Strategic Design

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Training

Golden Rule #3

- Steal From The Best, Invent The Rest
  - Get Team familiar with past games and robots
  - Games will often be similar to past games
    - Examples:
      - 2004, 2010, and 2013 climbing
      - 2007 and 2011
      - 2006 and 2012
    - Take advantage of this!
  - Ask veteran teams questions about their past robots

Specialized Training

- Drivetrain Design
- Mechanism Design
- Electrical/pneumatic tips
- Programming goals

Analyzing the Game

- Know the game rules inside and out
- Consider every method of scoring points
  - 2008: driving laps
  - 2012: 118's bridge mechanism
- Consider every method of preventing opponents form scoring
  - 2000 & 2012: stealing balls
  - 2004: capping goals

Game Analysis cont.

- Deciding on most effective scoring method directly determines robot design
- Understanding the ranking system
  - 2012 co-opertition points
  - Win/loss/tie
  - Adding scores

Cost-Benefit

- Difficulty vs. points awarded
  - Is it worth it?
  - What is the most cost-efficient scoring method?
    - Values of goals vs. ease of scoring
  - Preventing 10 points is just as valuable as scoring 10 points

Simplicity

- Always build within your limits
- Know your capabilities
- It is better to have fewer well-functioning mechanisms than many poorly-functioning mechanisms
  - Quality over quantity
  - Occam's razor: the simplest solution is often the best

Tradeoffs

- Some games will make you choose between one function or another
  - E.g. 2013: climbing often limited other functions
- Complexity vs. durability
  - Our 2013 intake, worked great, not very durable
  - Our 2012 intake, worked okay, very durable

Versatility

- Doing multiple functions with one mechanism is ideal.
  - Power-take off
  - Using intake as bridge manipulator
- Remember, your strategic priorities still dictate design. Limit sacrifice when improving versatility.

Prediction

- Predict what other teams will build
- What robots work well together?
- Predict realistic match scores
  - E.g. stacking in 2005 and 2003
  - Very few people predicted 250+ points matches in 2013

Stick to your guns

Drivetrain Design


NASA
254
254


Clippard
Clippard
Clippard
Dropbox
BAE SYSTEMS
Google
NASA
254


Arteris
The Kumar Family
POLYTEC PRODUCTS
GOOD PLASTICS
S&S Welding, Inc.
lumenetix
PACIFIC COAST METAL, INC.
OOYALA
NASA
BAE SYSTEMS
Bellarmine College Preparatory
254


NASA
AIRTRONICS
STALFAB
pwc
POLYTEC PRODUCTS
GOOD PLASTIC
PACIFIC COAST METAL INC
OOYALA
BAE SYSTEMS
Bellarmine College Preparatory
254


254
254
NASA
Gilbert Spray Coat
Bellarmine College Preparatory
BAE SYSTEMS


254


254
254
Bellarmine College Preparatory
NASA


NASA
AMES
254


254

Drivetrain Options

- Tank
  - 4 Wheel Drive
  - 6 Wheel Drive
  - 8 Wheel Drive
  - Treads
- Swerve
- Octanum
- **Not** Mecanum
- **Not** Omni

6 Wheel Tank

Golden Rule #1

- West Coast Drive
  - What is it?
- Why?
  - Proven design
  - Wide wheel base
    - Stable
    - Traction
  - Weight Saving
  - Room for electronics board
  - Space to mount structures

There’s nothing that hasn’t already been done

Mechanism Design

Basic Devices for Mechanisms

- Motors
  - Gearboxes
    - Single Speed Gearbox
    - Shifting Gearbox
    - Planetary Gearbox
  - Power transfer
    - Gears, ring gears, belts, chain, direct drive
  - Variable Movement

Basic Devices Cont.

- Pistons
  - Movement from point A to point B
  - non-variable
  - single or double position

Mechanism shapes

- KISS
- Minimum degrees of freedom
- Low Center of Gravity
  - Especially Motors and Battery
- Symmetry when possible
- Inside the frame perimeter when possible
- Robust when outside the frame perimeter

You Need to Move Something

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

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 the driver pick up an object 50ft away without a direct line of sight?

