



Game Analysis & Strategic Design

Team 1732

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Disclaimer

This isn't a step-by-step process. It's more like some tips with some structure in a general order?

Some stuff works for us but won't work for you. And vice versa.



Agenda

- Step Zero
 - Team Goals
 - Team Capabilities
- Strategic Design
 - Game Analysis
 - Design Selection
- Example Season

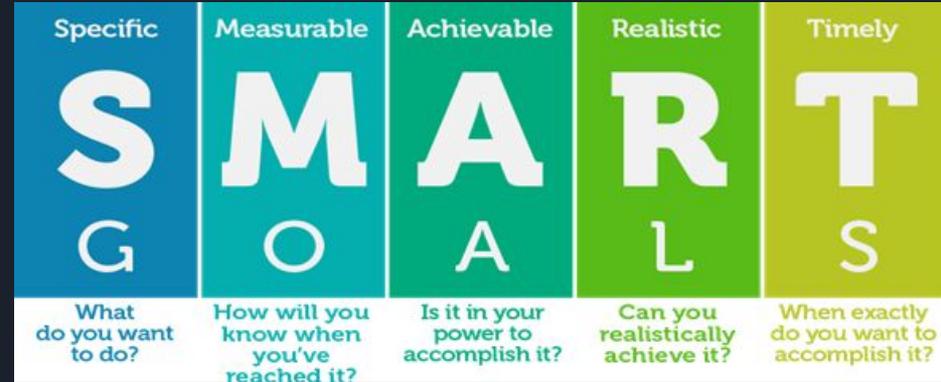
Step Zero



Step Zero: Team Goals

What do you want to achieve?

- Make SMART goals
- Examples:
 - Have a working robot in every match
 - Score a number of points per match
 - Play in eliminations (Be picked)
 - Be an alliance captain
 - Win a competition
- These goals will frame discussion about your robot design





Step Zero: Team Capabilities

- Assess your team capabilities and constraints honestly and realistically
 - Experience, machining access, budget, time, team size
 - How many people / groups can work at the same time vs. in sequence?
 - Even if you can build it, can you control it? Can you drive it?
- Account for scope and complexity
 - Several simple tasks will take the same or less time than a complex task



Step Zero: “Robot Points” Concept

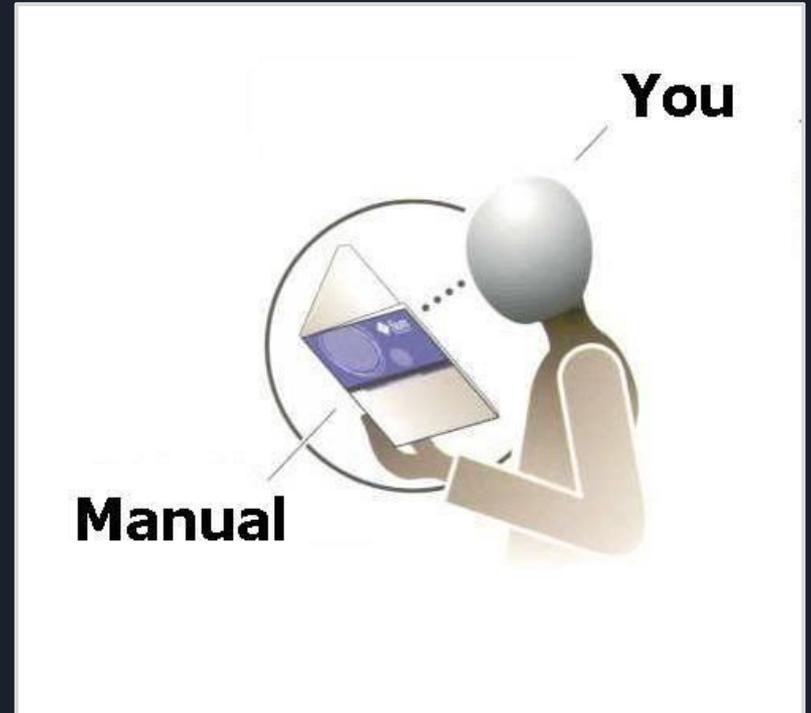
- Let’s say each team has a number of “Robot Points” to spend
 - Higher resource teams will have more Robot Points:
 - Low resource – <20 Points
 - Moderate Resource – 21-50 Points
 - High resource – 50+ Points
- Spend points to maximize resources
 - If you have 30 Robot Points, it’s better to have 3 functions at 10/10 instead of 5 at 6/10
- “Points” could mean
 - Money, machining time, person-hours
- Examples
 - Drivetrain
 - KoP Drive – 2
 - 6 Wheel West Coast – 6
 - Swerve – 10
 - Intake
 - Human Loaded – 2
 - Ground Pickup – 6
 - End game
 - Park - 0
 - Climb - 6
 - Autonomous routine
 - Drive forward - 1
 - Complex scoring - 10
- Note:
 - These point values are made up, but you get the idea

