The Joy of Simple Robots

FRC 2015 Palmetto Kick Off

USC Swearingen Engineering Center

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Off Season 2014 Spare Robot “Ramblin’ Rex”

Simple Robots:
Topics

- Strategic Design and Build Season Schedule
- Drive Train
- Mechanisms
- Strategy Examples: 2011 to 2014

Fail early… finish early

STRATEGIC DESIGN & BUILD SEASON SCHEDULE

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Excerpt:
Letter from Woodie Flowers
1999 Game Manual

As in the past, designing the competition has made our brains hurt for months. We have tried to:

- Create an exciting challenge which is new to all of us
- Make sure that we are ambivalent about potential ways to win
- Make sure that creativity and pursuit of excellence pays
- Make sure that a relatively simple design, operated skillfully, can be very competitive
- Insure that all participants will see levels of success rather than pass-fail tests

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1114 Simbotics
Strategic Design Pointers

- Strategic analysis is a must
  - *You must know what you want to do before you work on how*
  - Analyze all possible ways to score
  - Analyze ways to prevent opponents from scoring
  - Understand the ranking system
- Cost-Benefit Analysis
  - Compare difficulty of task to number of points scored
- Prioritize
  - Prioritize your scoring / defending strategy
  - Prioritize robot attributes and functions

1114 Simbotics
Strategic Design Pointers

- General Tips
  - Perfectionism can kill the schedule
  - *“Never let perfectionism get in the way of getting a good job done”*

1114 Simbotics
Build Season Timeline

The Beginning

Week 1

- Brainstorming – Days 1-4
- Design Freeze – Day 5
- Established robot design
- Mobility system frozen
- Frozen means no more changes!!
- General ideas for all mechanisms
- Mechanism Prototyping – Days 5-8
- Build Drive System – Days 5-14

The Middle

Week 2

- Mechanism Build – Days 8-21
- Programmers Begin Coding – Day 8
- Can & should start pseudo-coding earlier
- Robot Controls – Days 8-14
- Drive System Complete – Day 14
- Having the robot moving early is crucial!!

Week 3

- Begin Autonomous Testing – Day 15
- Most FIRST autonomy only involve the chassis

The End

Week 4

- Mechanism Integration – Days 22-28
- Wiring is not a quick job

Weeks 5-6

- Robot Done – Day 29
- Testing & Perfecting – Days 29-40
- Not as easy as it sounds
- Weight Reduction
- Driver Training – Days 29-40
- “Practiced drivers make bad robots win, and unpracticed drivers make good robots lose”

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http://www.simbotics.org/resources/team-management/build-season

4451 Build Season Milestones

- Week 1
  - Monday – Pick Drive Train
  - Thursday – Strategy & Basic Robot Function Finalized
- Week 2
  - Drive train fully functional
  - Begin autonomous testing
- Week 4
  - Fully functional robot
- Week 5 – 6
  - Drive team practice
  - Testing / perfecting

Why not build the kit bot?

DRIVE TRAIN

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Drive Train Selection

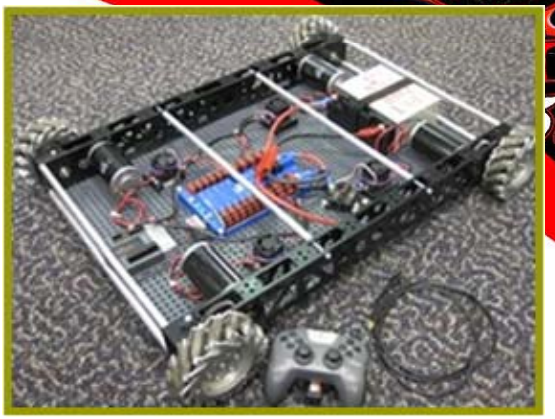
- Drive train attributes
  1. Reliable / low maintenance
  2. Meets your game objectives
  3. Completed fast to give your drive team practice time
  4. Low COG (improves driving characteristics)

- Why would you not use kit bot chassis?
  - Reliable skid steer design
  - Usually designed for 10 fps – good mid range speed
  - Can (and should) be built within the 1st week

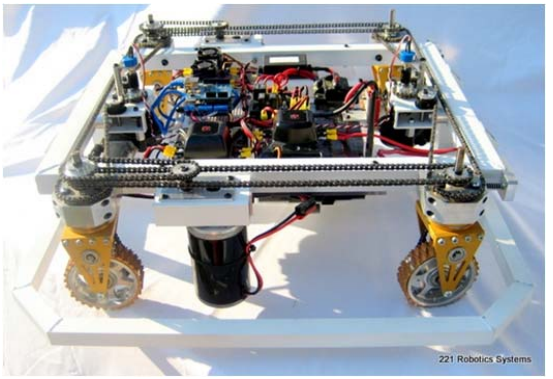
- <u>Bottom line:</u> Do not build a custom drive train during build season. *(Makes a great off season project for those interested)*

Custom Drive Train

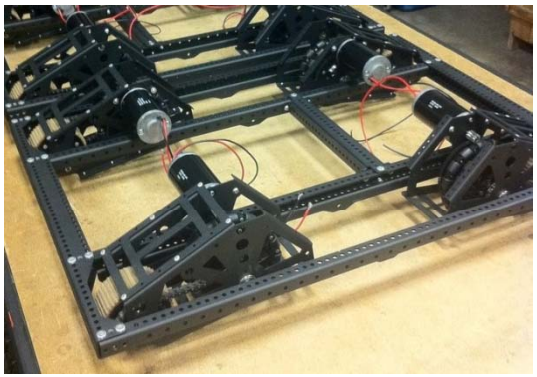
- **Mecanum**
  - Requires 4 gearboxes (extra weight)
  - Requires even weight distribution and gryo for best performance



