GKN AEROSPACE

Mechanisms & Manipulators

Beach Cities Robotics – Team 294

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Introduction

- So…You need to move something?

Introduction

- How are you going to…
  - acquire it?
  - manipulate it?
  - store it?
  - lift it?
  - position it?
  - release it?

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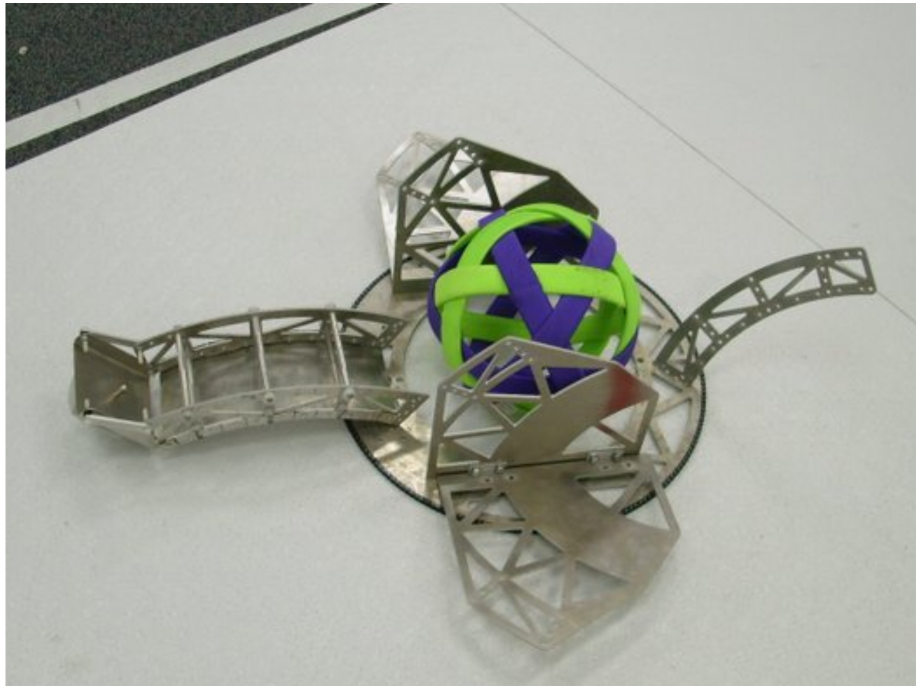
Topics

- Object Manipulation
- Lifting Mechanisms
  - Conceptualizing in 2D CAD
- Center of Gravity
- System Requirements



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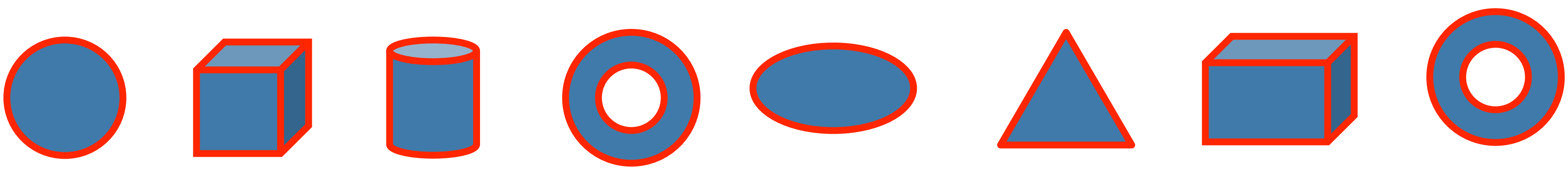
Object Perspective

- How does the object appear from the robot's perspective?
- How many different object configurations?
- What is the most stable object configuration?
- How does the object react?

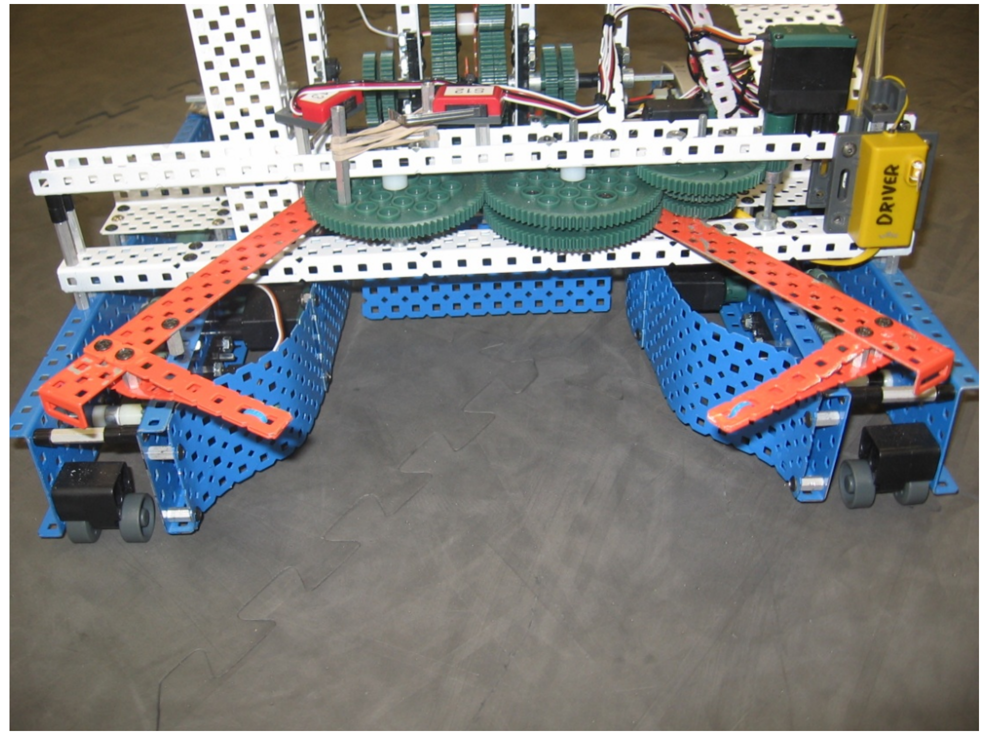
- Consider past objects
  - Ball, Cube, Cylinder, Ring, Football, Tetrahedron, Box, Floppies