Game Analysis



Game Analysis: The Rules

- Read the manual
 - This will show the limits of what can be done in the game
- Read the manual
 - This should eliminate illegal game strategy ideas
- Read the manual
 - You may find loopholes or chokehold strategies
- Read the manual
 - The manual will be updated – some ideas may become illegal
- Read the manual
 - And the Q&A



Game Analysis: Scoring Breakdown

- Read the game summary and scoring details from the Game Manual
 - (The game video can be helpful, but is occasionally misleading)
- List every way to score points
 - High goal, low goal, drive to a zone, etc.
- What's the high score?
- How does the ranking system work?
 - FRC loves "Ranking Points" (RPs)

Example: 2020 game - Infinite Recharge

Award	Awarded for...	AUTO	TELEOP	Qual.
INITIATION LINE	exit the infinite vertical volume created by the corresponding ALLIANCE'S INITIATION LINE any time before the end of AUTO (per ROBOT)	5	-	-
POWER CELLS	scored in BOTTOM PORT	2	1	-
	scored in OUTER PORT	4	2	-
	scored in INNER PORT	6	3	-
CONTROL PANEL	ROTATION CONTROL	-	10	-
	POSITION CONTROL	-	20	-
ENDGAME Points	HANG (per ROBOT)	-	25	-
	PARK (per ROBOT)	-	5	-
	LEVEL with 1-3 ROBOTS HANGING (per ALLIANCE)	-	15	-
SHIELD GENERATOR OPERATIONAL	earning at least sixty-five (65) ENDGAME points	-	-	1 Ranking Point
SHIELD GENERATOR ENERGIZED	Stage 3 ACTIVATED	-	-	1 Ranking Point
Tie	Completing a MATCH with the same number of points as your opponent	-	-	1 Ranking Point
Win	Completing a MATCH with more points than your opponent	-	-	2 Ranking Point

	Auto			Tele-op						Endgame			Totals	
	Line Crossed (y/n)	Bottom PC	Outer PC	Inner PC	Bottom PC	Outer PC	Inner PC	CP Rotation (y/n)	CP Position (y/n)	Climb (y/n)	Park (y/n)	Level? (y/n)	Points	Alliance Total
Robot 1	y	3	0	0	3	6	0			n	y		56	
Robot 2	y	3	0	0	5	5	1	y	n	y	n	y	54	182
Robot 3	y	0	3	0	0	15	0			y	n		72	
Robot 4	y	0	3	0	0	15	1			y	n		120	
Robot 5	y	0	3	0	0	20	0	y	y	y	n	y	82	274
Robot 6	y	0	3	0	0	15	0			y	n		72	

Game Analysis: Robot Tasks and Skills

Example: 2016 game - Stronghold

- List all of the skills that a robot needs to complete game tasks
 - Scoring
 - Navigating
 - Defending?

