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Robotics Club*

# **2011 FRC Virtual Training Session 4 Mechanisms**

**December 2 2011**

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# Mechanisms

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# Overview

## Manipulating Game Objects

- Collection Systems

- Intake Rollers
- Conveyors
- Claws
- Fixed, passive devices

- Positioning Methods

- Arms (rotating)
- Telescoping lifts
- 4-bar mechanisms

# Look at your object!

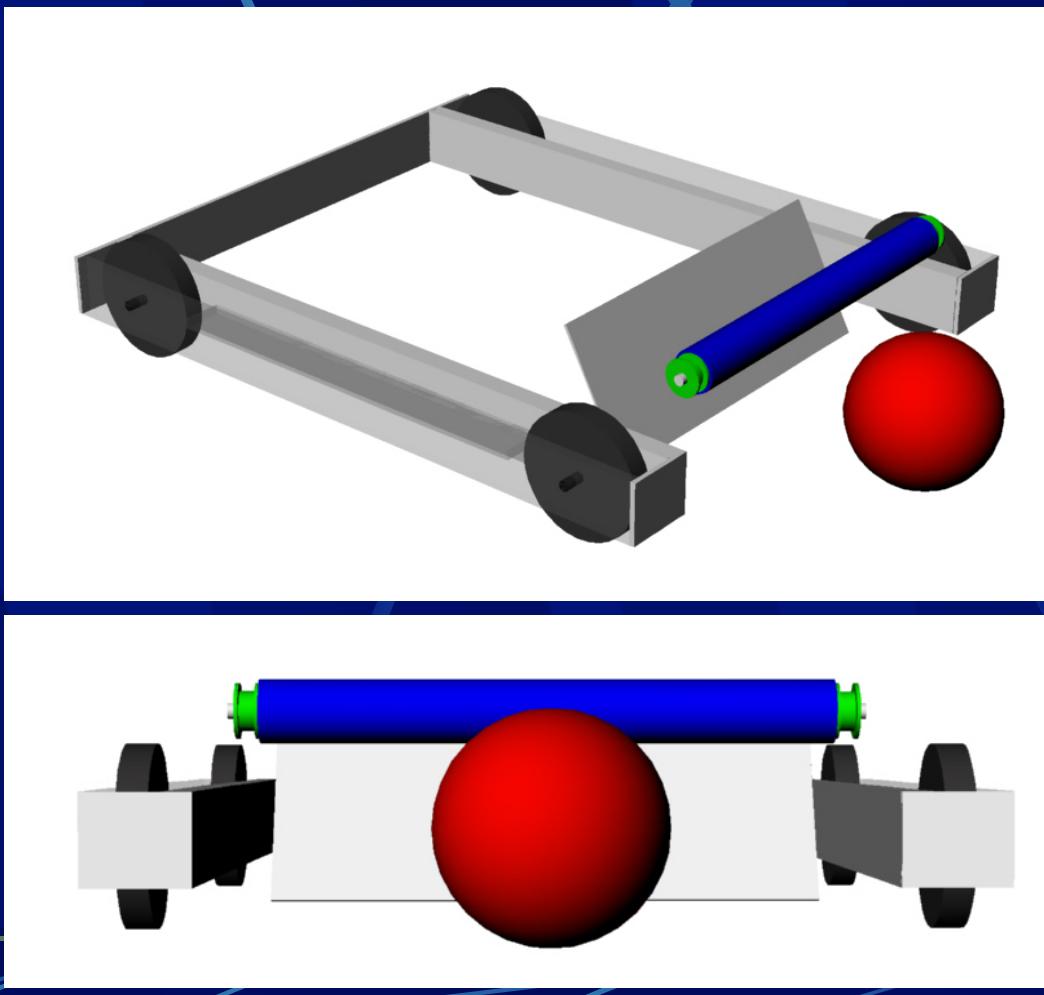
- Answer these questions *first*
  - Is it heavy?
  - Does it take up a large space?
  - Is it fragile?
  - Does the orientation matter?
  - Where is it? (floor, platform, human player)

# Intake Rollers



- Rotating cylinders designed to contact and move your game object
- Commonly used to pick up balls from the floor
- Horizontal or vertical

# Intake Rollers



# Intake Rollers

- Advantages

- Lightweight
- Pickup multiple objects quickly
- Large room for driver error
- Simple
  - Few parts to break

- Disadvantages

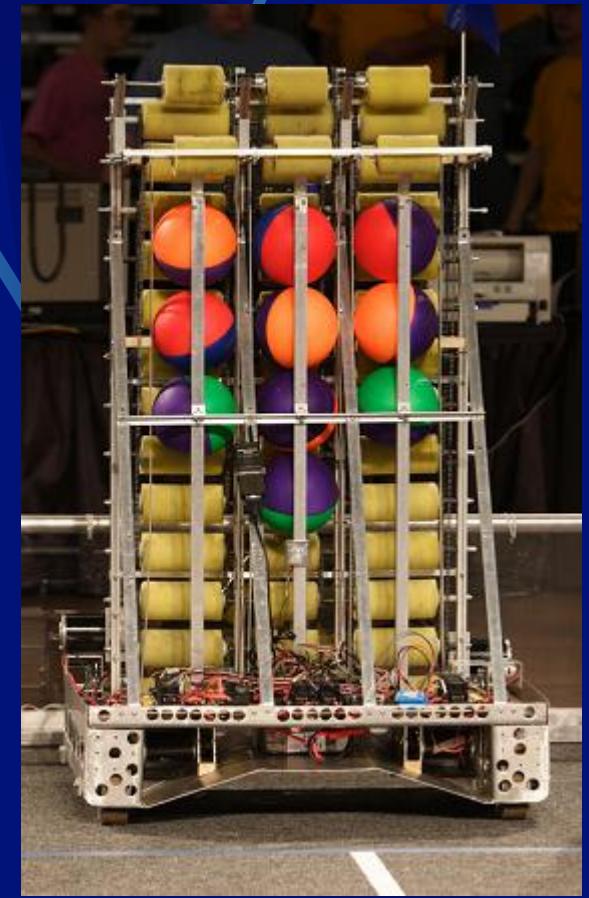
- Works best for balls
- Conveyors difficult to stay on reliably
- Can cause jamming
- Requires chassis space near floor