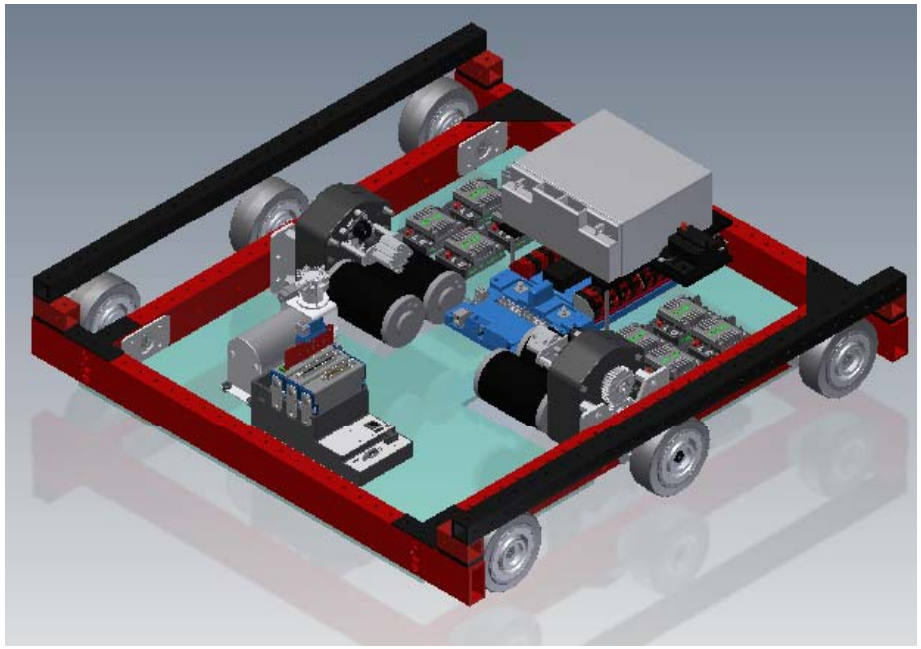
- **Swerve**
  - High degree of difficulty in construction
  - Requires significant investment in software



- **Switch drive (Omni / Traction)**
  - Extra weight for wheels and pneumatics
  - Very agile in omni mode – make sure your drive team has practice time



4451 Aerial Assist Custom Drive Train



- 2 speed “West Coast Drive”
- Good stuff:
  - Very low COG
  - Built with tools in our shop
  - 2x1 tube construction for full robot frame
- Not so good stuff:
  - Too fast in high speed for driver (17fps free speed)

Robust, repeatable

MECHANISMS

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Simplicity of Mechanisms

- Design Goals:
  - #1: Robust mechanism
    - Doesn't breakdown during game
    - Easy to maintain
  - #2: Repeatable performance
    - Alliances can count on your team to perform consistently
    - Easy for the drive team to use

EVERYTHING SHOULD BE MADE AS SIMPLE AS POSSIBLE, BUT NOT SIMPLER—ALBERT EINSTEIN

Minimum Competitive Concept

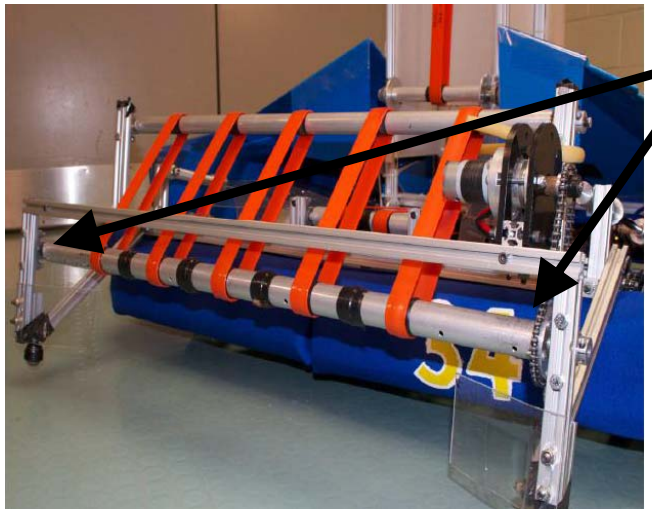
Isaac Rife – FRC 33 Killer Bees

- Assumptions are that one of the primary goals of the **MCC** is to play in elims (not necessarily win on Einstein), and you team has mid-pack to lower fabrication resources.

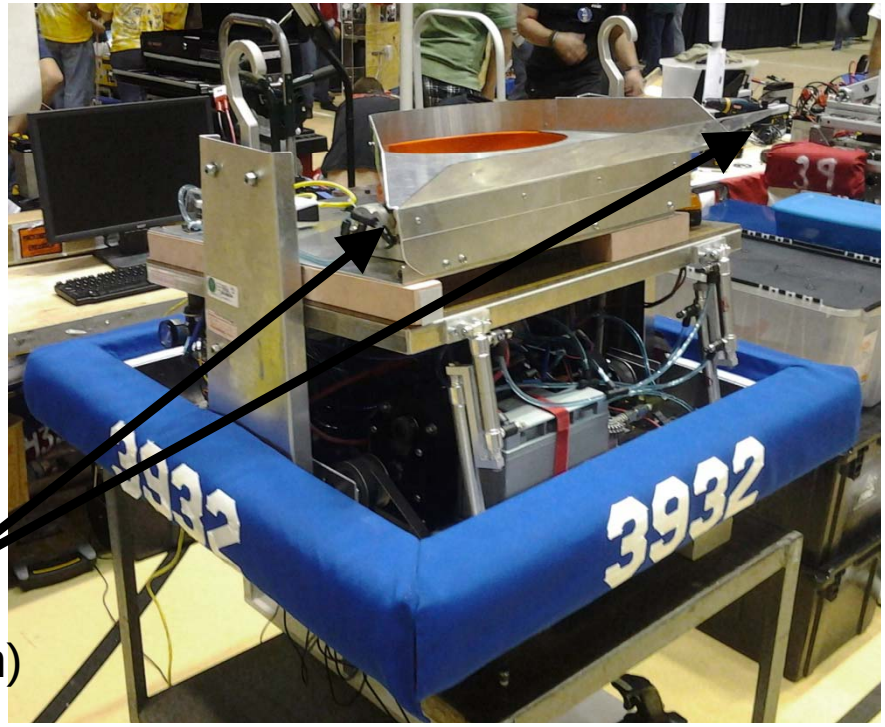
- Please list your assumptions, strategy to seed high, estimate of a winning score, and what robot design elements would achieve this score.