Acquisition Zone

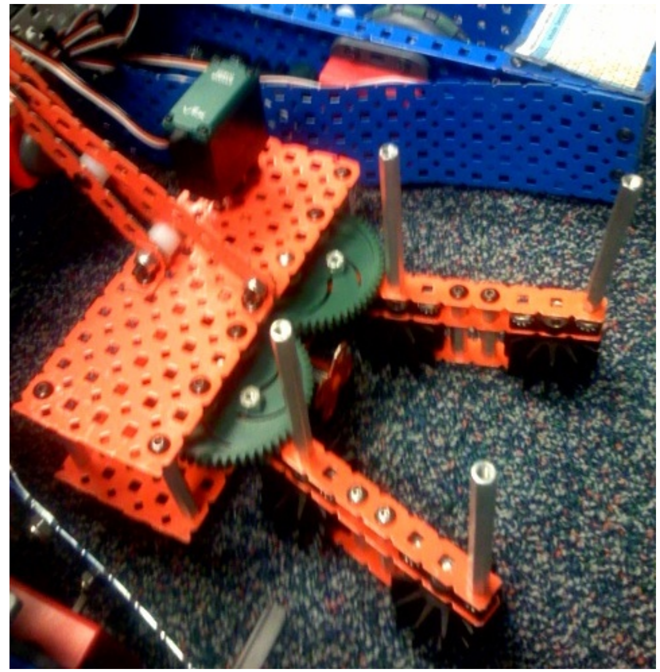
The acquisition zone is the effective intake area of the robot; the larger the better.

- How will the object react to the robot, field, intake device?
- Can you pick up an object 50ft away with the robot between you and the object?



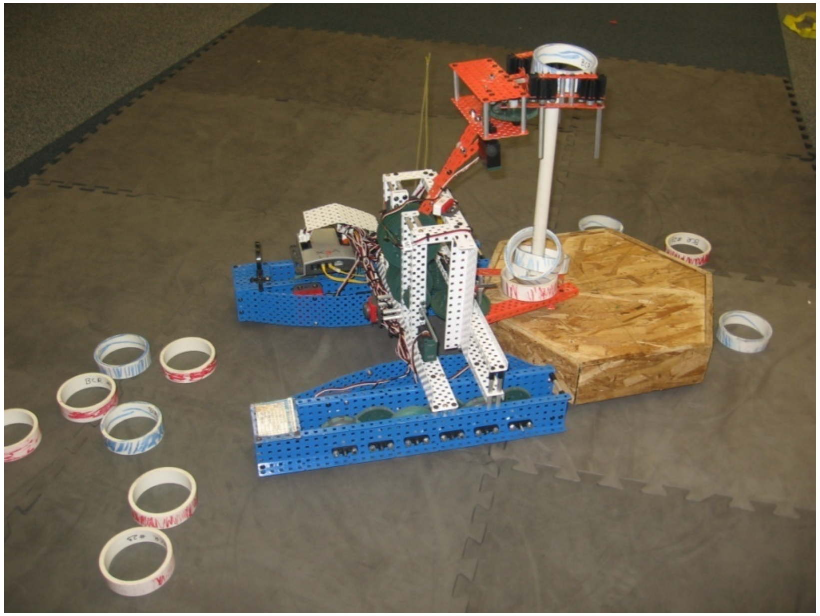
Continuous vs Single Intake

- Which is better?



