** Engineering Principle:



- Use feedback (sensory) control
  - Include limit switches in your design from the start
    - program the robot to automatically stop motors & servos
  - Use potentiometers & encoders to measure the lift's height
    - program the robot to move the lift to preset heights

Limit Switches

Limit switches tell the robot controller when arms and lifts have gone far enough.

Software can stop the servos and motors.

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Hint:

Use limit switches but still stop lifts & arms mechanically.

Mechanical Stops

&

brielse

Arm vs. Lift

Feature	Arm	Lift
Reach over object	Yes	No
Fall over, get back up	Yes, if strong enough	No
Go under barriers	Yes, fold down	No, limits lift potential
Center of gravity (Cg)	Can move it out from over robot	Centralized mass over robot
small space operation	No, needs swing room	Yes
How high?	**More articulations, more height (difficult)**	**More lift sections, more height (easier)**
Complexity	Moderate	High
Accumulation	1 or 2 at a time	Many objects
Combination	Insert 1-stage lift at bottom of arm	Insert 1-stage lift at bottom of arm

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Thanks/Resources

- Designing Competitive Manipulators: The Mechanics & Strategy

  by Greg Needel (www.robogreg.com)