4607's 2020 Strategy Paper

Goal of this Paper:

This paper is intended to document 4607's analysis, and breakdown of the game to help define our strategy, and enable us to create our strategic design. It's also intended as a service to the community to show how one team is breaking down the game, providing additional context for your own strategy discussions.

How To Score/Defend Points and Cycle Time Analysis:

Scoring Tasks	Auto			Teleop			Difficulty Ranking
	Cycle Value (3 Balls)	Point Value	Time Estimate	Cycle Value (5 Balls)	Point Value	Time Estimate	
Inner Port	18	6	15	15	3	30	8
Outer Port	20	4	15	10	2	25	5
Bottom Port	10	2	15	5	1	18	3
Initiation Line	NA	5	NA	NA	0	NA	1
Climbing	NA	0	NA	NA	25	18	5
Rotation Control	NA	0	NA	NA	10	12	5
Position Control	NA	0	NA	NA	20	10	4
Parking	NA	0	NA	NA	5	4	2
Level Climb	NA	0	NA	NA	15	10	7

Ranking Point Analysis:

Stage 3 Ranking Point:
Stage 1: 9 Power Cells
Stage 2: 20 additional Power Cells and Rotational Control
Stage 3: 20 additional Power Cells and Positional Control

That's 49 game pieces and two trips to the wheel of fortune. No way anybody is getting that Ranking Point! What was FIRST thinking?! How many of you have heard of a positive feedback loop? Basically when "Action A" is happening and that causes "Action B", and Action B accelerates Action A which accelerates Action B and so on.

FIRST built a positive feedback loop into the game this year. Basically if I get significantly ahead of my opponent in terms of cycling, (15 Power Cells to be exact) my opponent will be forced to start throwing game pieces out of their alliance station wall whether they're ready to intake them or not. Conveniently for me, those game pieces are right next to my goal, and ripe for the picking. This enables me to shorten my cycle time, score more Power Cells, and put more pressure on the opposing alliance.

If you're generating a positive feedback loop against your opponent, you've likely already won the match. However, in matches with a large skill gap, the positive feedback loop will make scoring 49 game pieces significantly more feasible. I suspect we'll see more than a few matches in which positive feedback loops contribute to the alliance's ability to acquire the otherwise exceptionally difficult Stage 3 Ranking Point.

Climb Ranking Point:
The Climb RP requires contributions from 2+ robots, but will be significantly more common than the Stage 3 RP, especially at early events. The Climb RP can be achieved by either 2 balanced robots or 3 robots climbing. Climbing is an extremely valuable aspect of the game, and a challenge that has been seen in most recent FRC games. As such, climbing should be decently common at all events, with more reliable climbers at later events. A typical quals alliance will likely have 1+ climber on it, and in many cases will have two climbers. If a team has a refined method by which to balance their climb with any other climber, they will have a high chance of achieving the climb RP in a majority of their matches.

There is a lot of talk about "buddy climbs" in which a team assists/enables another team to climb. These concepts will be accomplished by very few teams, but those that do will marginally improve their ability to seed high. Buddy climbs are for the few, and shouldn't be a design priority for most FRC teams.

Low robots that can effectively balance climbs and cycle at a valuable level will be very rare. If you're prioritizing climb balancing, you should be building a robot that is taller than 28". Climb balancing will be achieved in many ways including clamping onto the bar in a static location and shifting robot weight, as well as using a method to change where a robot is grabbing onto the bar.

Smart Robot Archetypes/Positions:

- Short Bot
    - Shoot high
    - Simple Climb
    - Capable of driving through the Trench
    - Can fill any role on an alliance besides defender
- Tall Bot
    - Shoot high
    - Balancing Climb
    - NOT capable of driving through the Trench
    - Not suited as well to cycling relative to a Low Bot, or moving across the field frequently, but is better for either the Long Shot or Rebounder role
- Elite Long Shot
    - Shooting from the far side of the field and hitting 2-3 point shots with reasonable consistency
    - Described in further detail below
- Long Shot
    - Shooting from the far side of the field with the primary goal of feeding another robot on your alliance
    - Described in further detail below
- Elite Rebounder
    - Collects misses and steals Power Cells from the opponent to score 3 pointers at close range
    - Described in further detail below
- Rebounder
    - Collects misses and steal Power Cells from the opponent to score 1-3 pointers at close range
    - Described in further detail below
- Cycler
    - A robot that runs back and forth from the Loading Zone to score in the Ports
    - Described in further detail below
- Feeder Bot
    - They should be able to enable more offense than they could prevent by playing defense
    - They facilitate better traffic flow of robots so that no more than one robot needs to drive under the Control Panel
    - They help to starve the other alliance of Power Cells (built in defense)