Surrounding Objects

- Don’t forget about the objects left on the field!
  - The robot base also “manipulates” objects
- Can stray objects hinder robot motion?
- Examples:
  - Squeaky’s trap door design
  - Squeaky’s fins
  - Cobra’s tunnel design



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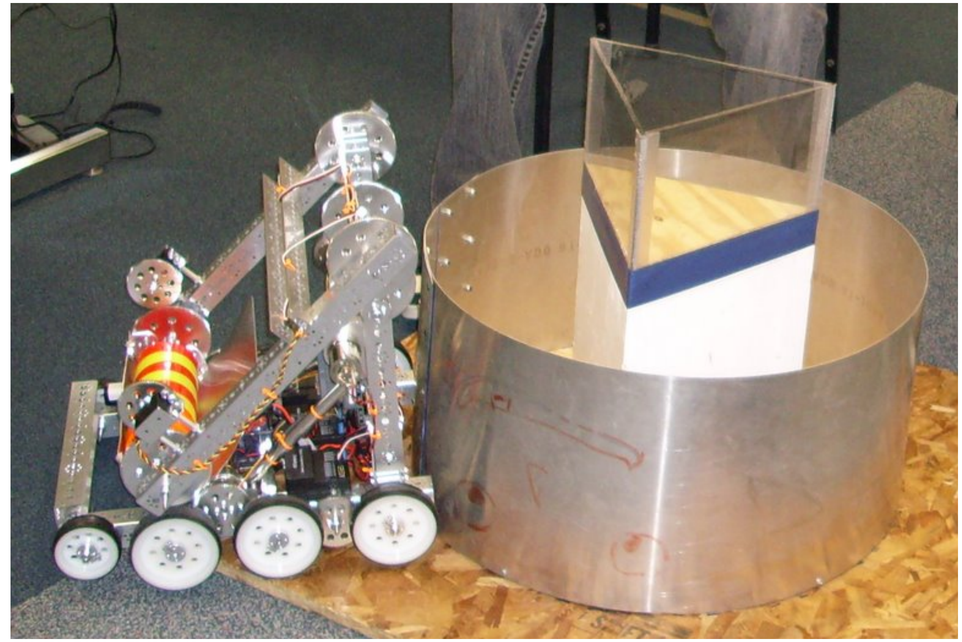
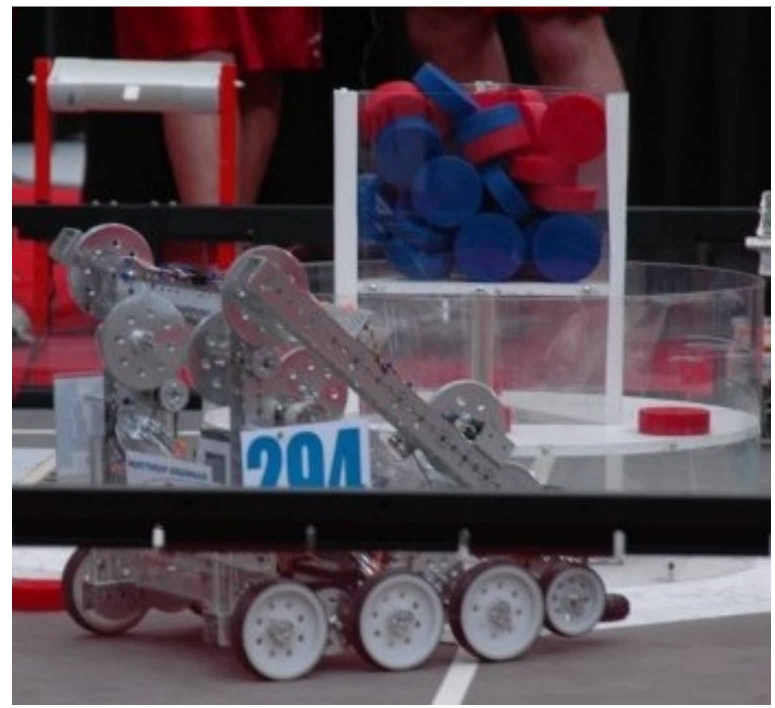
Device Alignment



- How can you guarantee proper placement?
- Are there physical objects to orientate the robot?



- Quick alignment is key to on field success!
- 2D CAD will greatly assist!

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Scissor Lift

Pros

- Robot footprint remains constant
- Mechanism protected by base
- Compact design relative to the lift

Cons

- Requires substantial initial force
- Synchronizing two scissors is difficult
- Many moving parts
- Complicates ground intake
- Uneven vertical velocity