Robot Skills	Tasks	Auto	Teleop	Quals	Elims	Required Skills	Beneficial Skills
1 Drive	Reach Defense	2				1	
2 Drive over Small Bump	Cross Low Bar	10	5			1,3,20	
3 Drive on ramp	Cross French Ramps	10	5			1,3,16	17
4 Drive (Most Terrain)	Cross Portcullis	10	5			1,3,15	14
5 Herd Boulder	Cross Moat	10	5			1,3,4	
6 Hold Boulder	Cross Ramparts	10	5			1,3,4	
7 Receive Boulder from Lower Wall Hole	Cross Drawbridge	10	5			1,3,13	12
8 Receive Boulder from Upper Wall Hole	Cross Sally Door	10	5			1,3,19	18
9 Pick Up Boulder	Cross Rough Terrain	10	5			1,3,4	
10 Shoot Boulder	Cross Rock Wall	10	5			1,3,4	
11 Release Boulder	Boulder Top	10	5			1,6,9,10	2,3,4,5,7,8,11
12 Hold Drawbridge for Others	Boulder Bottom	5	2			1,2,3,5	4,6,7,8,9,11
13 Drop Drawbridge from Neutral	Climb Tower		15			1,2,3,21	4
14 Hold Portcullis for Others	Challenge Tower		5			1,2,3	4
15 Lift Portcullis	Capture Tower			1RP	25	1,2,3	4
16 Push Down French Ramps	Breach Defenses			1RP	20	1,2,3,4,13,15,16,19,20	12,13,15,17,18
17 Lift French Ramps for Others							
18 Hold Sully Door for Others							
19 Open Sully Door from Neutral							
20 Limbo							
21 Climb Tower							
22 Defend							
23 Dislodge Self							
24 Dislodge Others							
25 Hold Low Bar Flap Open							



Game Analysis: Match Strategies

- How do you actually play the game?
 - A fun activity is playing a human game to compare different strategies

Typical Strategies:

- **Shootout**
 - Ignore the opponents and just score
- **Counterplay**
 - Use one or more robots to interrupt the other alliance's game plan
- **Starvation**
 - Deny the opposing alliance any opportunity to score
- **Chokehold**
 - Accomplish some set of tasks that makes it impossible to lose control
- Think about both your scoring potential and the *differential* to your opponents

Robot archetypes:

- **Scorer**
 - Accomplish the “main” game task
- **Supporter**
 - Accomplish “side goals”
- **Endgame/Bonus**
 - Get the “end game” or “bonus” points
- **Defense**
 - Prevent opponents from scoring 10 points is as good as you scoring 10 points
- Robots can be none to many of these

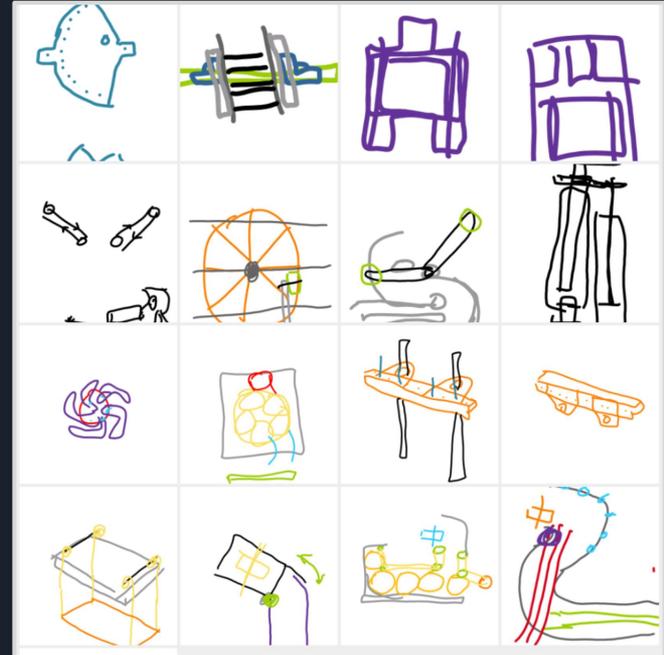
Game Analysis: Match Strategies

- You pick a general path, but maybe not a specific design right away
 - You should leave some questions open and use prototypes and outside data to answer them
- Be realistic
- Alliance compatibility
- Rules of thumb
 - Elite teams can do 8 full field cycles per match in perfect conditions
 - The best teams will do this a few times a season
 - Middle tier teams can do 4 cycles per match and average maybe 2-3



