



# ***Building To Your Capabilities***



**Strategic Decisions To Make Your  
Team As Successful As Possible**





## Our Background:

- I am Brandon Holley
- 15<sup>th</sup> FRC Season
  - 9<sup>th</sup> as Team 125 Mentor
- Mechanical Engineer
  - Northeastern University
  - Design engineer at Sonos Inc.
- Boston Local Kickoff Coordinator
- Northeastern University District Event Chairman
- Beantown Blitz Coordinator



## PLAY:1

### MINI BUT MIGHTY

No other wireless speaker packs so much deep, crystal clear HiFi sound into such a compact design.







# Why are we all here today?

- Expanding our knowledge base
- Expanding our capabilities
- Jumpstart our build season
- Get newcomers up to speed
  
- Robots...duh!





## Definition of Success:

- Success- The accomplishment of an aim or purpose
- Every team has different objectives
- INSPIRATION is a goal all FIRST teams share
- Today's focus (for me):  
**On-field success!**





## Group Discussion:

What is the single greatest accomplishment your team has experienced?

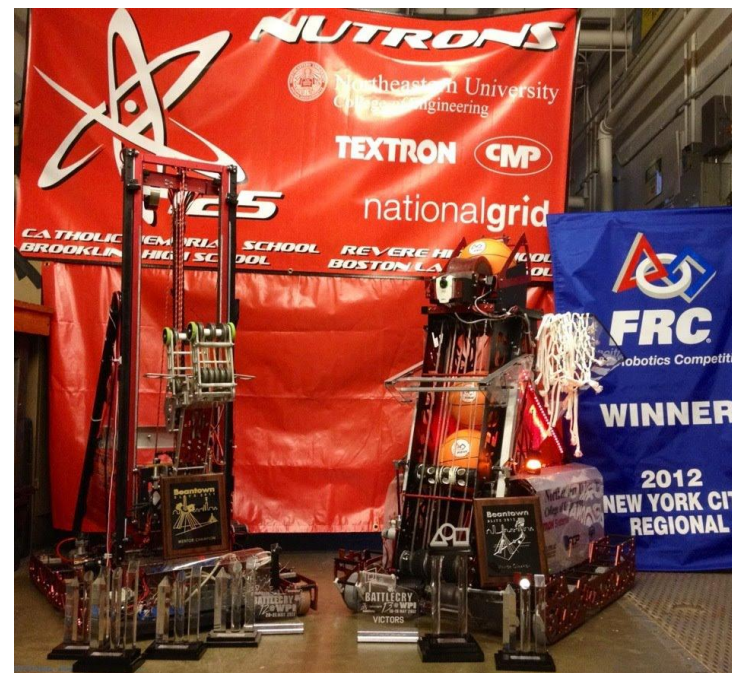






# We can all achieve greatness!

- Every team has the ability to have tremendous on-field success
- Different paths will take us there
  - This is why FIRST is awesome!





## On-Field Success:

- Can lead to:
  - Enhanced team pride
  - Expanded base of talent
    - New students
    - New mentors
    - More involved parents
  - Builds momentum
    - Local media
    - Attracts potential sponsors





## Setting Goals:

- Goals should be 'reach'-type goals...
- ....Yet, achievable for your team
  - 0.0015% of FRC teams won the Championship
- Small, tangible, steps
  - Rome was not built in a day







## Possible Robot-Specific Goals:

- Being chosen for an elimination alliance
  - Top 40% of robots at a competition
- Ranking in the top 8, and choosing an alliance
  - Top 15% of robots at a competition
- Making it to the finals
  - Top 10% of robots at a competition
- Winning an event
  - Top 5% of robots at a competition
- Winning a judged award
  - Preparation and training can help your chances!
  - Rookies have access to specific Rookie awards (that are worth a lot in the District system....)



## Group Exercise!

- Come up with a challenging but satisfying goal for your team for this upcoming year!





## Celebrate Failure:

- We will all fail to reach goals at some point:
  - Poor strategic decisions
  - Poor execution of ideas
  - Plain old bad luck
- Greet this with a smile, and use this as fuel to push even harder







## Breaking Down “The Game”:

- Is a whole seminar in itself...
- Game offers many elements:
  - High risk/high reward (3 pointers, climb & dump)
  - Safer, more attainable options (2 pointers, 10 point climb)
- End game has been especially critical:
  - Minibots
  - Bridge balancing
  - Pyramid climbs



# The Ripple Effect:

Decisions made in the first hours of build season **WILL** ripple through the entire season!