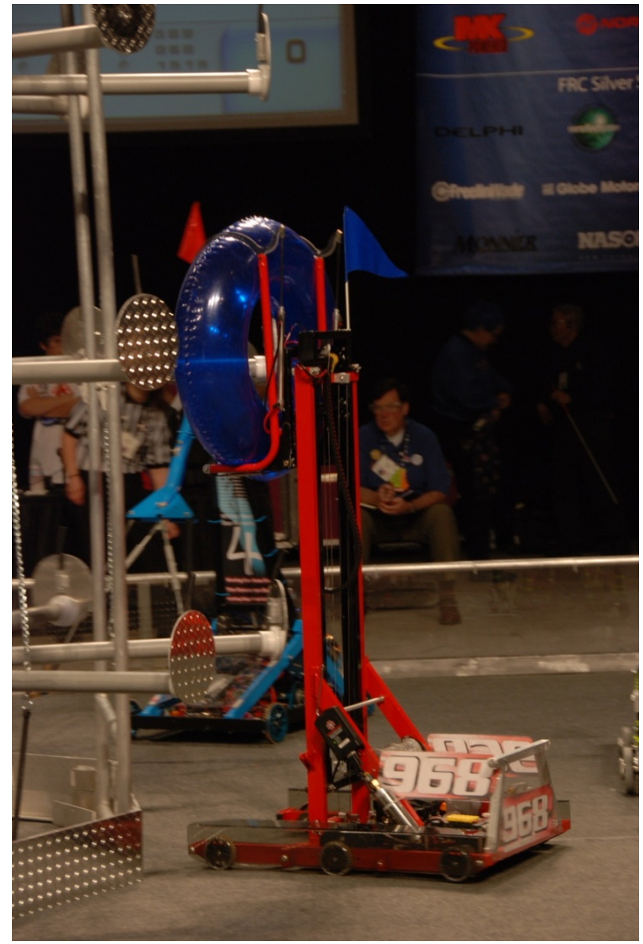
Telescope

Pros

- Robot footprint remains constant
- Mechanism protected by base
- Most direct route up
- Can reach the ground

Cons

- Intricate design
- High center of gravity
- Powering multi-stages is complex



Single Jointed Arm

Pros

- Simple
- Can reach the ground
- Can reach behind
- Light weight
- Object orientation changes

Cons

- Extends outside of the base
- Object orientation changes
- Moment at shoulder

Multi-Jointed Arm

Pros

- Extremely long reach
- Can reach backwards
- Position objects to any orientation

Cons

- Largely unprotected
- Powering multi-stages is complex
- High moment at shoulder joint
  - Cannot lift heavy objects
- Difficult to control

4-Bar

Pros

- Simple & robust
- Objects retains orientation
- Can reach the ground
- Slight outward forward reach

Cons

- Extends outside base
- Moment at shoulder joint
- Cannot reach backwards
- Can constrain manipulator size

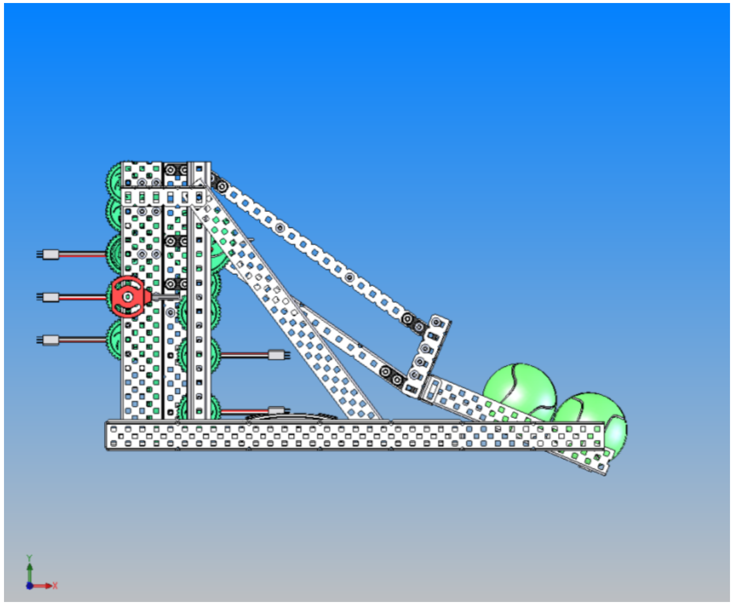
Uneven 4-Bar

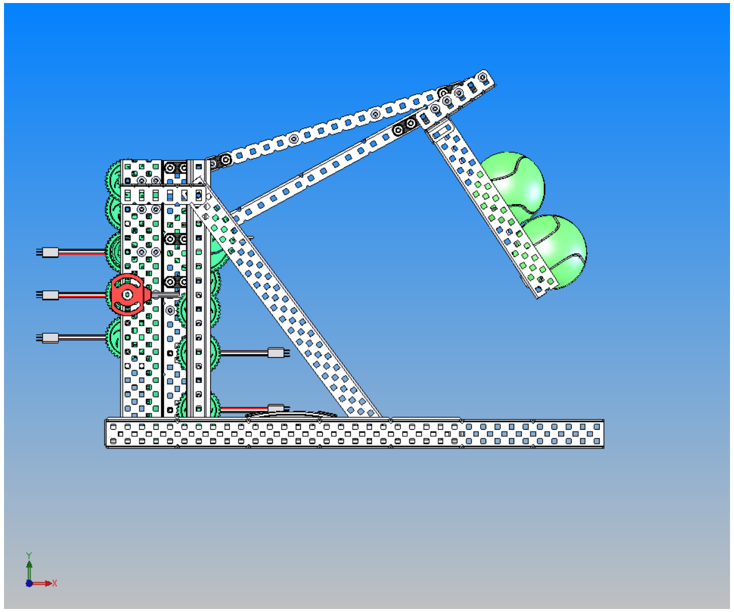
Pros

- Simple & robust
- End effecter changes orientation
- Can reach the ground
- Slight outward forward reach

Cons

- Extends outside base
- Moment at shoulder joint
- Cannot reach backwards
- Can constrain manipulator size