# Conveyors

- Effective with rollers at picking up and MOVING objects
- A flat, wide, moving belt
- Series of smaller belts in parallel



# Examples

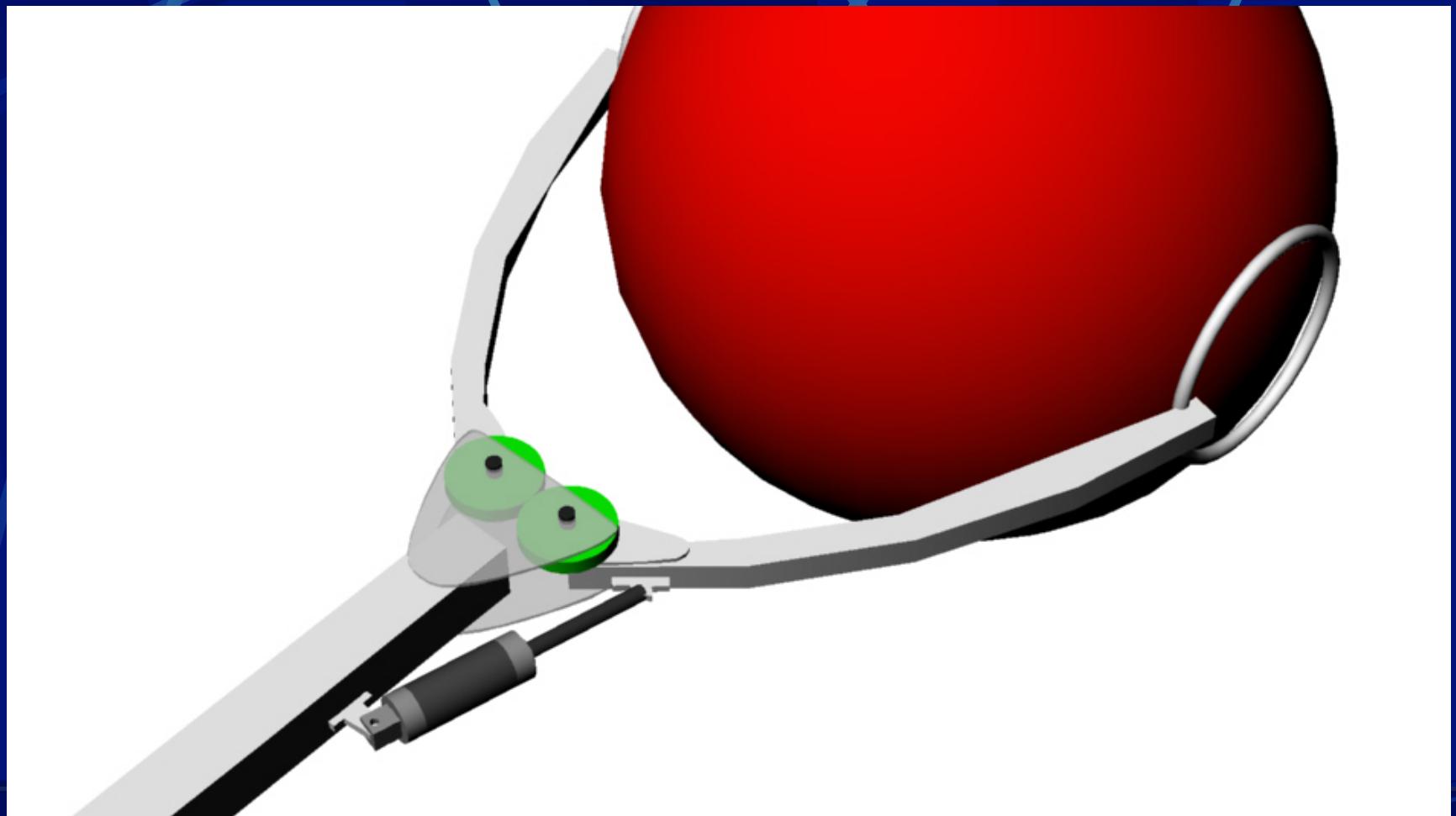


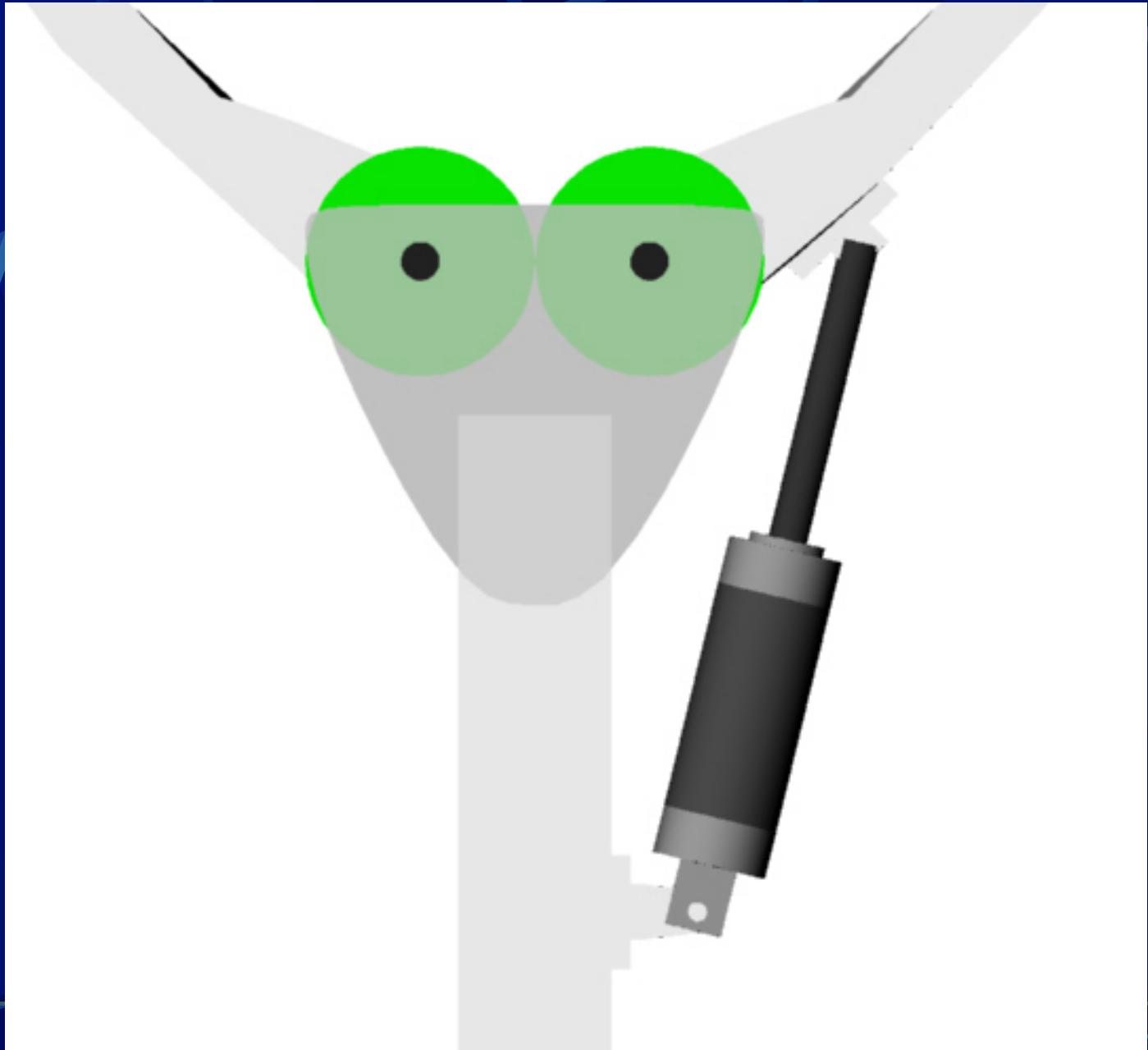
# Claws



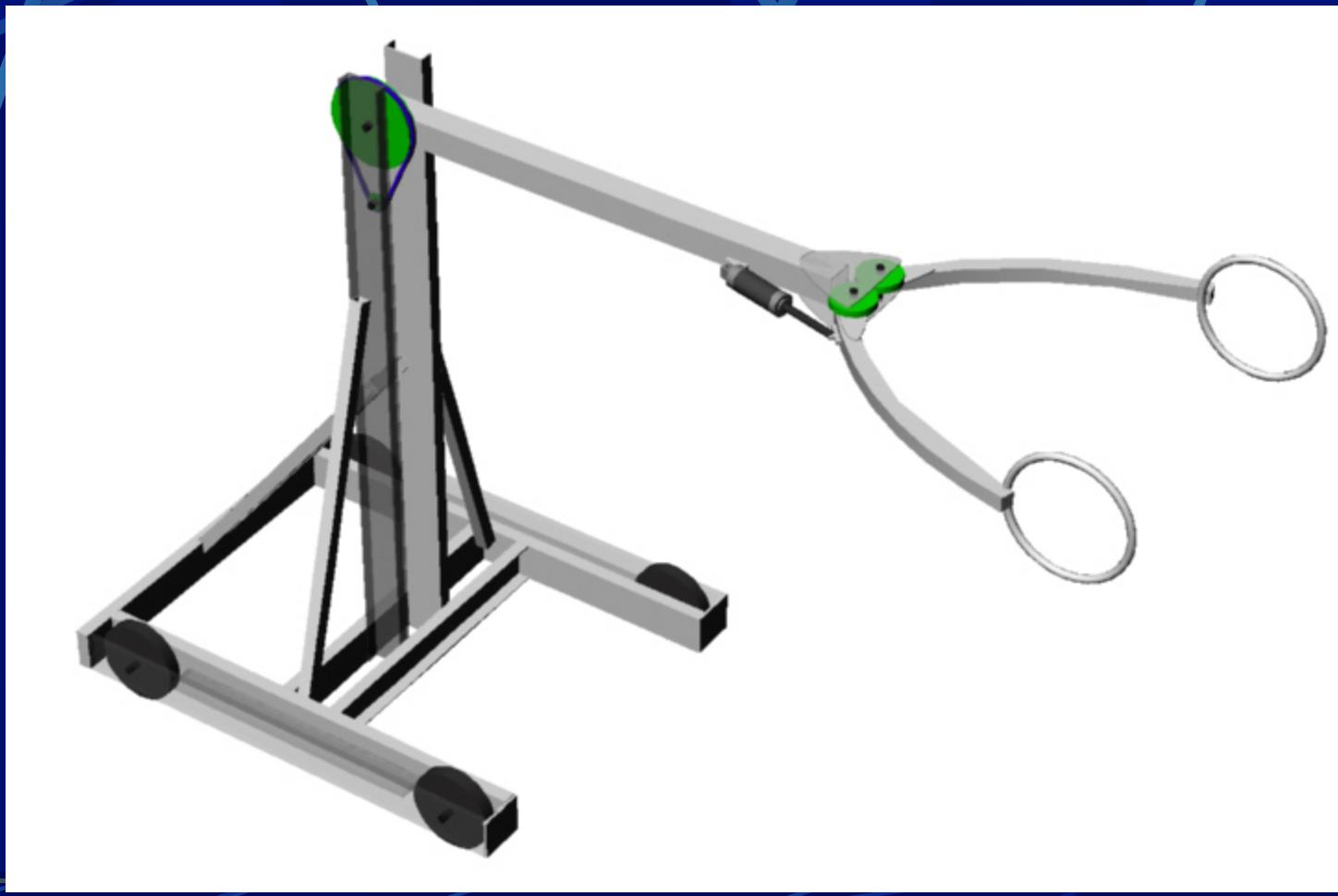
- Appendages which open and close to grasp onto an object
- “fingers” rotating to close around an object
- “fingers” move towards each other to clamp onto an object
- Any orientation, can pick up almost everything

# Claws





# Claws



# Claws

- Advantages

- Lightweight
- Grab very large objects
- Grab strangely shaped objects
- Easiest to build without machine tools

- Disadvantages

- Work best with pneumatics
- Take up large volume often
- Require good drivers and careful positioning
- Only pick up one object at a time

# Examples



# Fixed Devices



- KISS!
- A simply shaped device that interacts with the object
- Useful only if object has something to grasp onto