Simplicity of Operation

- Gathering game pieces – wider is better



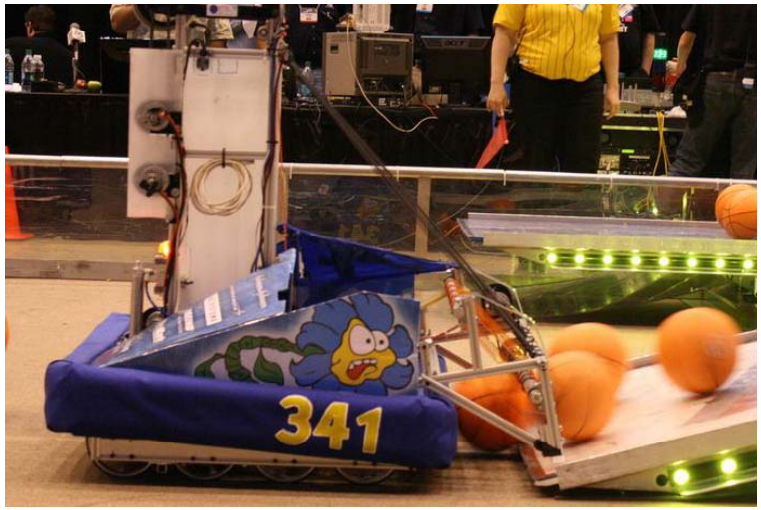
2012 ball pick up



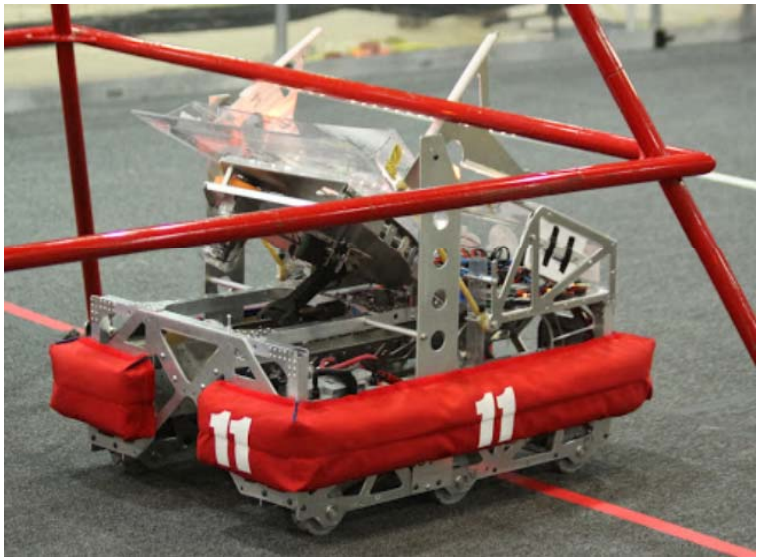
2013 Frisbee Pick up
(at human player station)

Simplicity of Operation

- Multiple functions in one device



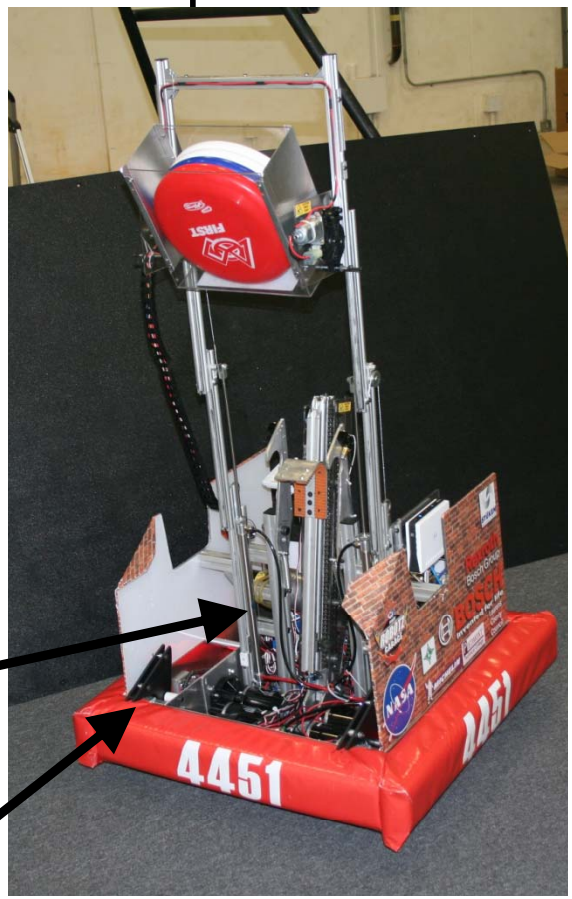
2012: Ball collector & bridge manipulator



2013: 10 point hanger & shot distance alignment

Simplicity of Operation

- Need two positions? How about pneumatics?



Cylinder used to extend elevator instead of motors

Spring loaded bumper wedges

4451 2014 Robot
Complexity of Operation

Good stuff

- Positioning system increased shot accuracy
- Potentiometer on winch gave us consistent shot power
- Auto reload shooter

Not so good stuff

- Ball pick up was not well integrated with shooter. Took several tries to load ball.
- Shooter had to be moved from ball pick up position to primary shooting position.
- HP needed to be close to load robot

Unused stuff

- Variable power shooter was not used for competitive advantage
- 2 speed drive train was not fully utilized

180 SPAM
Same robot… simpler execution

- Good stuff
  - Fast / wide pick up
  - Single power shooter… fast
  - Simple roller eject
  - Plastic hands to aid human loading

2014 Off Season Spare Robot
Simplicity of Operation
Minimum Competitive Concept

- Last minute addition to SCRIW
  - One day build on existing practice drive base
- Strategy:
  - Inbounder / defender
  - Can score in low goal
- Features:
  - 1 speed drive train
  - Human load from top
  - Powered roller eject
  - No floor pick-up
  - 60” wall – defend and inbound backboard
- Result:
  - Qualified 1st
- Good Stuff
  - Only one motor in the scoring section
  - Easy to human load
  - Defense = Get in front of someone with that tall wall
- No So good stuff
  - A little top heavy which impacted driving performance
- If we had the time
  - Deploy front roller for floor pick up capability
  - Hinge side panels to make it easier to human load from a distance.