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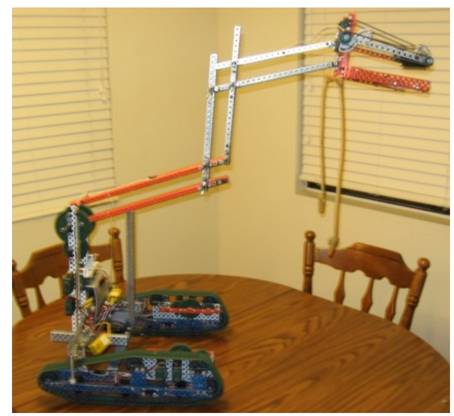
Multi-Bar (Parallel 8 Bar)

Pros

- Powered through 1 joint
- Object retains orientation
- Can reach the ground
- Extreme upward and forward reach



Cons

- Extends outside base
- Large moment at shoulder joint
- Cannot reach backwards
- Can constrain manipulator size

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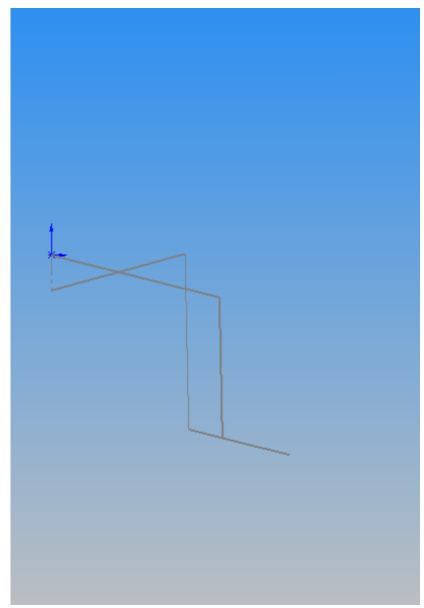
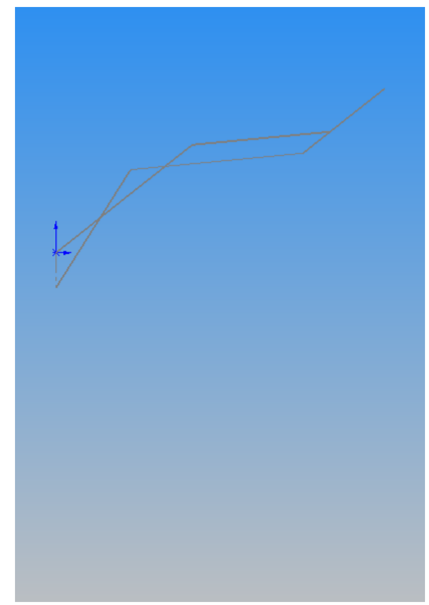
Multi-Bar (Crossed 8 Bar)

Pros

- Powered through 1 joint
- Object changes orientation
- Can reach the ground
- Extreme upward and forward reach





Cons

- Extends outside base
- Large moment at shoulder joint
- Cannot reach backwards
- Can constrain manipulator size
- Complex integration