# Fixed Devices

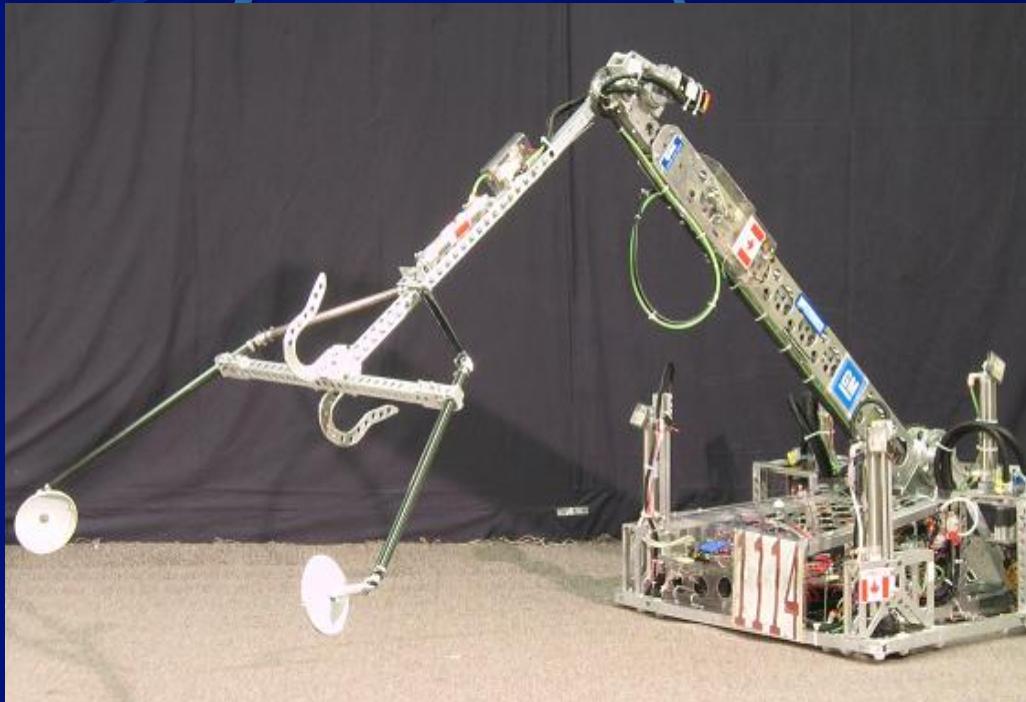
- Advantages

- Lightweight!
  - More weight to make other parts work better
- Reliable
  - No moving parts break
- Cheapest and easiest to manufacture

- Disadvantages

- Only work with certain objects
- Limited ability
  - Relies upon skill of driver and specific setups
- No room for adaptability in a match

# Arms (rotational lift)

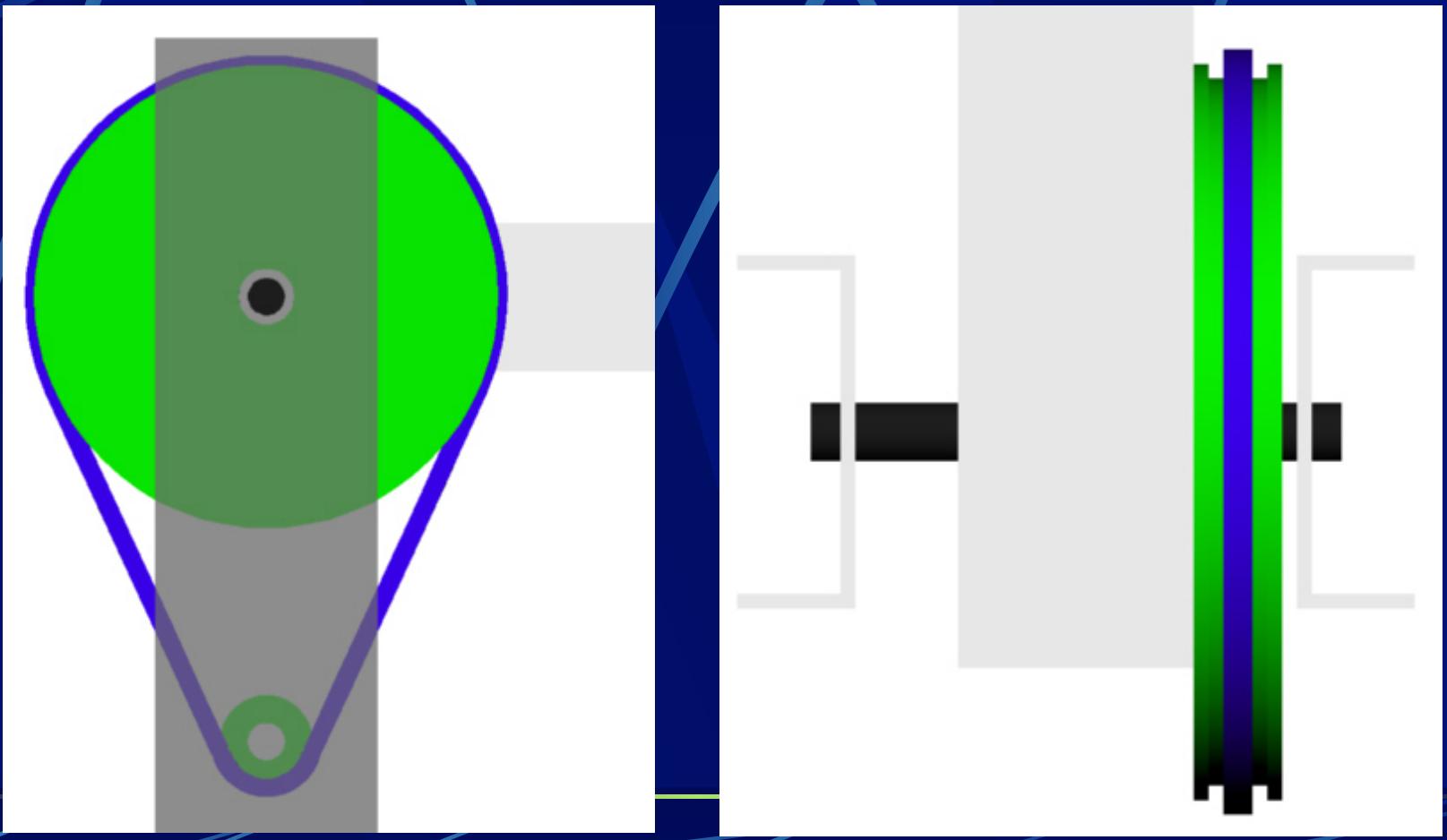


- Consist of one or more points of rotation
- Manipulator on the end of an arm
- Versatile and effective
- Lift objects high simply