Minimum Competitive Concept

STRATEGY EXAMPLES: 2011 - 2014

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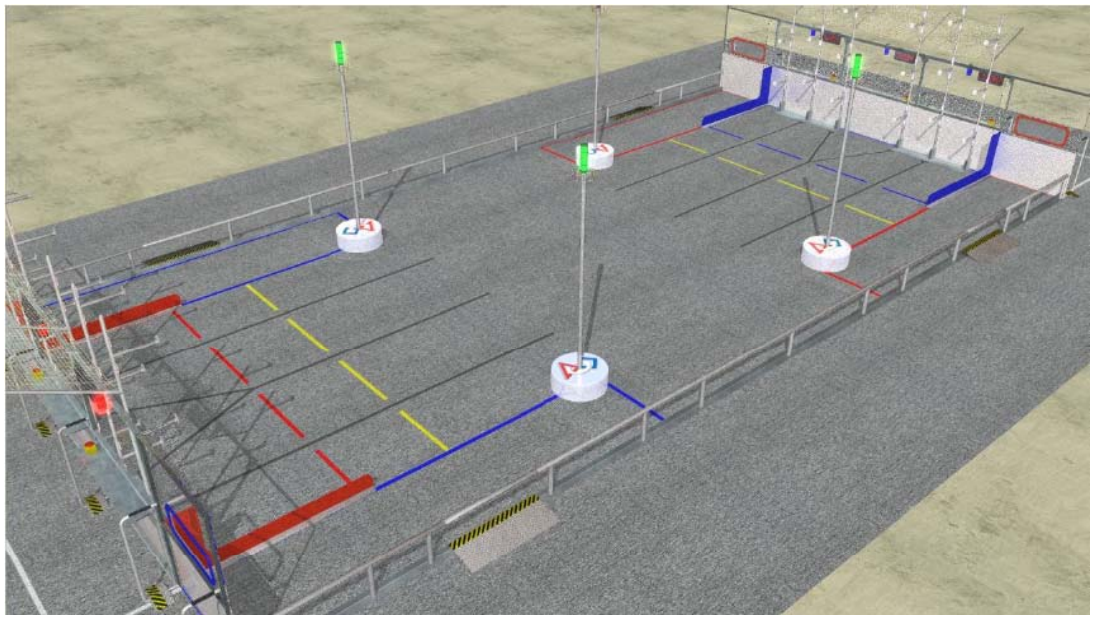
2011 Logomotion



Ranking System

- Qualification Score – W / L / T
- 1st Tie Breaker - Average un-penalized score of losing alliance
- 2nd Tie Breaker – Team's highest match score

Autonomous

Ubertubes hung during Autonomous	
On bottom row	2 points
On middle row	4 points
On top row	6 points

Tele-op

Logo pieces	*Alone*	*Over Ubertube*
On bottom ROW	1 point	2 points
On middle ROW	2 points	4 points
On top ROW	3 points	6 points

Double row score for making a "logo"

End Game

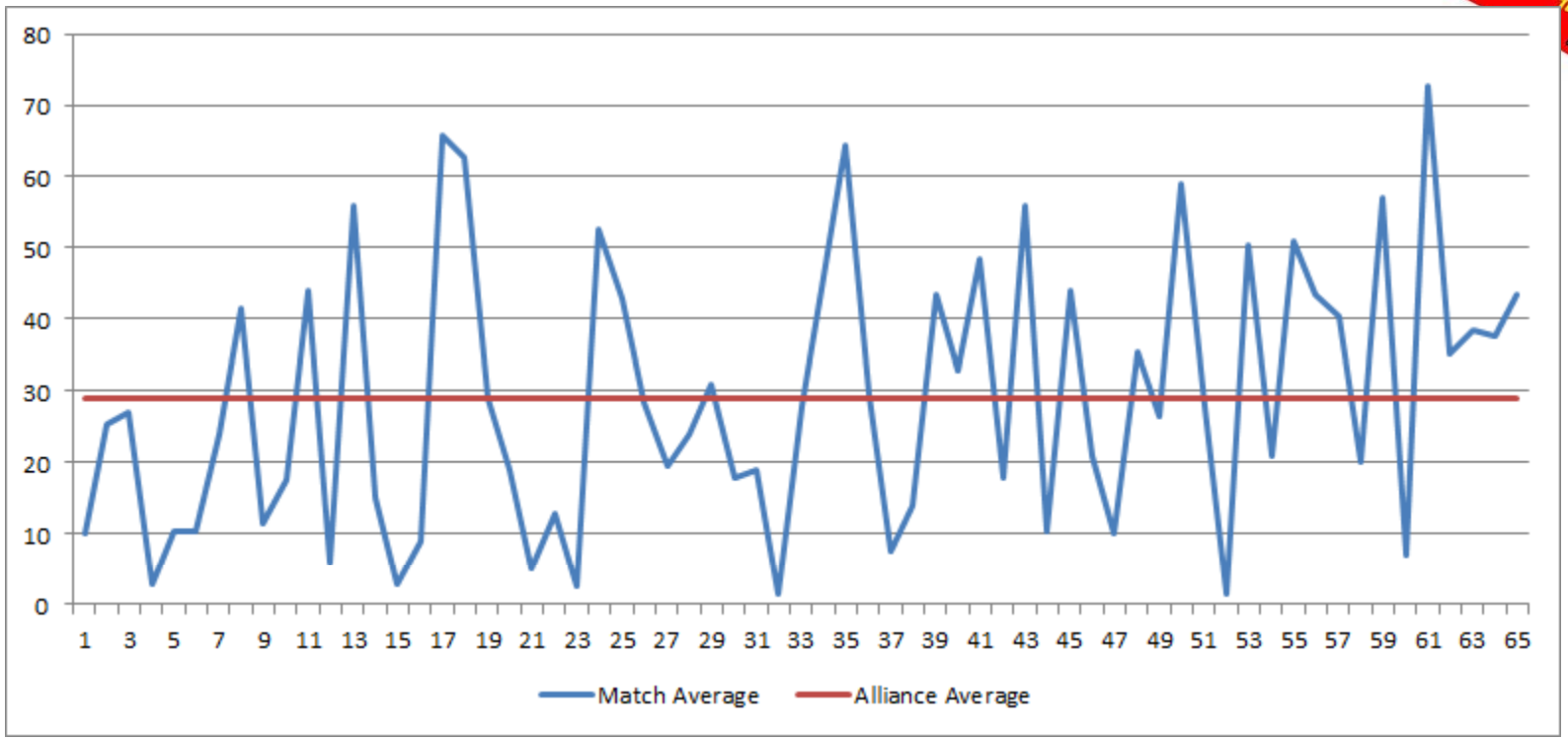
Minibot race bonus	
1st MINIBOT	30 points
2nd MINIBOT	20 points
3rd MINIBOT	15 points
4th MINIBOT	10 points

2011 Logomotion
Minimum Competitive Concept

- Option 1: Mini-bot only plus defense
  - 10 to 30 points for mini-bot race
  - High number of point per single action
  - 3 tubes on high rank with 1 autonomous uber tube = 30 points