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Combining Mechanism

Pros

- Can integrate the best features from each design

Cons

- Complex
- Numerous controls required

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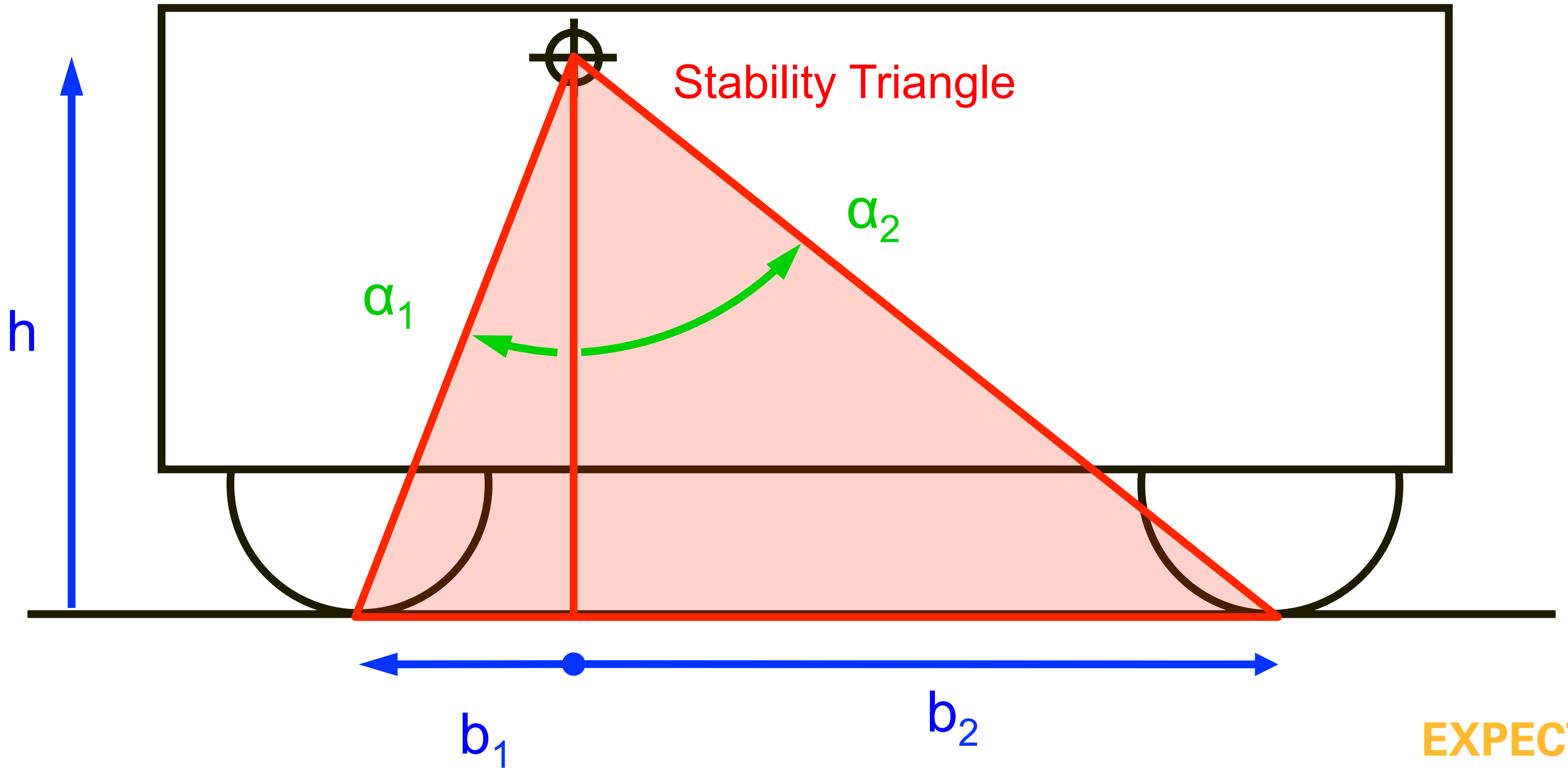
Center of Gravity

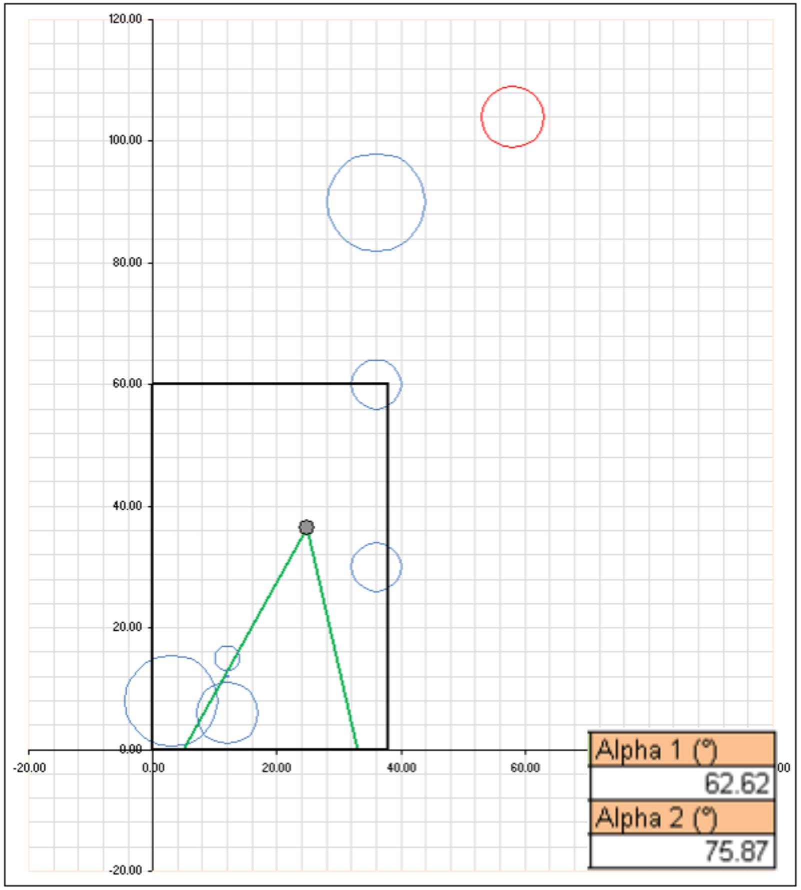
- Why keep it low?
  - Lowering the center of gravity maximizes alpha!