Continuous vs. Single Intake

Golden Rule #2

- Can objects hinder intake ability or movement?
- 2012 & 2013: Picking up multiple game pieces
- Continuous Intake = ROLLY GRABBERS
- Single Intake = Claw/Hook

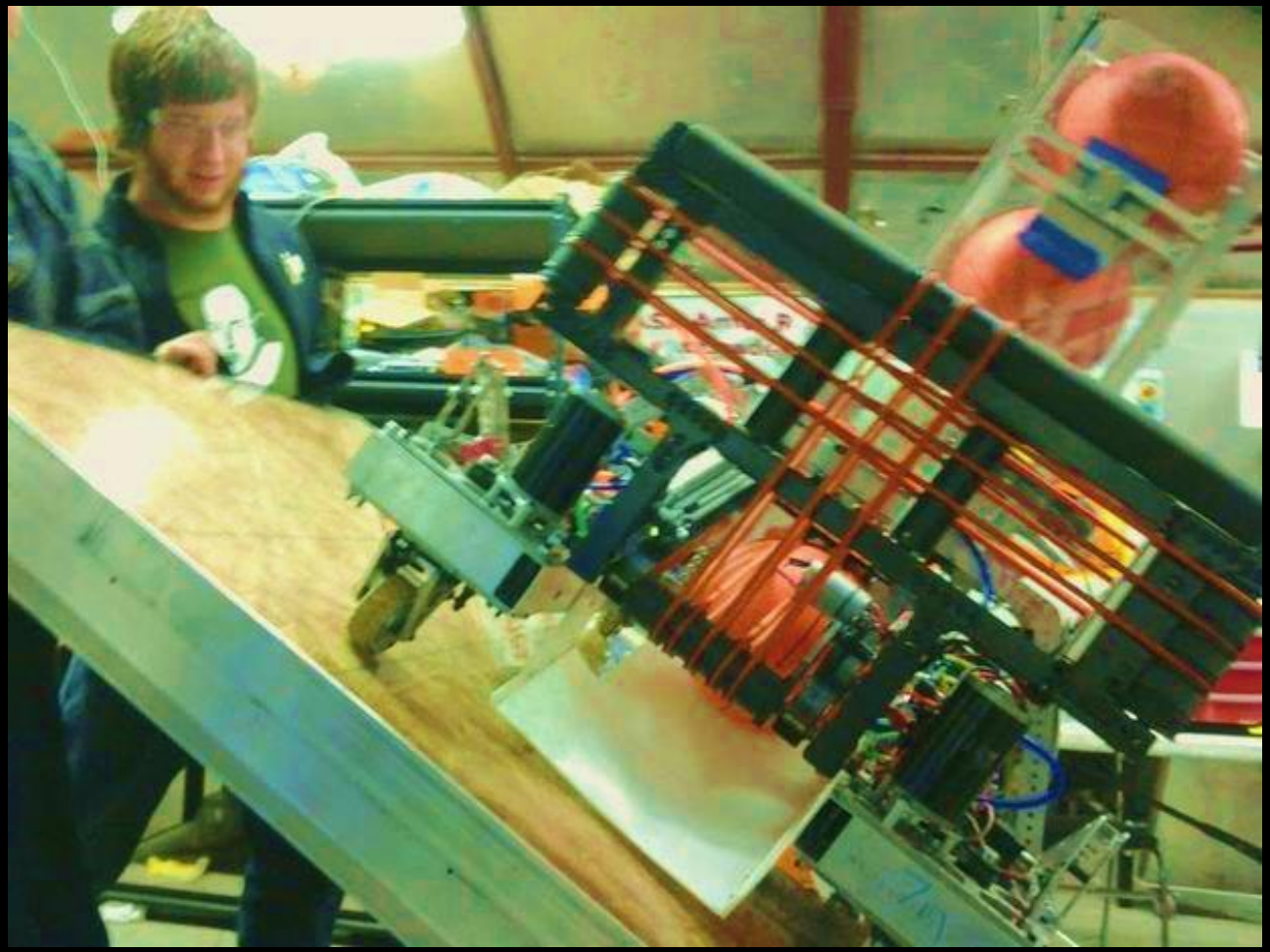
Device Alignment

- How can you guarantee proper placement?
- Are there physical objects to orient the robot?
- Quick alignment is key to scoring efficiency and on field success!