Not Smart Robot Archetypes:

- Control Panel Specialist + Climb
    - Mechanism for Control Panel
    - Low Intake
    - Climb
- Defense Only
    - You must be able to manipulate Power Cells to have a realistic chance of playing in the playoffs at any level.
- Any Robot that Doesn't Climb

Offensive Robot Roles:

- There are 3 logical roles for proficient scorers:
    - Rebounder/Close Range 2-3 pointers
    - Long Shot for 2-3 pointers
    - Cyclers
- Long Shots are going to be scoring recycled game pieces that their opponents have scored
    - Depending on the match, these game pieces have a high probability of running out, especially if the Long Shot is efficient, and the opposing alliance is weak
- Rebounders are going to be scoring game pieces from near their alliance Ports/Target Zone
    - These include:
        - Game pieces staged around the field at the beginning of the match
        - Missed shots from their alliance (ideal if paired with a long range shooter)
        - Recycled game pieces from their opponent, especially when a positive feedback loop is created by out cycling the opponent by 15 Power Cells
- Cyclers will primarily focus on running cycles from the Loading Zone to the Ports
    - Game piece acquisition will be opportunistic and should come from the most efficient source
- Teams will want their robots to be capable of filling more than one role in a match
    - Efficient Long Shots will score themselves out of a job in some matches, especially against weaker competition
    - Rebounders are only as effective as their alliance is at creating opportunities for acquiring Power Cells near their Ports
        - These include missed shots, fed Power Cells from alliance members, and recycled Power Cells generated by out cycling the opposing alliance
    - Running cycles is the least efficient way to score on an alliance that could otherwise take advantage of Rebounders/Long Distance Shooters

- Rebounders will generally resort to cycling when rebounding isn't an option
- Cyclers are best served by being under 28" such that they can travel through their Trench undefended

Defense In Ultimate Recharge:

At decently high levels of play the Power Cells are going to be recycled frequently... they'll basically go in a circle around the field with each alliance chasing the other alliance and trying to force them to flood. In thinking about it as a circle, I think the most logical place to defend is near the opponents' loading zone. If you don't have a defender there, there's nothing stopping the opponent's Long Shot robot from quickly emptying their reserve of Power Cells. Defending there seems like it would interrupt the opponent's match flow the most.

Additionally, by having your defender near your own Ports, you'll maximize their opportunity to score opportunistically as they acquire game pieces. There is minimal benefit to defending on your own half of the field if you have a robot that can make shots from there. If you do keep your defender on that side of the field, you're creating more traffic and inviting more defense from the opposing alliance. Keeping Power Cells out of your alliance station and on the opponents' side of the field should be realistic for a Long Shot style robot, even if that means just chucking the Power Cells to the other side of the field for your alliance partners to acquire. If the Power Cells are far away from your opponent's Ports, and you have two robots on that side of the field to defend and score, you're putting your alliance in a good position to win.

The best defenders in Infinite Recharge will be max height, and have a blocker that sticks out 12". They will also have powerful drivetrains that are able to navigate the entire field with ease. Elite defenders will also have the ability to steal Power Cells and score them as they load up their hoppers. There is no situation in which it makes sense to build a dedicated defender that can't also manipulate Power Cells.

Triple Offense or 2 Offense 1 Defense?

This question is a lot harder to answer than last year. The weakest robot on most alliances has a very good chance of being able to create more points than prevent points. More than likely the answer to this question is "both", or "it depends". If you're against a capable Long Shot style robot, you're foolish to let them hammer away at the Outer Port undefended. Disrupting that cycle will likely save your alliance from falling behind on cycles and needing to kick out Power Cells that you're not ready for. If nobody on the opposing alliance can shoot from their side of the field, you can use your third robot to put more pressure on the opposing alliance by scoring, or facilitating through feeding.