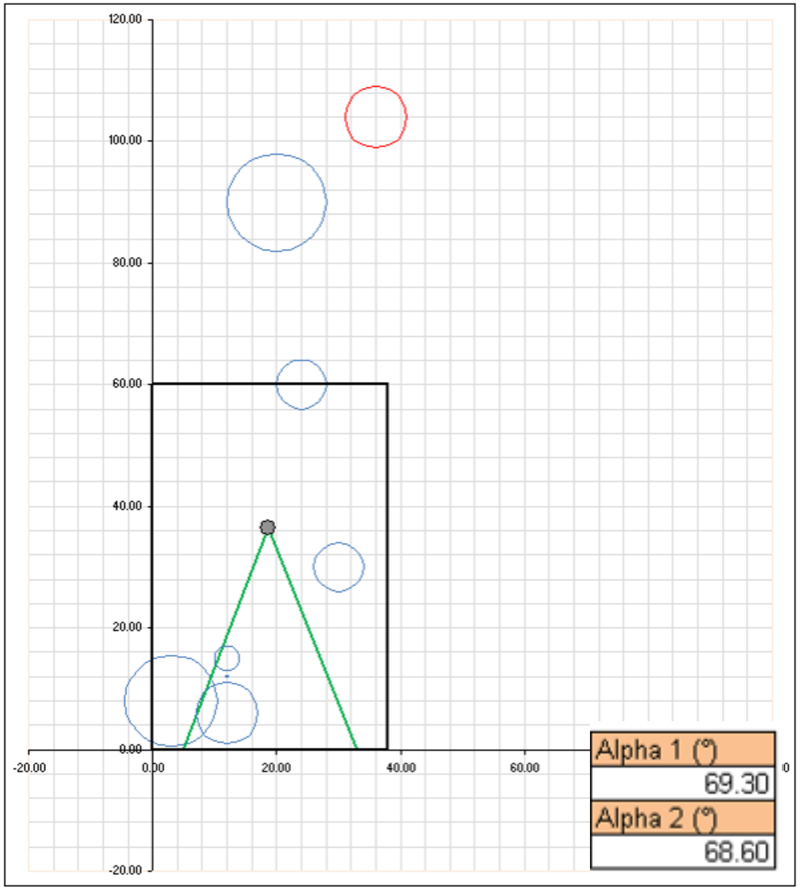


Center of Gravity

- BCR 2008 FRC initial CG estimate

$$\bar{x}W = \sum x_i W_i$$
$$\bar{y}W = \sum y_i W_i$$
$$\bar{z}W = \sum z_i W_i$$





System Requirements

- Designing is all about tradeoffs
  - Speed vs torque
  - Low CG vs reaching high
  - Weight vs features
  - Control vs power

System Requirements

- Requirements
  - Before designing a robot, we must know what it needs to do
  - The design requirements usually stem from the game
  - Strategy plays a big part in the requirements
  - Decide the requirements as a team

Whole Robot Concept & System Engineering!

System Requirements: Motor Performance

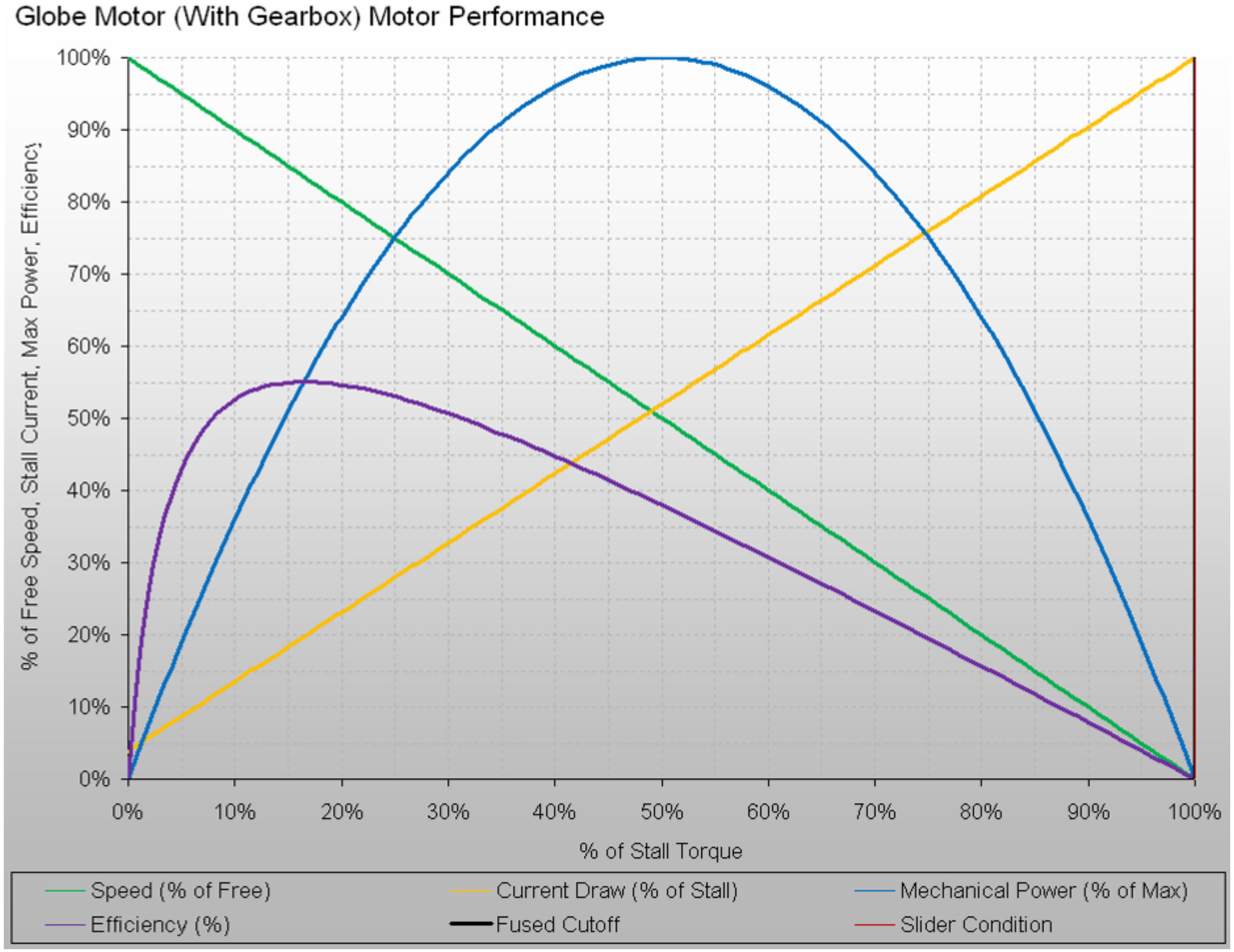
$$\omega = -\frac{\omega_{fs,op}}{\tau_{stall,op}}\tau + \omega_{fs,op}$$