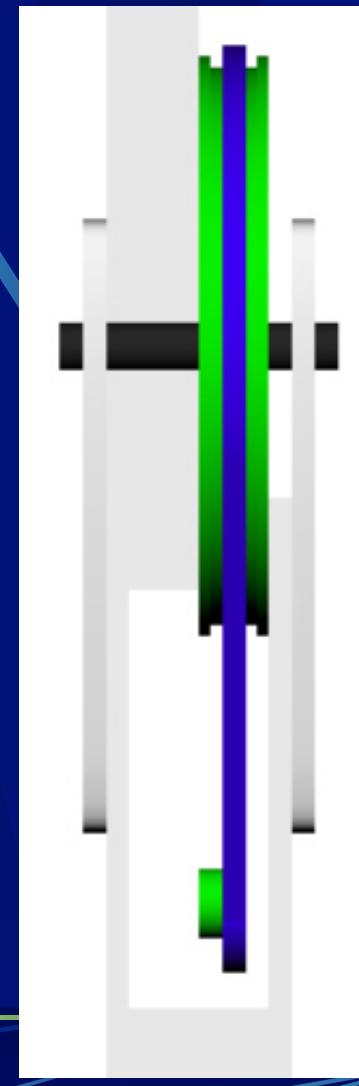
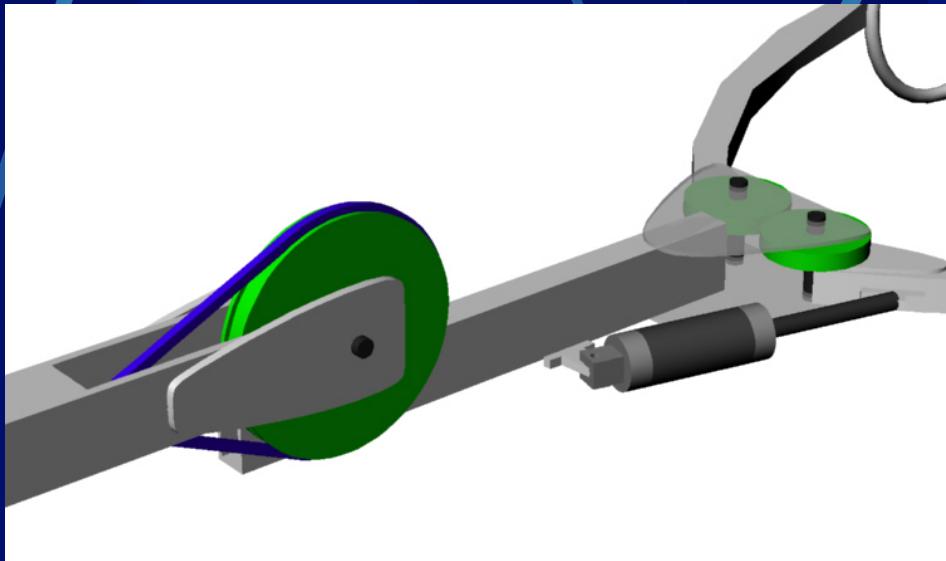
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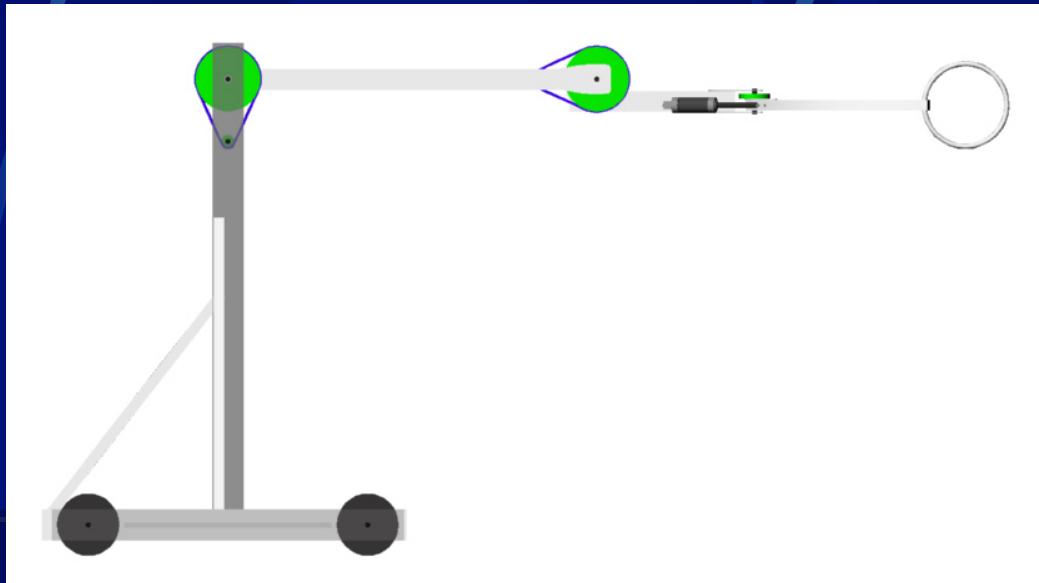
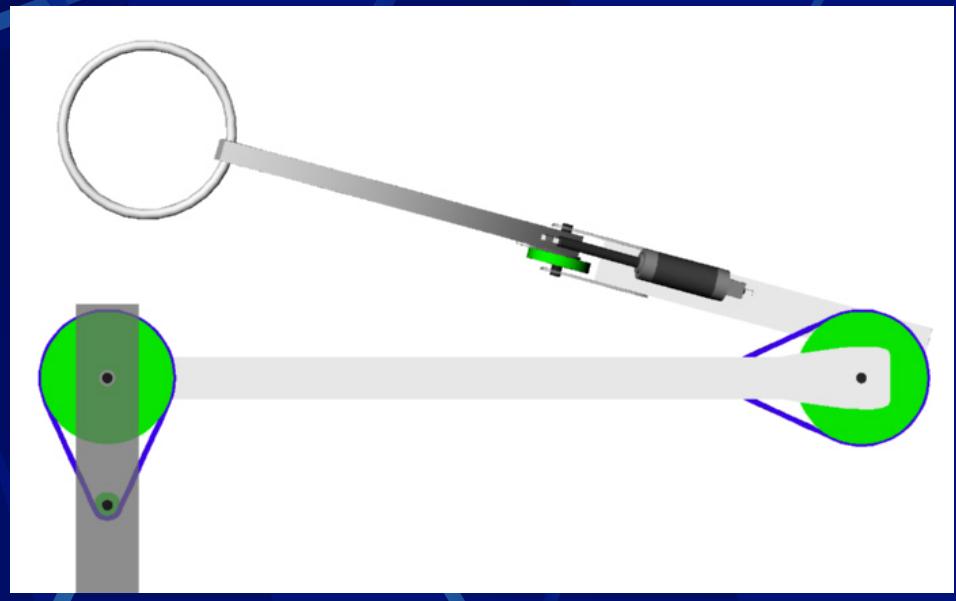
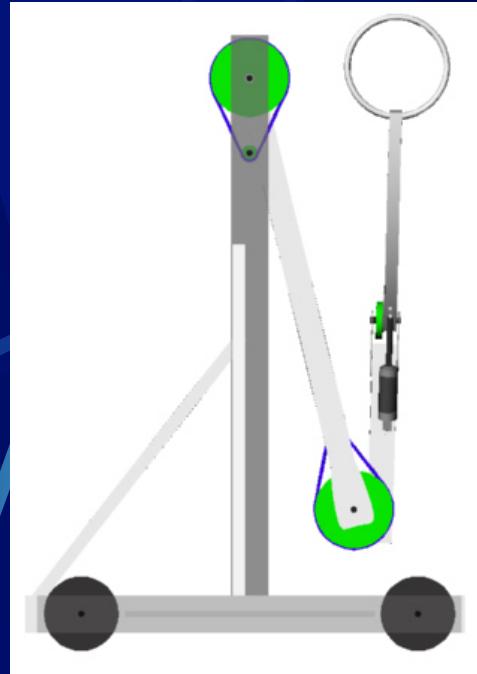