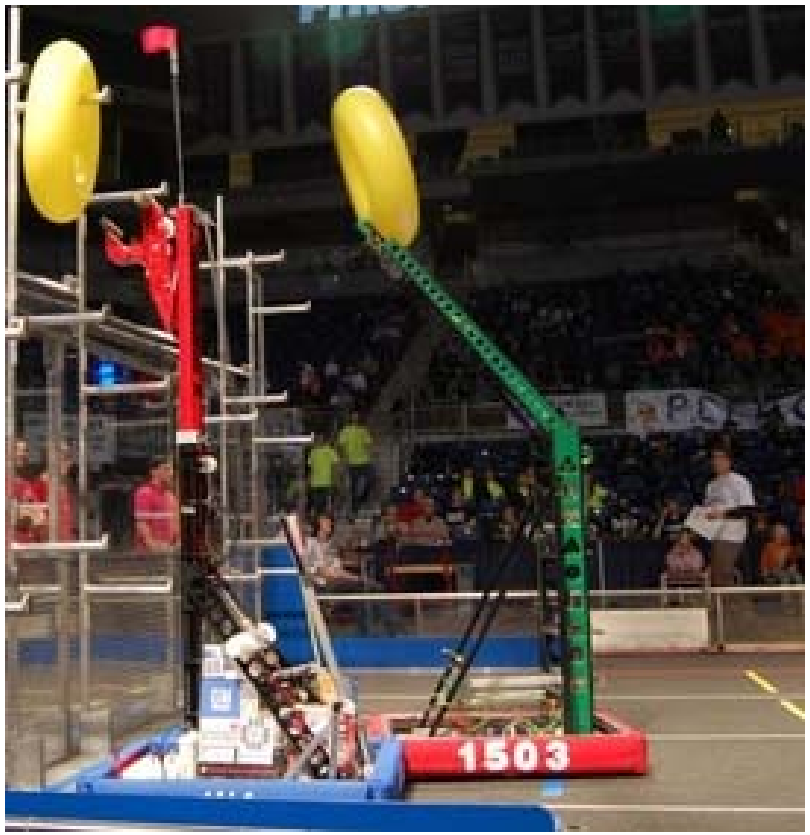
- Option 2: Low rack specialist
  - Human load only
  - No arm or elevator
  - No mini-bot
  - 1 uber tube in auto 2 points
  - 3 tubes in tele-op 8 points

2011 Palmetto Qualification Scores



- Average alliance score = 29
- One 1st place mini bot = 30

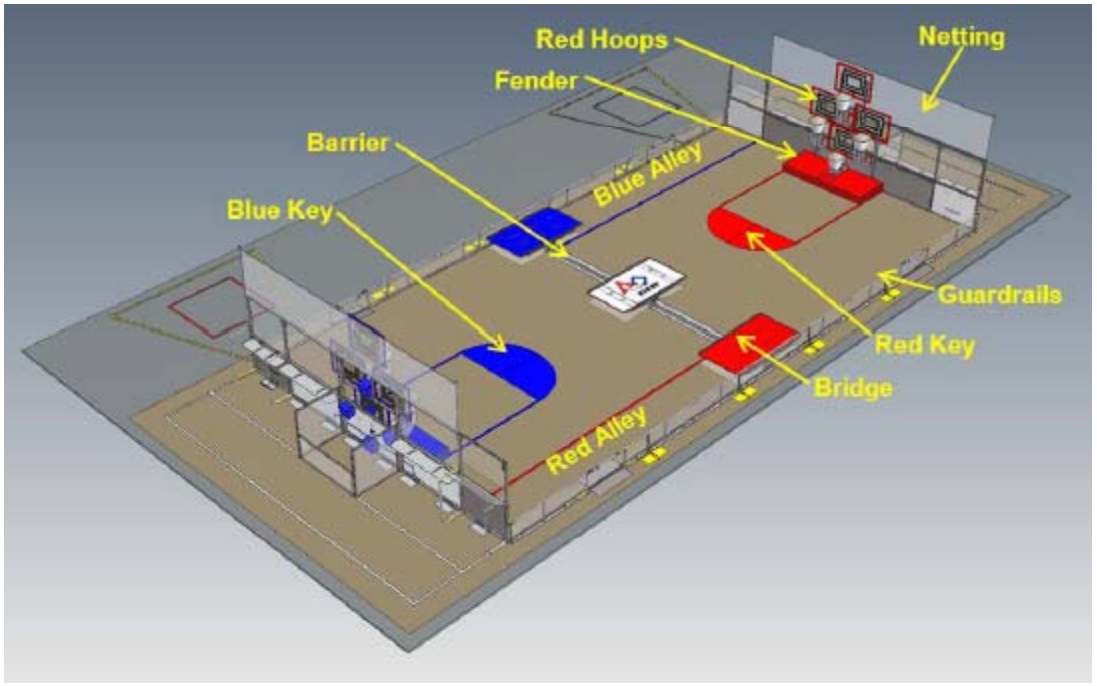
2011 Logomotion
FRC 1503: Spartonics



- Strategy
  - 1 Uber tube in Auto
  - Finish top row in tele-op
  - Reliable mini-bot
- Features
  - Single speed drive train
  - Single joint arm
  - Pick up at human player station only
- Notables
  - Finished practice robot in 3 weeks
  - Drive team practice 2 to 3 hours every day
- Results
  - Winner Pittsburgh
  - Winner Greater Toronto East
  - Winner Newton Division

http://www.thebluealliance.com/match/2011new_qm105

2012 Rebound Rumble



Ranking System

- Qualification Score – W / L / T plus 2 points for co-op bridge
- 1st Tie Breaker – Auto points
- 2nd Tie Breaker – Bridge points

Basket Points

Hoop	Points
Top	3
Middle	2
Bottom	1

3 point autonomous bonus per basket

Bridge Points

# of Robots	Qualification	Elimination
1	10	10
2	20	20
3	20	40

2012 Rebound Rumble
Minimum Competitive Concept

- Bridge balancer / ball collector / defender
  - 10 point balance specialist
  - Focus on co-op bridge balancing for extra qualification points
  - Defend by going over bridge and stealing balls
  - Features
    - Single speed kit chassis
    - Low center of gravity to aid balancing
    - Small chassis for room on bridge
    - Combination ball collector / bridge manipulator