Kickoff-> Build Season-> Competition Season





## Game Breakdown Impact:

- Establish a winning strategy
  - Be sure to break the game down
- Use lessons learned in previous years (if applicable)
  - For rookie teams, ask veterans nearby for advice!
- Be honest with yourselves
  - Where most teams go wrong







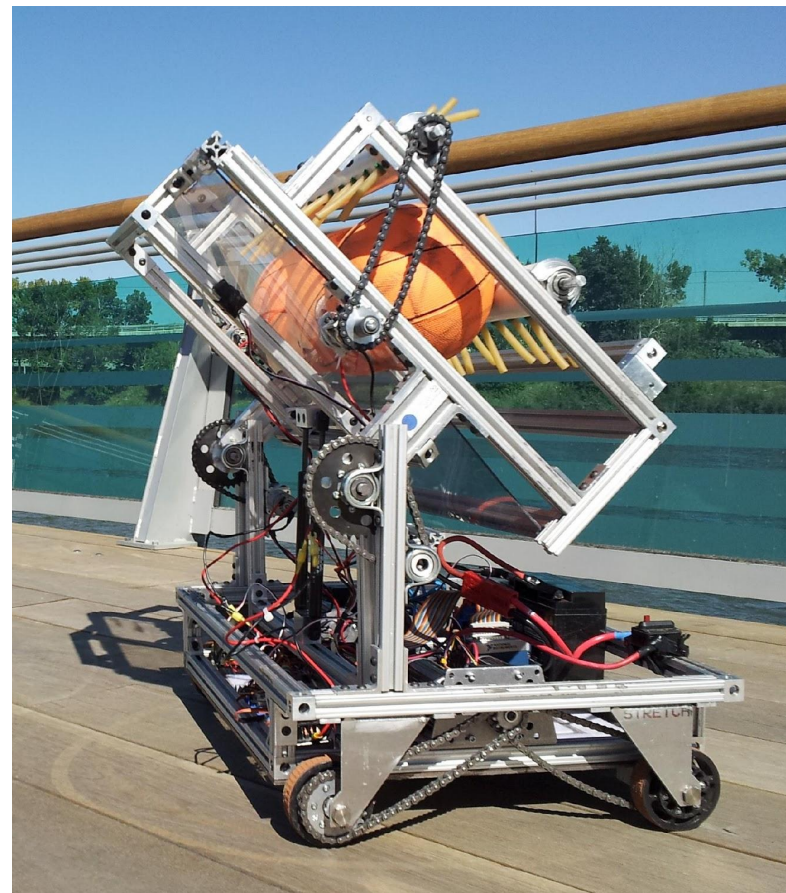
## Case Studies!

- FRC Team 4334- Best rookie season ever?
- FRC 610- Ruthlessly simple
- FRC Team 1503- Learning from past mistakes
- FRC Team 1114- Greatest single season in (modern) FIRST history



## FRC Team #4334- ATA (2012)

- Definition of “Building to your capabilities”
- Really understood themselves:
  - Rookie team
  - Relatively scarcely FRC populated area
- Wanted to build a successful, competitive robot
  - Knew best chance was building the best ‘support’ robot in FIRST





## 4334's 2012 Strategy:

- “Wide” profile robot
- 36” wide intake
  - Easier ball pickup
- Ball dumper
  - Pass balls over barrier to teammates
- 21” long
  - Can triple balance with 2 long bots if necessary
- Pop 4 pointers into lower goal in autonomous
  - Pass to solid teammates if they were consistent 3 point shooters



[http://www.youtube.com/watch?feature=player\\_detailpage&v=ABTTuwNsu6A#t=211s](http://www.youtube.com/watch?feature=player_detailpage&v=ABTTuwNsu6A#t=211s)