# Shoulder Joint



# Adding a Wrist





# Arms (rotational lift)

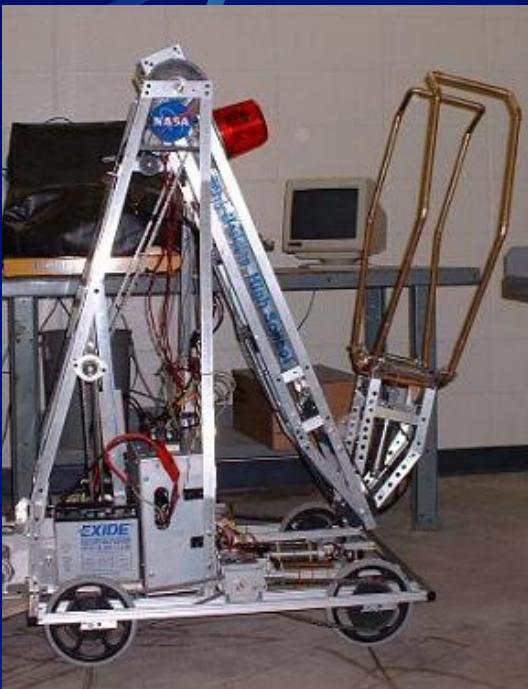
- Advantages

- Mechanically reliable for most heights
- A shoulder and wrist provide excellent control
- Can reach over robots and still fold up
- Multiple functions
- Can be built simply!
  - Capstans
  - Sprocket and chain

- Disadvantages

- Requires high strength parts
- Can raise CG too high
- Must fit into starting size limit
- Can require careful strategy not to hurt other robots