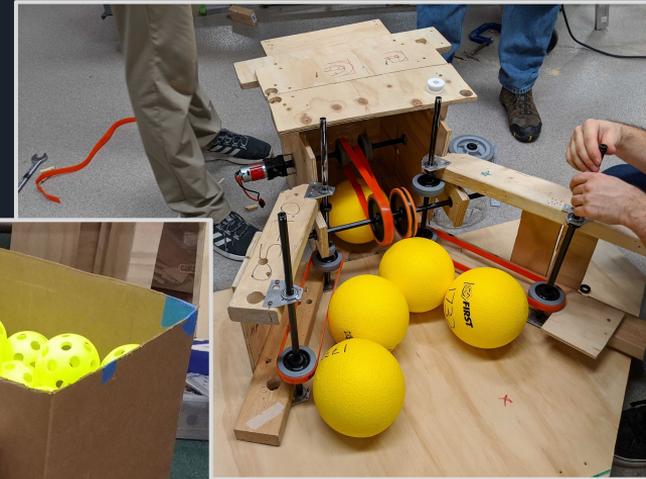
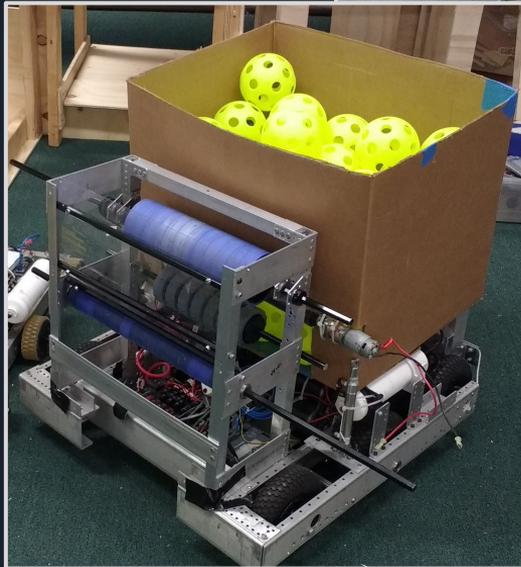
Game Analysis: Robot Concepts

- Start to scribble robot concepts
 - These should accomplish the match strategies you described
 - How do you combine “robot skills” into a full robot concept?
 - Think back to “Robot Points” - how much complexity can you plan on?
 - Use anything to communicate
 - Whiteboards, MS Paint, block CAD, cardboard and hot glue
 - The details may come eventually



Robot Analysis: Gamepiece “Flow”

- How are different Robot Skills related?
 - How do different mechanisms rely on each other?
- Gamepiece “Flow”
 - How does a gamepiece get to the goal?
 - Where is the bottleneck?
 - It doesn't matter if the scorer is the best in the world if nothing gets to it
 - Examples
 - An intake feeds an indexer which feeds a scorer.
 - A claw is moved on an elevator to get to the scoring height



Design Selection Methods





Design Selection: Focusing Your Strategy

- Narrow down robot concepts based on goals and feasibility
 - 2-3 concepts to further analyze
- Think about how these robots will play the game in an alliance
 - Can the design be successful solo?
 - Is the design reliant on Alliance partners?
- List which game tasks are required for selected concepts
 - This will help prioritize robot functions
 - Drivetrain should almost always be a top priority (very few exceptions)



Design Selection: Tradeoffs + Priorities

- Mutually exclusive tradeoffs?
 - Speed vs power
 - Complexity vs durability
 - Wide vs long frame
 - High vs low center of gravity (easier shot vs tippy robot)
- Prioritization of complexity
 - Time spent on
 - Design, Build, Program, Test, Practice, Iterate, Compete, Repeat
 - Use your strategic priorities to decide the design process
 - Which mechanism do we focus on first?



Design Selection: Wait and try it?