## 4334's Results in 2012

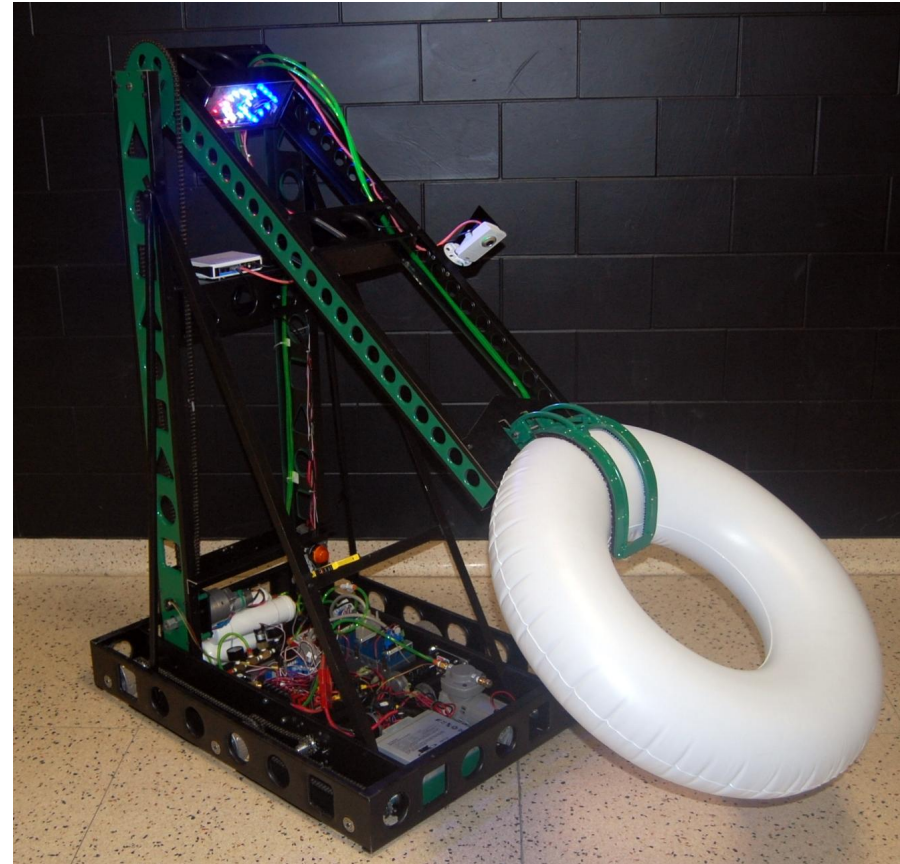
- Seeded 13<sup>th</sup> at their first ever regional (GTR East)
  - Rookie All Star Award
  - Coopertion Award
  - Highest Rookie Seed
- Selected by #1 seed in Archimedes Division at Championship in St, Louis
  - Archimedes Division Champions
- Indiana Robotics Invitational Participant
  - Selected 13<sup>th</sup> overall
  - Indiana Robotics Invitational Champions



## FRC Team #1503 – Spartonics (2011)

- After a “disaster” year in 2010, Spartonics simplified their approach
- Low part count
- COTS items
- Reliability

<http://www.youtube.com/watch?v=31Buw-A9BS0&feature=youtu.be>





## 1503's Decisions in 2011

- “In 2010, Team 1503 tried to build a robot that could be a "jack of all trades." This was a draining season due to the complexity of the 2010 game and a lack of human bodies to actually fabricate components for the robot. The season was a failure by our standards, making it no further than the semi finals at regionals with an overall negative OPR.

In 2011, 1503 decided to build a specialty robot that had a super low part count. The robot was designed with as many COTS components as possible, with some outsourced sheet metal work. There were even fewer machinist students than the previous year, but the strategy of building a specialty robot, (a robot that was strictly human fed to score on the top row,) paid off. It won two regionals in dominating fashion, and ended up winning its division at championships.”