# Examples

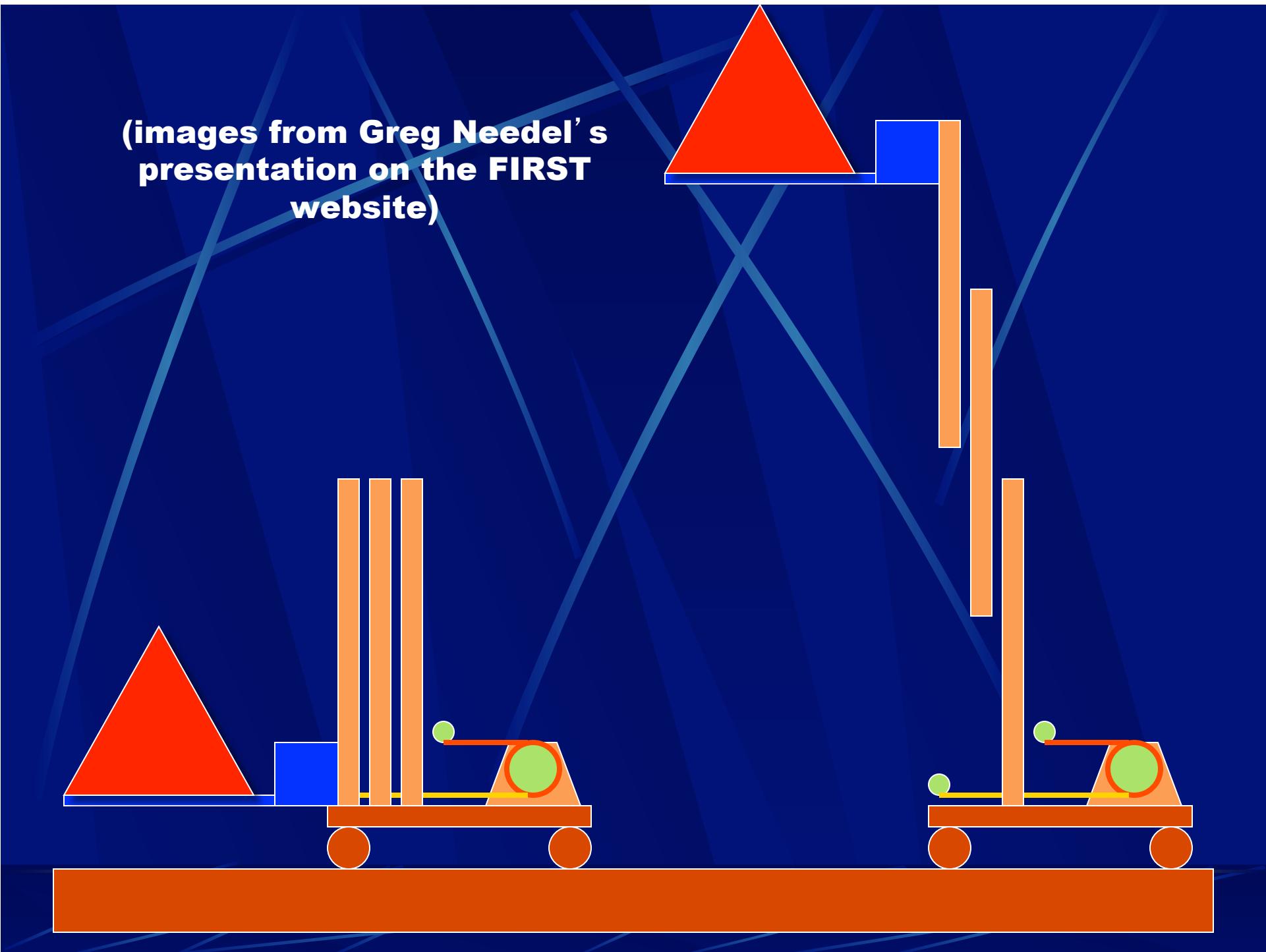


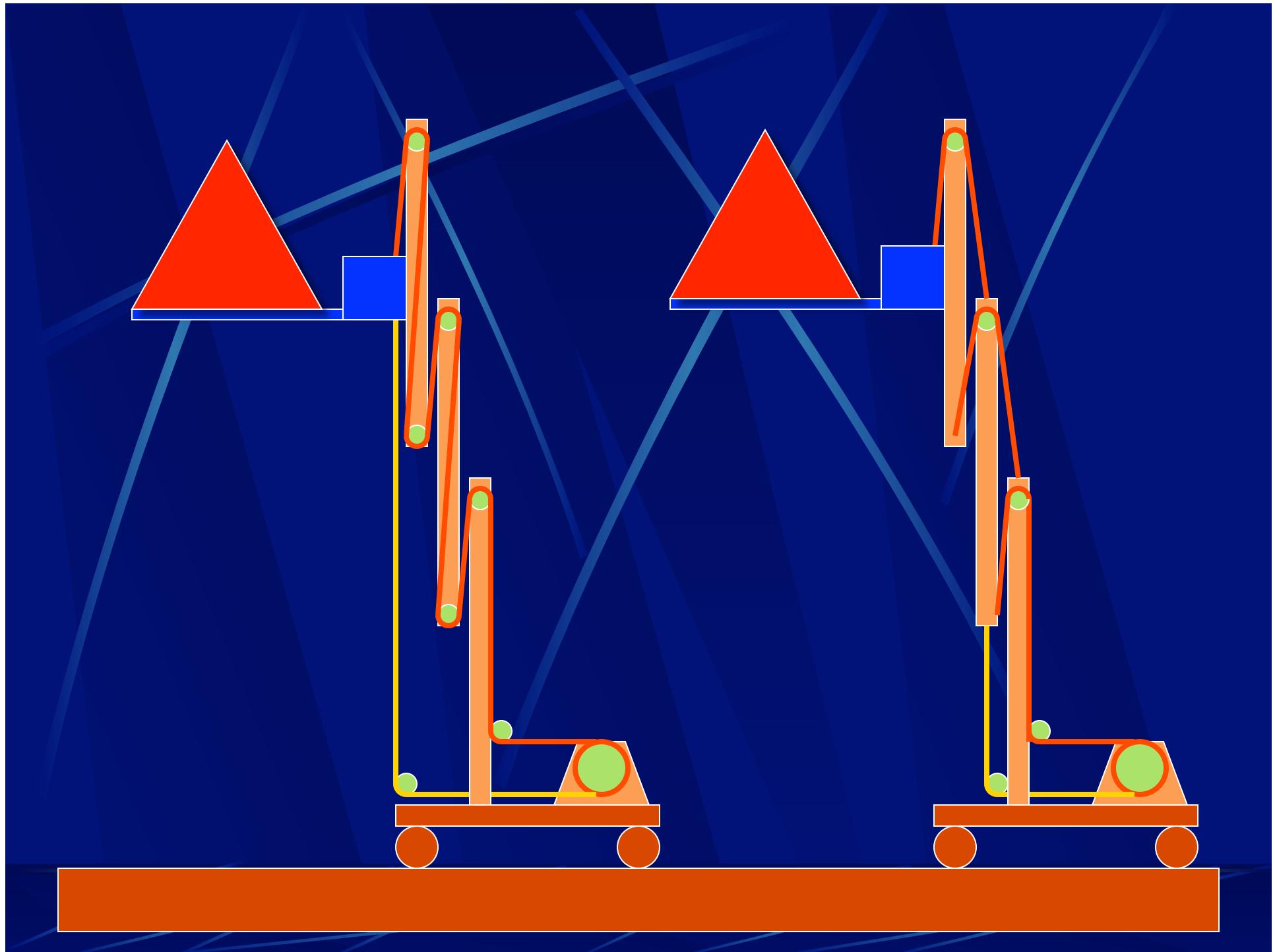
# Telescoping



- Sliding sections that move linearly
- Mostly powered by a winch pulling on a cable
- Similar to the front of a forklift

**(images from Greg Needel's presentation on the FIRST website)**





# Telescoping

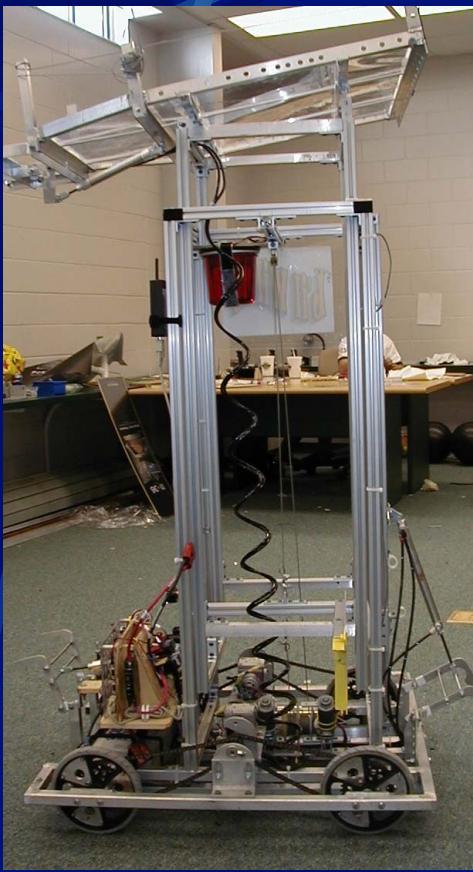
- Advantages

- Able to extend very far with little space consumed
- Stable linear path
- Less for driver to think about
- Simply powered by a winch