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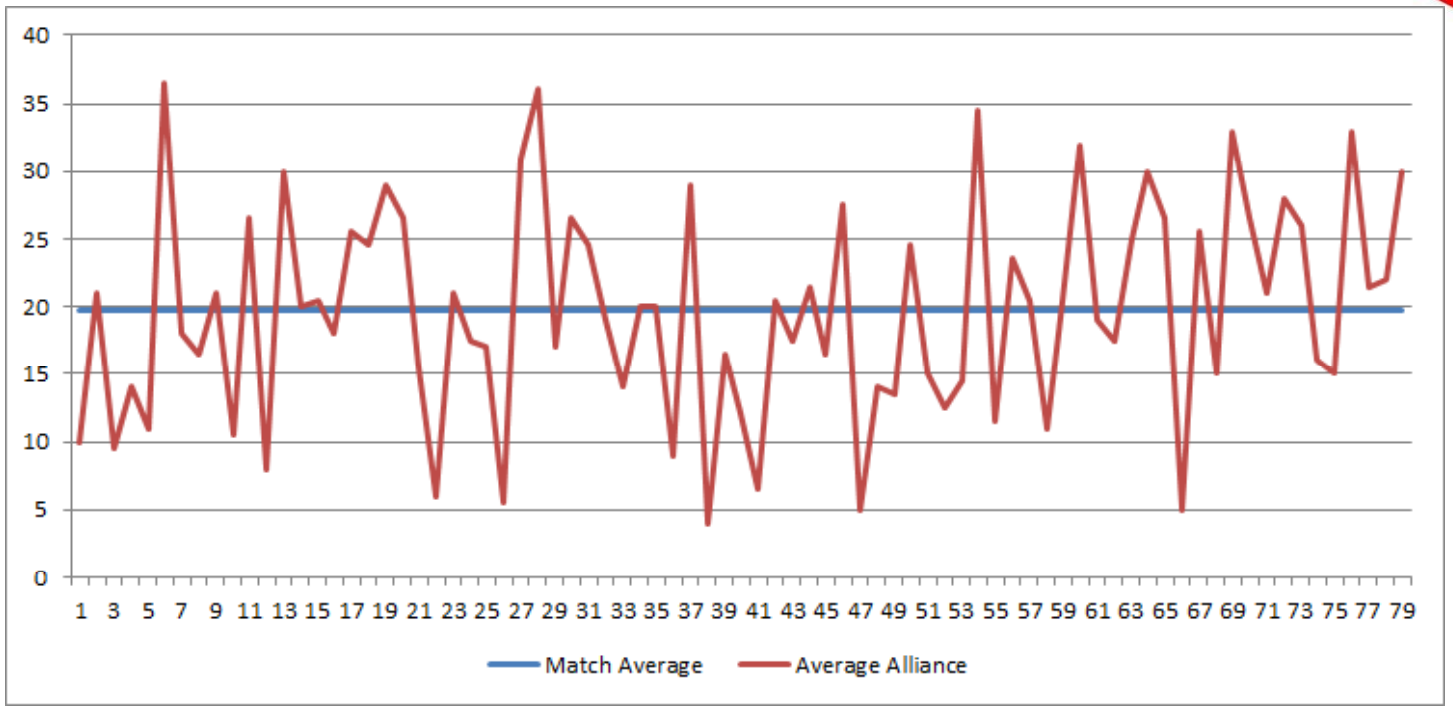
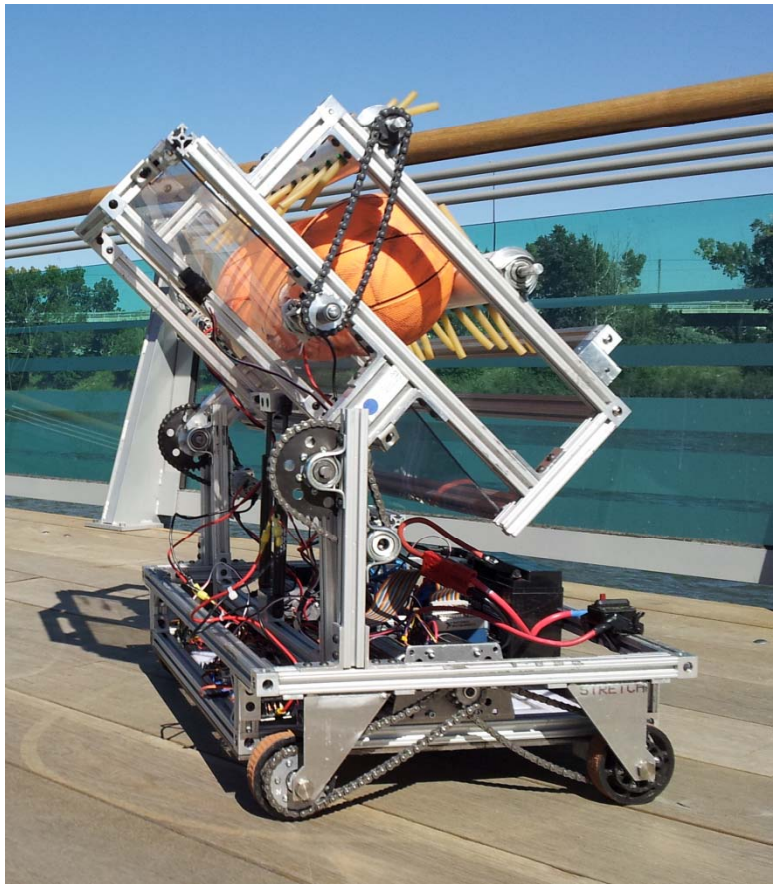
2012 Palmetto Qualification Scores