-Nick Lawrence, Team 1503s Captain and Driver in 2011





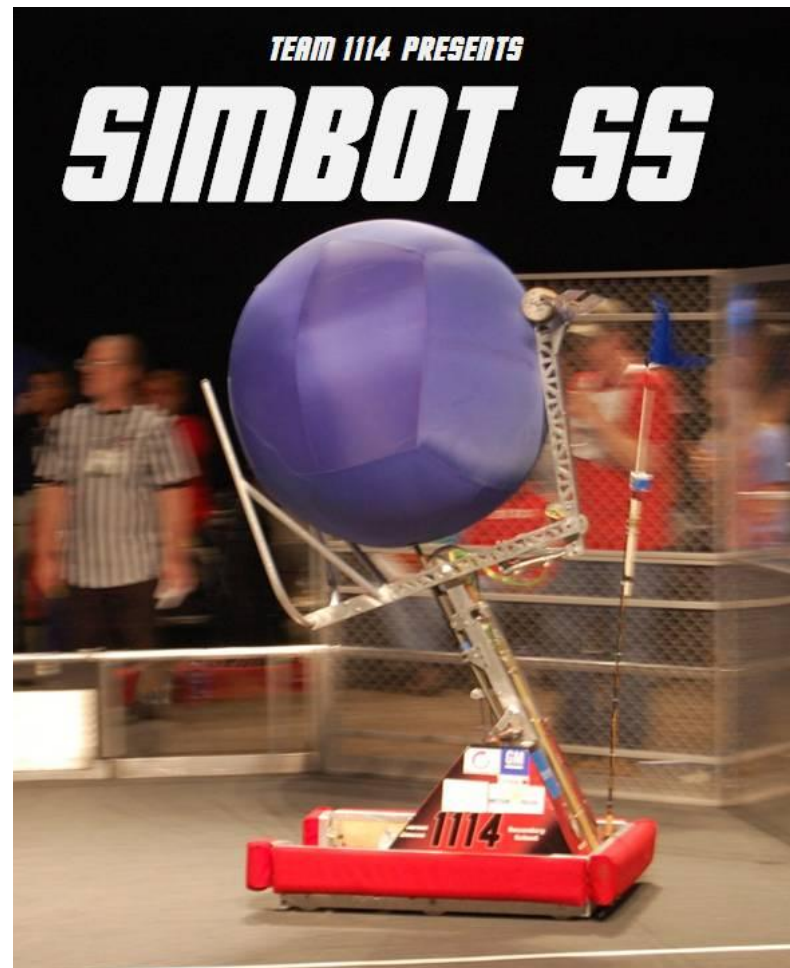
# 1503's Results in 2011

- Overall record of 41-9-0
- Pittsburgh Regional Winners
  - 5<sup>th</sup> Seed
  - Xerox Creativity Award
- Greater Toronto Regional East Winners
  - 3<sup>rd</sup> Seed
  - Engineering Excellence Award
- Newton Division Winners
- World Championship Finalists
- Indiana Robotics Invitational Participant



# FRC Team #1114- Simbotics (2008)

- Unparalleled design strategy
- Simple design executed near flawlessness
- Design excellence comes from excellent analysis of the game
  - Essentially predicted how a match would evolve before one had ever been played





# 1114's Architecture

- Birth of the Kit Bot on Steroids (will be covered in a bit)
- Minimal custom parts
  - Only where performance is markedly enhanced
- Focused on reliability/simplicity
- Simple design allowed for considerable drive practice
  - Always the difference maker between good and great teams

[http://www.youtube.com/watch?v=NYNEAL\\_dK6I](http://www.youtube.com/watch?v=NYNEAL_dK6I)