- Disadvantages

- Jamming, they jam, and jamming too.
- Hard to repair
- Require being stored in a long straight area
- Do not handle bending loads well

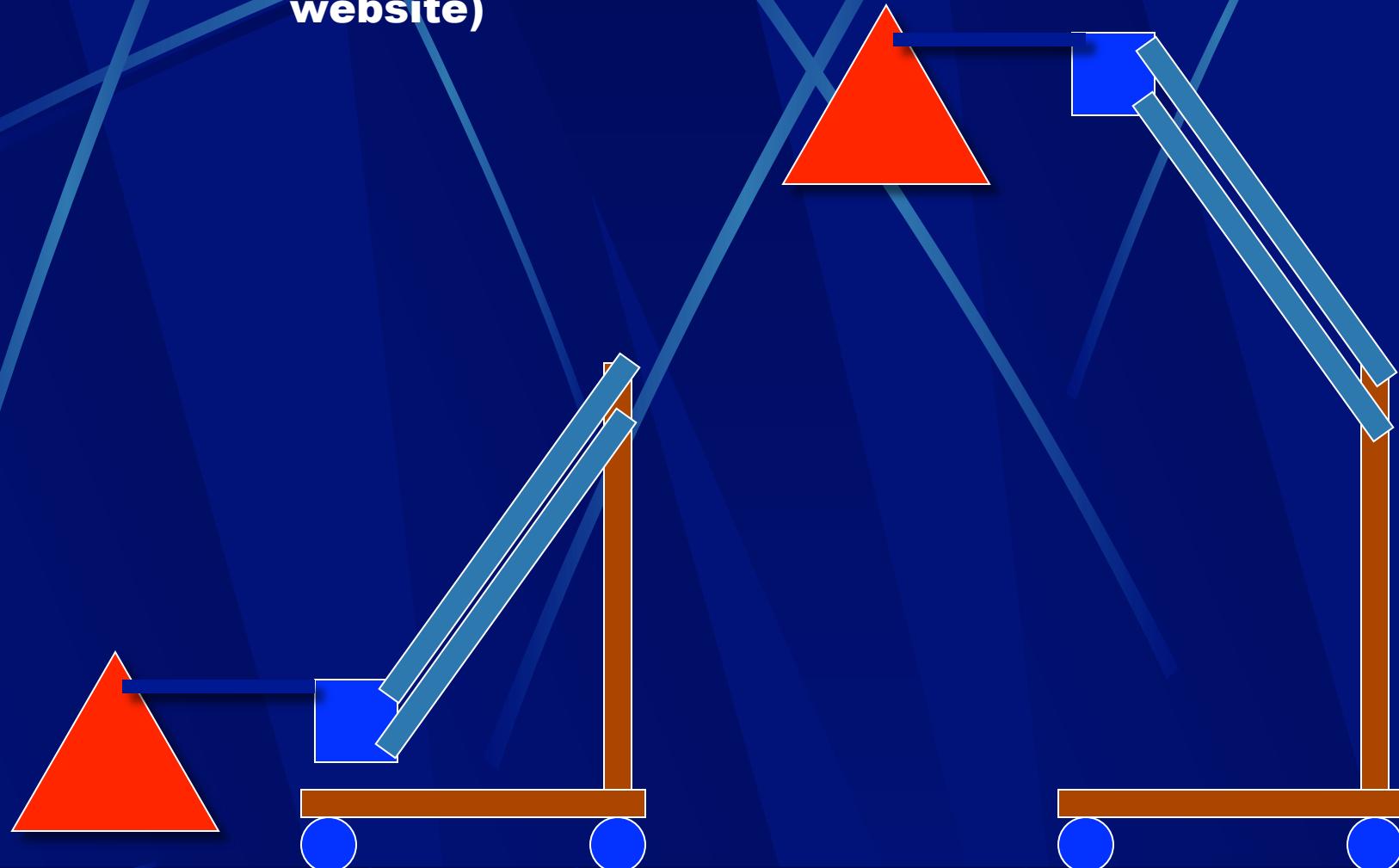
# Examples



# 4-Bar linkages



**(images from Greg Needel's presentation on the FIRST website)**



# 4-Bar (rotational lift)

- Advantages

- Controls orientation of arm and object
- Complex motion from a simple input
- Simple to implement

- Disadvantages

- Limited range of motion
- More moving parts
- Over center toggling
- Certain links can require lots of torque

# Design Selection

- How high does the object need to be lifted?
  - Arm with 1 joint vs. elevator with 1 section, etc
- Does the robot need to fit under an obstacle?
  - Arm folded down vs. telescoping arm with a pivot
- How much weight and space is there for it?
  - A conveyor system blocks half the robot vs. must weigh less than 10lbs and lift 10ft high
- *Prioritize first!*

# Materials

- Steel
  - Axles, pins, bolts
- Aluminum
  - Structural shapes, plates, axles
- Plastics
  - Lighter parts, complex shapes, covers

# Transmission

- Sprockets and chain
  - #25, #35
- Gears
  - ~20 pitch to ~12 pitch
- Urethane round belts
- Timing belts and timing pulleys
- Capstans

# Vendors

- [Mcmaster.com](http://Mcmaster.com)
  - All transmission parts and materials
- [Onlinemetals.com](http://Onlinemetals.com)
  - Aluminum structural
- [Sdp-si.com](http://Sdp-si.com)
  - transmission
- [Banebots.com](http://Banebots.com)
  - Gearboxes
- [Robotmarketplace.com](http://Robotmarketplace.com)
  - Gearboxes
- [Home Depot](#)
  - Small amounts of aluminum tubing

# Questions?

(super excited about mechanism building)