- Average alliance score = 20
- MCC estimate = 10

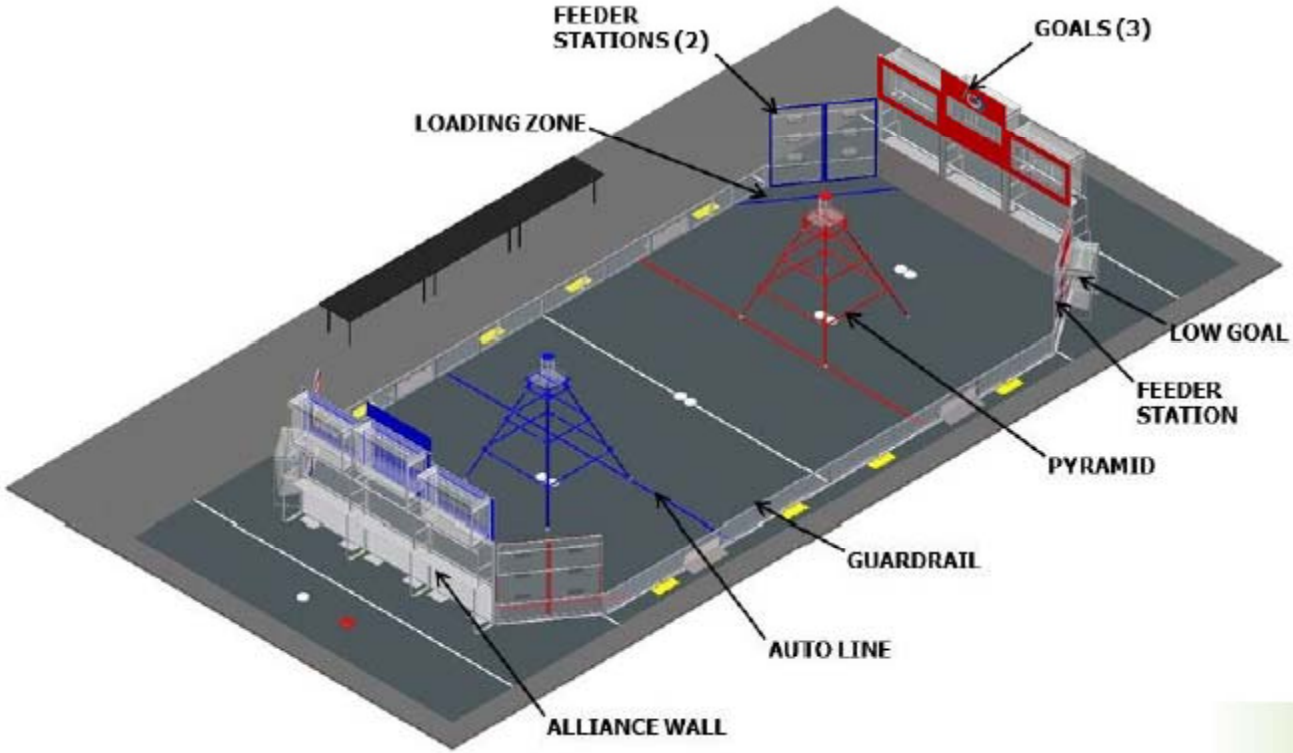
2012 Rebound Rumble
FRC 4334: Alberta Tech Alliance



- Strategy
  - Defender / ball collector
  - Balance on bridge
- Features
  - Floor collector / bridge manipulator
  - Small footprint for triple balance
- Results
  - Semi Finalist Greater Toronto East
  - Winner Archimedes Division

http://www.thebluealliance.com/match/2012arc_f1m3

2013 Ultimate Ascent

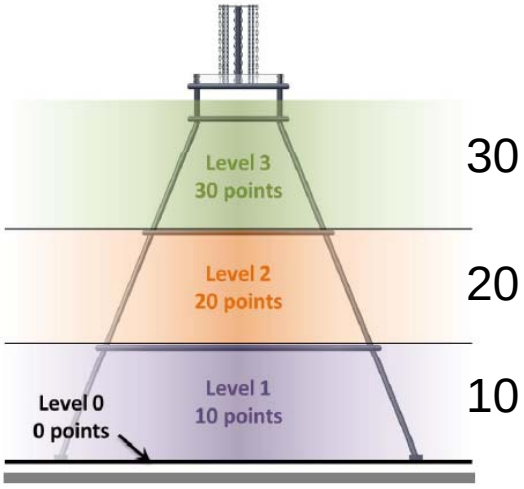


- Ranking System
  - Qualification Score – W / L / T
  - 1st Tie Breaker – Auto
  - 2nd Tie Breaker – Climb Points

Disc Points

	AUTO	TELEOP
LOW GOAL	2	1
MIDDLE GOAL	4	2
HIGH GOAL	6	3
PYRAMID GOAL	N/A	5

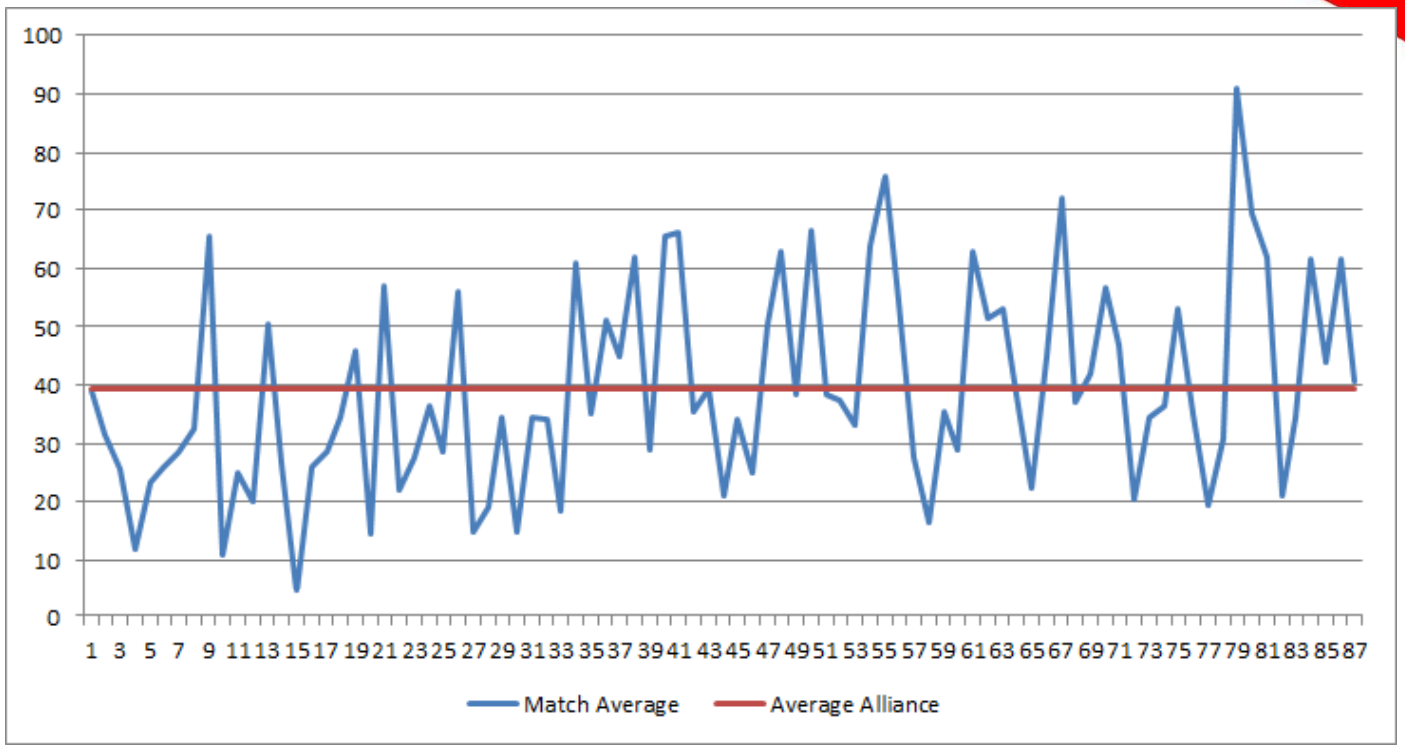
Climb Points



2013 Ultimate Ascent
Minimum Competitive Concept

- Low goal dumper / 10 point hanger / blocker
  - Human load only
  - Dumper tray for low goal
  - 2 disc auto
  - Features and attributes
    - Kit bot chassis
    - Top shelf with tilt control
    - Fixed “wedge” 10 point hanger
    - Option – tall blocker on front