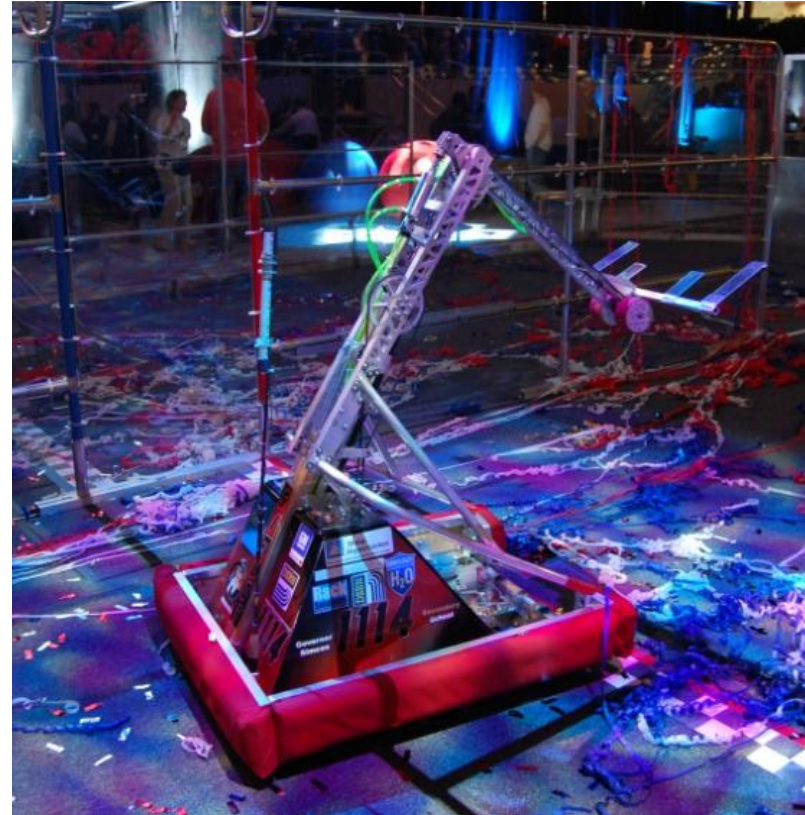






## 1114's Results in 2008

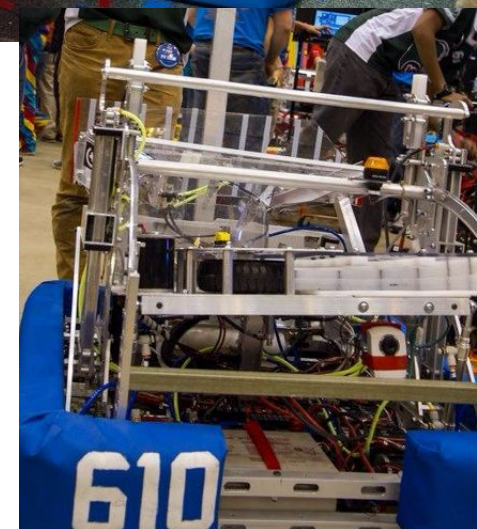
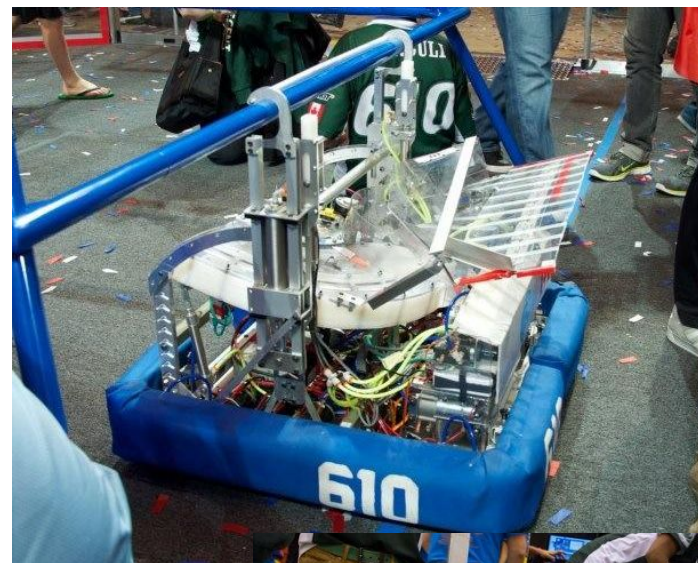
- Overall record of 68-10-0
- Midwest Regional Winners
  - 3<sup>rd</sup> seed
- Waterloo Regional Winners
  - 3<sup>rd</sup> seed
  - GM Industrial Design Award
- Greater Toronto Regional Winners
  - 1<sup>st</sup> Seed
  - GM Industrial Design Award
- Galileo Division Winners
  - 1<sup>st</sup> Seed
- World Championship Winners
- Indiana Robotics Invitational Participant





## FRC Team #610- The Coyotes (2013)

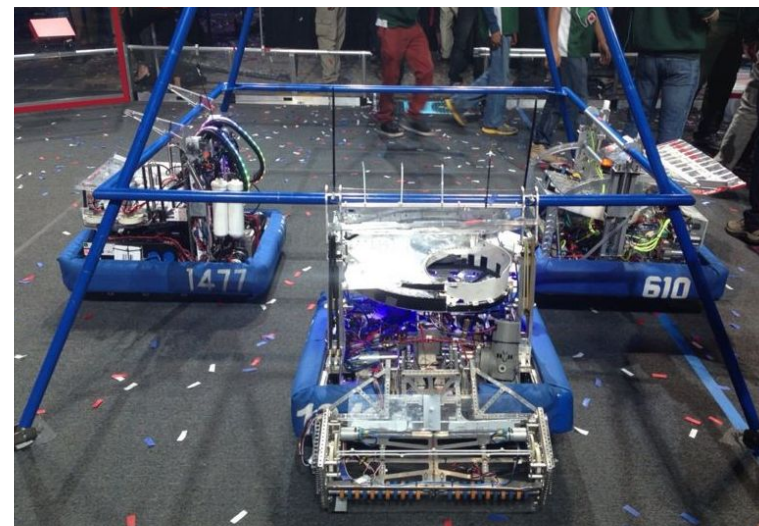
- Applied technical expertise to a relatively straightforward design
- Perfected a few systems vs. building several mediocre ones:
  - Extremely well driven
  - Added features as the season progressed
- Quick, accurate, deadly





## 610's 2013 Strategy:

- “Square” profile robot
- 6 CIM, 6 Wheel Drive
- 3 Point Shooter
  - Human loaded
  - Shoot opposite side of loader
- 2x 6” Pneumatic Wheeled Shooter
  - 5200 RPM
  - 2 Mini CIM
- 10pt. Pneumatic Climb



<http://www.youtube.com/watch?v=i5xB3Plq1ms>





## 610's Results in 2013

- Seeded 1<sup>st</sup> at Granite State Regional
  - Regional Winners
  - Engineering Excellence Award
- Seeded 3<sup>rd</sup> at Waterloo Regional
  - Regional Finalists
  - Motorola Quality Award
- Seeded 14<sup>th</sup> on Galileo
  - Selected by #5 seed, Galileo Division Champs
  - 2013 FRC World Champions