There's only so much that you can talk about around a table

- Some decisions have to be informed by prototyping and testing
 - Which material works best for this gamepiece?
 - How hard is it to pick this up off the carpet?
- If different design paths depend on radically different mechanisms, can you use testing to focus on a better option?
 - If a game involves scoring balls in a high goal (2020, 2017, 2016, 2014...) and you're considering multiple launchers (flywheel, catapult, puncher...) maybe testing will eliminate one early on



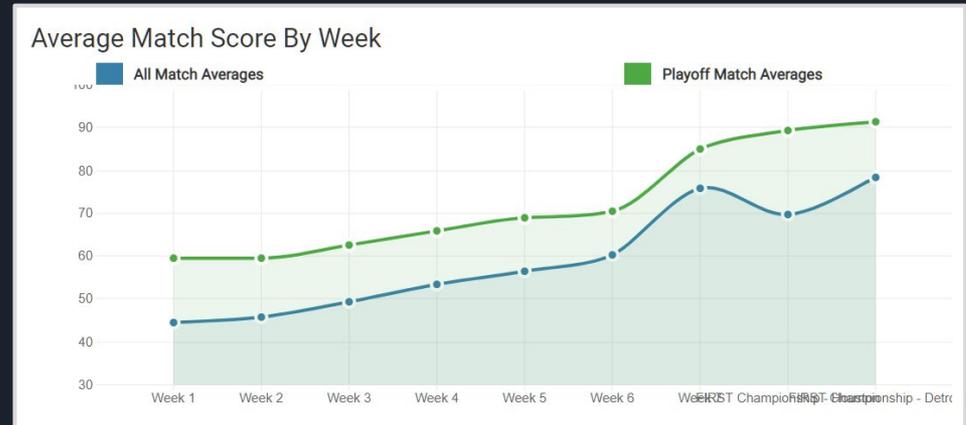
Design Selection: Wait and copy?

Steal from the best.

- Check past games!
 - If a game has a horizontal pull-up bar, what did teams do in 2020, 2018, 2016, 2013...
 - “Ok cool, telescoping or unfolding arms, not a grappling hook.”
- Are there any teams around you or online who want to work together or show ideas?
 - Teams are a different mix of “Open” or “Secret”
 - #Openalliance on Chiefdelphi
 - “Robot in 3 days”
 - Everybot
 - Literally, just search YouTube

Design Selection: Feature Ramp

- How much can you work on at a time?
 - What's most important?
 - Drivetrain > Endgame > Main Scoring > Secondary Scoring?
 - Block out space for a mechanism, ignore it, and get back to it later
- What features matter when?
 - The level of play will get better. You only have to beat the teams at your event!
- Examples:
 - 2020 color wheel
 - 2019 panel vs cargo
 - 2016 low goal
 - More advanced autonomous





Design Selection: Making a Decision

- It shouldn't be an argument
 - Data from analysis, prototypes and other teams should make it a more objective conversation
- When things escalate:
 - Decision matrix?
 - More testing? Prove it.
 - Don't get attached to your own idea/prototype
 - "A good plan violently executed now is better than a perfect plan executed next week."
 - Also, it won't be perfect next week...
 - IF it comes down to voting, someone will always walk away mad.

Example Season



Example: 2017 Steamworks, Team 1732

- Goals:
 - Win a Regional and be competitive at Champs
- Resources:
 - Budget for practice bot
 - Drillpress/bandsaw machining (no CNC)
 - Local practice field (Thanks Robotigers 2830!)
- Game analysis + priorities
 1. Gear scoring + Climbing
 2. Drive practice
 3. Ball scoring
 4. Additional autonomous routines
- Feature Ramp-up:
 - Regional 1: Gear scoring, climbing
 - Regional 2: Practice ball scoring, but play to win
 - Champs: Faster climbing, faster ball scoring
 - Offseason: Moved climber up for faster climb





Resources

- Old games
 - Rules/videos
 - <https://www.firstinspires.org/resource-library/frc/archived-game-documentation>
 - Match footage
 - <https://www.thebluealliance.com/>
- Effective FIRST Strategies-Karthik Kanagasabapathy
 - <https://www.youtube.com/watch?v=xJYv7uxXMn0>
- Goal Setting- Mike Corsetto
 - <https://www.youtube.com/watch?v=TyBWSDEluXI>
- Simple Thinking- Adam Heard
 - https://www.youtube.com/watch?v=JyPHwNx_KXM



Questions?

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