The Basics of Manipulation

- Common FRC Objects
  - Balls
  - Tubes
  - Objects that are flush with the floor
- Keys
  - Volume of game piece
  - Speed of acquisition and release
- Rolly grabbers
  - They can pick up anything

Balls



Tubes

Discs

Electrical and Pneumatic Tips

- Electrical wiring in FRC is an art
- Look at teams like 254, 973, and 1538
  - Do as they do
- Look at teams like 1678 in 2013
  - Don’t do as they do
  - Cost us a match on Einstein

Programming

- Autonomous = huge points
  - 2011: autonomous = double points
  - 2013: 90 points possible, that is equivalent to a top tier robot scoring in tele-op,
  - 2013: 42 point auto and 10 point hang

    better than 18 point auto and 30 point hang
  - 2014: 65 point auto from 254
  - 2015: 2826 28 point, 3 tote, 3 RC auto

Keys to Good Programming

- Precision Autonomous Driving
  - Using encoders + gyro
- Camera Alignment
  - Faster scoring
- PID Loops for arms and driving accuracy
  - Ex. 2011 Tube Rack
- Bang Bang controller for shooter wheels
  - Key in 2012 and 2013

The best 6 weeks of your life

Build season

Build Season Overview

- Accelerated Schedule is Important
- When setting schedule: “Aim for the Moon, Land among the Stars”
- Students ALWAYS assume there is more time than there is
- Often, Mentors do too!

Brainstorming and Kick-off day

- Understand the rules. Know the game inside and out.
- What?
  - What is our strategy? What will the robot do?
- How?
  - How will the robot carry out this function?
- Why?
  - #winning

Rack n’ Roll 2007

Practice Kick-off

Game rules

- Scoring
  - central “spider” rack
  - 24 “legs”
  - 3 rows
  - 8 columns
- Robot restrictions and features

Scoring

- Tubes
  - 2 per leg
  - Keeper (auto only)
    - cannot be moved, spoiled, or covered
  - Ringer
    - cannot be moved, can be spoiled
  - Spoiler
    - Can be moved, negates covered tube
  - Exponential scoring

# tubes in row	1	2	3	4	5	6	7	8
Points	2	4	8	16	32	64	128	256

Scoring

- Ramp
  - Lift alliance partners off the ground
  - 4-12” 15 points
  - >12” 30 points

Robot restrictions and features

- 28”x38” starting footprint
  - Footprint does not apply during matches
- No detachable parts
- 4, 5, or 6’ height depending on weight. 120, 110, or 100lbs respectively.
- Bumpers around perimeter during match operation
- Vision targets on scoring rack.

Week 1

- Days 1 – 4
  - Brainstorming
- Day 5
  - Design Freeze
- Days 5 – 8
  - Prototyping
  - Drive-base electrical layout
- Days 5 – 14
  - Build drivetrain
  - Programmers begin code for drive train

Week 2

- Days 8 – 14
  - Robot controls
  - Finish drivetrain
    - Crucial for other mechanisms and electronics
- Days 8 – 21
  - Mechanism construction
  - Programming
    - Finish drivetrain code

Week 3

- Day 15
  - Begin testing autonomous code on drive train

Week 4

- Days 22 – 28
  - Mechanism integration
  - Wiring

Weeks 5 & 6

- Day 29
  - Robot finished
- Days 29 – 40
  - Testing, fixing, refining, and perfecting
  - Driver training
  - A good driver always beats a good robot

The real deal

Competition season

The Biggest Lie in FRC

- Myth: build season is 6 weeks
- Reality: build season never ends

Withholding allowance

- Allowed to bring < 30 lbs of parts
- Keep parts to fine tune and bring to competition
  - Last resort, do not rely on this!
  - Installation of new parts takes up precious time in the pits
- Allowed to Add Components
  - Stingers in 2012

Practice robot

- Identical to competition robot
  - If not full robot, copy of drive-base
- Large investment, large reward

Watch other Competitions

- Watch other regionals
  - Webcast parties (with pancakes!)
- Read Chief Delphi
- Volunteer at events
- Look at other robots for ideas
  - There is still time to re/design and add new parts

At the Competition

- Scouting
  - Qualitative and quantitative data
  - 1st Pick offensive bot, 2nd pick defensive bot
    - 1st pick: purely quantitative, who scores the most, who complements our strategy
    - 2nd pick: defense plus value added (non-tele-op score)
- Know your opponents. Match strategy depends on their abilities.
- Predict elimination draft. This is how we won Curie Division.

Pit Management

- Organization and cleanliness
  - You can’t use tools that you can’t find
  - Lots of metal shavings = lots of electrical failures
- Battery management
- Team member accessibility
  - Stay in contact in case we need you

Conclusion

Robots don’t win competitions, teams do.

Questions?