## Common Themes:

- Focused on core aspects:
  - Simple
  - Reliable
- Understood the game to exceptional levels
- Focused on COTS items where possible
  - Used custom parts to enhance features
- Well driven
  - Practice! Practice! Practice!
  - Robot needs to be done with enough time to allow practice



## *Group Decision Making*

- Volumes of work on this topic...
- The NUTRONS approach:
  - “VOTE” is a 4-letter word
  - Try Consensus Building
  - An unjustified opinion is worthless!
  - Be *quantitative* whenever possible



## *Weighted Objectives Tables*

- A tool used to help designers choose between several concepts based on a number of *weighted* criteria.
- This tool is especially effective because it makes comparisons based on what is “most important” to the designer.



## Weighted Objectives Tables

Comparison Criteria	Weight
Cost	5
Complexity	10
Weight	5
Tightness of Grip	5
Required Driver Precision	15
Speed of Grab	10

Total: **50**

Roller Claw	
Score	Weighted Score
3	15
3	30
4	20
3	15
5	75
4	40

**195**

Pinchy Claw	
Score	Weighted Score
3	15
2	20
2	10
5	25
3	45
3	30

**145**

Scoop	
Score	Weighted Score
5	25
5	50
5	25
1	5
2	30
4	40

**175**





## Now that you've drank the Kool-Aid...

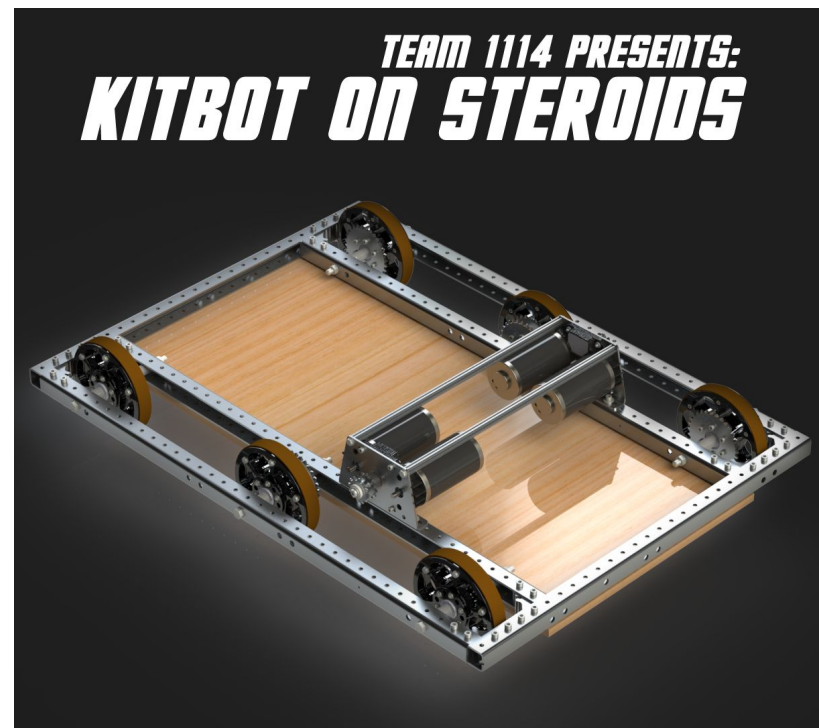
- What we'll discuss:
  - The now famous “Kitbot on Steroids”
  - COTS, COTS, COTS, wherever possible:
    - Andy Mark
    - Vex Pro (IFI)
    - West Coast Products
    - Team 221 LLC
    - Banebots
    - 80/20 rapid framing (use sparingly)





# Kit Bot on Steroids

- Invented by FRC Team #1114
- Drivetrain is the most important aspect of your robot
  - Also 2<sup>nd</sup> and 3<sup>rd</sup> most important....
- Kitbot has become very solid starting point
- Simple changes to the kitbot will allow for an even better robot
- Allows for slightly more customization than standard kitbot