2013 Palmetto Qualification Scores



- Average alliance score = 40
- MCC estimate = 14 to 22 points

2013 Ultimate Ascent
FRC 3313: Mechatronics

- Strategy
  - Shoot from front of pyramid – Auto & Tele-op
  - Hang for 10 points
- Features
  - Bucket as frisbee hoper
  - Single wheel shooter
  - Pneumatic cylinder hang
- Results
  - Semi Finalist 10,000 Lakes Regional

https://www.youtube.com/watch?v=Pvq5otqt4mI

2014 Aerial Assist

Ranking System

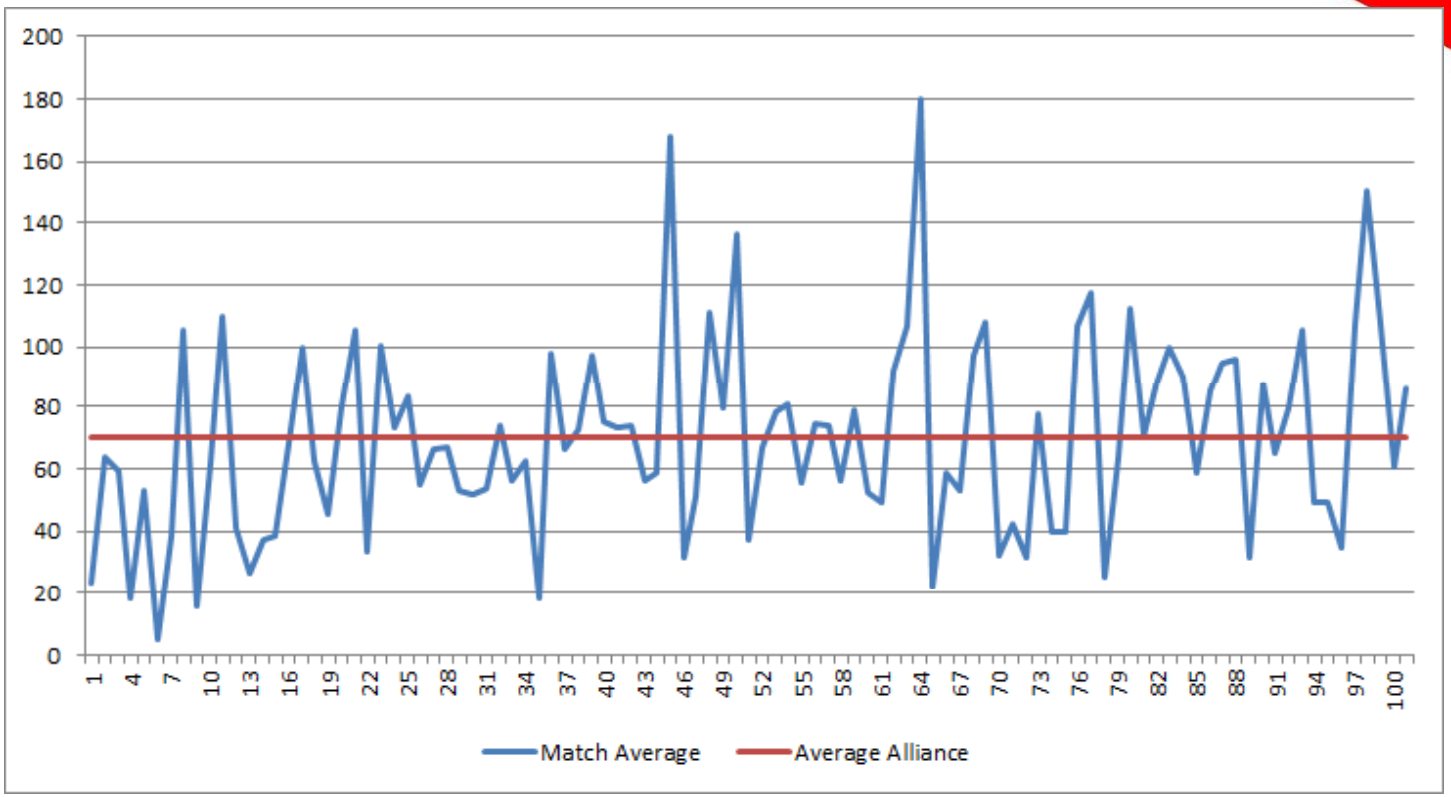
- Qualification Score – W / L / T
- 1st Tie Breaker – Assist Points
- 2nd Tie Breaker – Auto Points

Action	Base	AUTO (=Base+5)	AUTO & HOT (=Base+AUTO+5)	1 ASSIST (=Base+0)	2 ASSIST (=Base+10)	3 ASSIST (=Base+30)
LOW GOAL	1	6	11	1	11	31
HIGH GOAL	10	15	20	10	20	40
TRUSS	10					
Mobility		5				
CATCH	10					

2014 Aerial Assist
Minimum Competitive Concept

- Human load / low goal / assist / blocker
  - Human load at a minimum
  - Box to hold ball with gate or roller eject
  - 5 point auto mobility score
  - Floor pickup – optional
  - Low goal auto score - optional
  - Features and attributes
    - Kit bot chassis
    - Tall front for blocker
    - Easy to human load
    - Quick eject for assist or low goal score

2014 Palmetto Qualification Scores



- Average alliance score = 70
- MCC estimate = 5 auto + 10 assist pts per cycle

2014 Aerial Assist
FRC 4935: T-Rex

- Strategy
  - Assist robot / defender
  - 5 point autonomous
- Features
  - Kitbot drive train
  - Extendable roller / floor pick-up
- Results
  - Winner Palmetto
  - Semi finalist North Carolina
  - 5 – 5 record Curie Division

http://www.thebluealliance.com/match/2014cur_qm6