$$P = \tau\omega\frac{2\pi}{60}$$

$$I = \frac{I_{stall,op} - I_{fs,op}}{\tau_{stall,op}}\tau + I_{fs,op}$$

$$P = IV_{op}$$

$$e = \frac{P_{mechanical}}{P_{electrical}}$$



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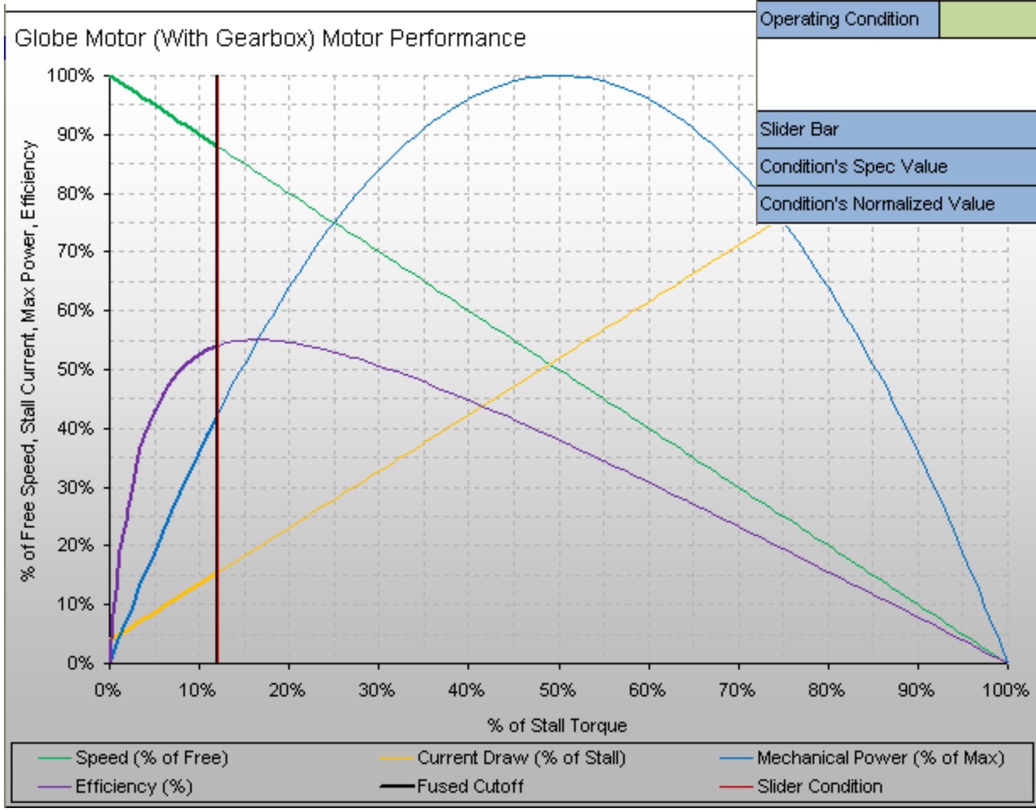
System Requirements: Motor Performance

Motor	Globe Motor (With Gearbox)					
Fuse	2	Amps				

	Voltage (V)	Free Speed (RPM)	Stall Torque (N*m)	Stall Current (Amp)	Free Current (Amp)	Max Power (Watt)
Specifications	12	100	19.00	21.00	0.82	49.74
Operating Condition	7.2	60	11.40	12.60	0.49	17.91

	Torque (N m)	Speed (RPM)	Current (Amp)	Power (Watts)	Efficiency (%)
Slider Bar					
Condition's Spec Value	1.368	52.800	1.945	7.564	54.0%
Condition's Normalized Value	12.0%	88.0%	15.4%	42.2%	54.0%



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