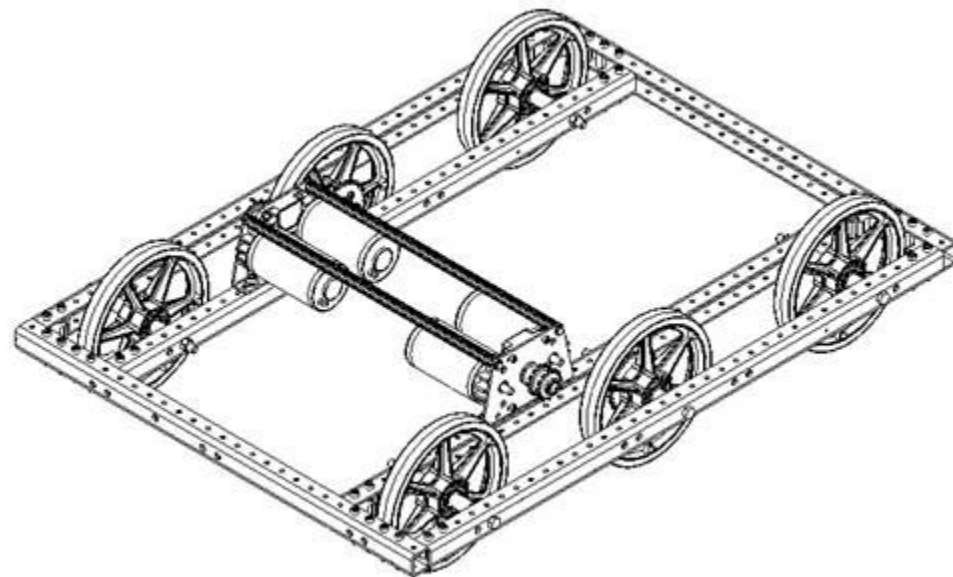




# Standard Kit of Parts Drivetrain

## 2012 KOP Drivetrain :

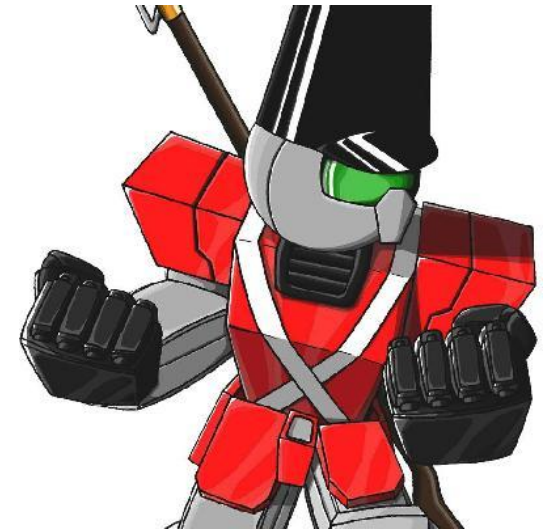
- 6WD with dropped center wheel
- 2 out of 6 wheels are driven
- Uses 8" FIRST Kit of Parts Wheels
- Outer wheel holes spaced perfectly
  - No tensioners required
- Has holes for 8WD if required
- Uses CIMple boxes
  - Geared to drive very fast ( $>18$  ft/s)
  - Gearbox sprocket = 12T
  - Wheel sprocket = 26T
- Overall, very good drivetrain





# Kitbot on Steroids

- Chain all 6 wheels together
  - Full pushing potential
- Replace 8" KoP wheels with 6" AndyMark or VEX Pro traction wheels
  - Higher traction
  - Smaller diameter
    - Requires less sprocket reduction
    - Lower CoG
- Add base plate for rigidity
- Change gear ratio to something a bit more manageable
  - Wheel sprocket
    - 36T → 9.9 ft/s
    - 32T → 11.1 ft/s
    - 30T → 11.9 ft/s
    - 28T → 12.7 ft/s
    - 26T → 13.7 ft/s
- Other potential upgrades
  - Replace CIMple Boxes with 2 speed gearbox
    - Will need to recalculate wheel and gearbox sprockets







## KBoS Advantages:

- Step above standard kitbot
  - All driven wheels
- Tuned speed
  - Allows for more specific gameplay design
- Enhanced reliability
  - Powering all wheels
  - Added rigidity from base plate
- Great stepping stone into more custom drive systems



# How to get your very own KBoS!

- Simbotics has done an amazing job putting together resources that allow teams to make their own KBoS:
  - <http://www.simbotics.org/resources/kitbot>
- Includes a 17 minute video with step by step instructions and pointers
- 3D CAD data as well as PDFs are also available
- They also have an iOS app!
  - Search for 'SimPhone' in the Apple Store



## COTS Items

- COTS = Commercial Off-The-Shelf
  - Items able to be commonly purchased from vendors
- Like anything, there are good and bad COTS items
- Can boost robot performance:
  - Focus on critical components
  - Spend less time constructing intermediate systems that can create weak points
    - Gearboxes
    - Wheels



# AndyMark

- Provide kitbot as well as other components found in KOP
- Born from FIRST
- Match many FIRST-related requirements
- Unmatched customer service
- High quality products



[www.andymark.com](http://www.andymark.com)





## AndyMark Items of Interest

- Gears
  - Steel, Aluminum
- Sprockets
  - Steel, Aluminum
  - #25 and #35 chain
- Hubs/Adapters
  - Interface with comr KOPmotors
- Spare motors





## AndyMark Shifters

- Calling card item
- Rock solid designs
- Serious investment for a season
- Produce 2 speed robot
- Easily integrated into Kitbot
  - KBoS





# WestCoast Products



- Young company
- Promising future
- Current offerings:
  - Aluminum gears
    - Additional sizes over AM
    - Aluminum alternatives to AM shifting gears
  - Hubs
    - Integration with COTS wheels



[www.wcproducts.net](http://www.wcproducts.net)



## BaneBots

- KOP contributor
- Variety of motors
- Planetary gearboxes
  - Useful for integration with smaller motors
  - Variety of reductions (4:1- $\rightarrow$ 256:1)
- Wheels
  - Not useful for drive systems
  - Useful for mechanisms



[www.banebots.com](http://www.banebots.com)





## VexPro (Formerly Innovation First)

- Longtime FIRST supporter
- Electrical Components
  - Speed Controllers/Relays
  - Robot Controllers
- Mechanical components include:
  - Wheels, Gearboxes
  - Pneumatic Components
  - Gears/Bearings/Hardware



<http://www.vexrobotics.com/products/vexpro/>



## 80/20

- “Industrial erector set”
- Uses standard frame and connections
- Can be pricey
- Extremely easy to build solid frames
- Slider attachments make for excellent extension mechanisms

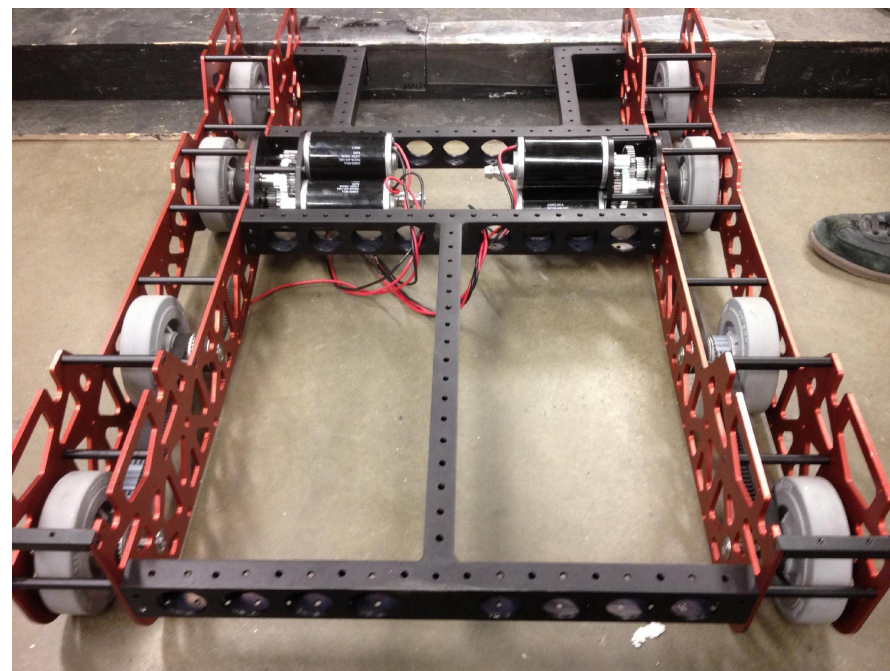
<http://www.8020.net/>





## How to use these items:

- Enhance a drive system:
  - Shifters for 2 speeds
  - Gearbox components for custom gearboxes
  - Non-kit wheels for higher traction
    - Omni for maneuverability
    - Mecanum wheels for agility





## How to use these items:

- Create a gear reduction for a subsystem:
  - Get motor to reasonable output
  - Useful output shaft
  - Integrate into system itself
    - Intake
    - Roller claw
    - Shooter wheels







## Take-aways

- Set well-founded goals for your team
- Be honest with yourselves
- Establish a growth plan
  - Rome wasn't built in a year!
- Simplify approach wherever possible
- Use COTS items as a method to simplify and add reliability to your designs
- The “easy” approach may require the most “cojones”





# Thank you

- Contact anytime:
  - [brandonjholley@gmail.com](mailto:brandonjholley@gmail.com)
- Presentation feedback always welcome as well!
- Presentations will be posted
  - [www.nutrons.com](http://www.nutrons.com)