It's also notable that by slowing down your opponent, you're slowing down your own supply of Power Cells available for your Loading Zone. There may be situations in which the better offensive alliance intentionally doesn't defend so that the flow of Power Cells around the circle can move more quickly, giving the more powerful offensive alliance a better chance at achieving the Stage 3 Ranking Point. If you are the slower offensive alliance, you'll want to defend in hopes that you can win the match that way - 2 RP's is better than 0, even if that means forgoing the possibility of 3 or 4 RP's.

Who Seeds High:

- A climb balancing mechanism will be the greatest source of additional ranking points
- Ranking averages will likely be less than they've been in previous years at early events, depending on how common climbers are
  - This would make winning matches slightly more important than previous years for ranking high
- Cycling is the primary focus of this game, and as a result the teams that have the best cyclers will be in a position to win most of their matches, but they are at the mercy of their schedule as it relates to climbing
  - A single balanced climb is only 10 points less than two unbalanced climbs, making it a possibility to overcome that deficit with elite cycling
- Teams that figure out how to enable other robots that can't climb to do a balanced climb with them will be very well insulated from a bad schedule

When to Hoard, When to Flood:

It makes sense to keep your reserve as low as possible throughout the beginning and middle portions of the match. Whenever you're able to take a Power Cell from behind your driver station you should take that opportunity. The more Power Cells that are on your opponents' side of the field, the better off you are. However, if you are capable of making the Long Shot, and you're evenly matched with the opposing alliance, you may want to keep a reserve behind your alliance station wall for use during the end game. As your opponents are lining up to climb, you'll have ~20 seconds of undefended cycles. A highly proficient team with a quick climb should be able to get off an additional 1 cycle into the Outer Port in that time before heading back to climb.

There have been discussions about "game piece starvation" being a valid strategy, but I don't believe it is. By intentionally keeping Power Cells behind your alliance station wall, you're at risk of being forced to flood if the opposing alliance has a sudden burst of scoring, especially given that there will be at least 18 Power Cells available to them at any given time. Hoarding is certainly a niche strategy, and generally you won't want to intentionally keep any Power Cells on your side of the field.

Autonomous Strategies:

- Feeding is a very real strategy this year
  - Teams with inaccurate shooters, or no shooters at all will want to be sure they are able to feed teams with accurate shooters during auton, and accurate shooters should consider how to acquire Power Cells from their alliance partners during auton
- You are rarely if ever benefited from not preloading - you want those Power Cells near your Ports whether they're scored or not
  - Sitting on the field near your Ports seems better than the alternative
- The autonomous scoring is equivalent to 2013 in which autonomous was a crucial element
  - The end game is worth more than in 2013, and cycling during teleop should result in higher scores than 2013, so overall auton may be slightly less powerful than in 2013
- Shooting 6 or even 8 Power Cells will be accomplished regularly by top teams at later events, and won't be unheard of at early events
- There are a lot of higher level autonomous strategies that we haven't completely worked through yet… but auton is going to turn into a chess match at high levels of play

Notable Design Tradeoffs:

- Drive under Trench or not
  - This is the same as the tall vs short robot debate which is discussed below
- Shoot from far away or not
  - The only consideration here is how much power you put into your shooter… if you're already building a shooter then it's hard not to justify throwing enough power at it to throw from the far side of the field relative to your Ports
- Pneumatic Wheels for navigating the field obstacles or not
  - Early testing suggests that pneumatic wheels would allow a robot to minimize the effect of the steel tubing in the middle of the field
  - Pneumatic wheels are heavy, cause headaches with extreme amounts of turning scrub, and the most accessible versions of pneumatic wheels are typically 8"
- Shifting weight climber vs simple climber

- - - To me, this one is answered by whether a team chooses to be tall or not
      - If tall, spend the resources to balance your climbs
      - If short, do a simple climb and optimize cycling, but also make sure you're compatible with a balancing climber by designing a climber hook that doesn't slide back and forth on the bar
- Two position shooter vs Single Position Shooter vs Infinite Position Shooter
  - The more places you can score from the harder you are to defend… but also the more complex your mechanism needs to be, and the more testing/tuning you need to do with your shooter
  - The answer to this question comes down to team resources

Tall Bot vs Short Bot Considerations:

- Tall Robots (defined as unable to drive under the Trench) are generally served best by avoiding cycling across the field, and either occupying the Long Shot or Rebounder Positions
- Tall Robots have a significant advantage when it comes to packaging, climbing, defendability, and angle of shooting
- Short Robots can fill any scoring position on an alliance with significant benefits in the cycler role, and small disadvantages in the Rebounder and Long Shot roles
- Short Robots have a significant advantage in traversing the field, cycling, and switching between scoring roles
- The defendability argument against low robots seems to be overblown in my opinion
  - It's difficult to design a tall robot that is unblockable against a max height, max extension blocker
  - Both tall and short robots are undefendable from their Target Zone if they can get there
    - Which short robots generally have an agility advantage due to lower CoG, but have a harder angle for making the shot
  - Short robots that can shoot from multiple positions including the far side of the field from their Ports are essentially undefendable by one robot
    - The defender would need to close out on the short robot while shooting from long range, and by the time they navigate the terrain to get there, the short robot can zip through the Trench to get off shots from the protected zone there, or worst case can cycle to the Target Zone assuming they can hit that shot
- The biggest reason to choose a tall robot is the ease with which a team can build a climb balancing mechanism
  - The tradeoff boils down to climb balancing mechanism vs improved cycling ability
    - This tradeoff can essentially be answered by answering the question about whether you'd rather seed 1st, or be picked 1st

- Climb balancers have a higher chance of seeding first while better cyclers have a better chance of being chosen first

The Control Panel:

The Control Panel only becomes relevant after 29 Power Cells are scored. A lot of teams might think the Control Panel is easy to do, and therefore should be included on their robot. This logic is flawed… no matter how easy it is to do, if you're never in a position to do it, you're wasting your time designing the mechanism, and you're wasting weight and space on your robot. If I'm not going to contribute to scoring a significant portion of 29 game pieces during a match, I should have little to no expectation that I'll need to use the Control Panel that match. If I'm a team that can contribute a significant portion of 29 game pieces in a match and I'm capable of doing it, the odds are low that I'll trust another team to do the Control Panel for me given the fact that it needs to be done before my next cycle contributes to the Stage 3 Capacity. It's also notable that an alliance only ever needs 1 robot that's capable of doing the Control Panel.

The Control Panel is worth 10 and 20 points for Rotational and Positional Control respectively. Given the fact that unlocking the Control Panel requires 29 Power Cells, it's unlikely that you'll need the points from the Control Panel to win you any matches. The primary function of the Control Panel is enabling Ranking Points via activating Stage 3. It's widely thought that activating Stage 3 is going to be a difficult task akin to achieving the 4 Rotor RP in Steamworks. Exceedingly rare in early weeks and becoming only moderately repeatable for elite teams depending on their qualification schedule and matchups.

I think it's generally a good idea for teams to leave their Control Panel mechanism ideas in their heads, and keep them their until later weeks when they become more necessary. There isn't any bag so the penalty for ignoring an aspect of the game is greatly reduced relative to previous years.

Balancing the Climb:

- Consistently climbing and balancing will be the largest separating factor for ranking
  - Teams that are proficient scorers in addition to consistent balancers will seed very highly and likely make up a large percentage of the alliance captains
- Balancing Concept: Let your alliance partner go first, have them slide to the edge of climber bar, then climb by grabbing the outer edge and clamping on - ensuring you're both climbing as far out on the bar as possible
  - You'll need to ensure your weights match - having the ability to modify your robot weight to match it with your alliance partner pre-match would be a great feature
  - Alternatively you'll need to climb at a calculated distance from the edge to account for differences in robot weights - being able to shift your weight either

internally or by moving your position where you're grabbing on the bar will be critical for consistently balancing
- A device referred to as a "stinger" in 2012 could also help to balance the climb
  - Basically a stinger is a device that is used to stabilize the climb from the ground that is lifted up when the climb has been balanced
- Another concept that has been floated around a lot is a wheeled hook
  - Basically this would enable you to "drive" on the bar, thus shifting your weight and enabling balancing
- Balancing is non-trivial, and is significantly more complex than a simple climb

4607's Priorities and Component Descriptions

4607's 2020 Season Goal:
- Build a robot that is the top pick at the Great Northern Regional with enough potential to improve to be a first round pick in Detroit.

4607 Robot Description:
- Effectively touch a game piece and hold it
  - 5 game pieces
- 3 scoring locations into the Outer Port
  - Target zone
  - Fully contained inside the Trench Run
  - "Full court shot" from behind the the Control Panel
- Drive over the field obstacles at full speed with no concern for tipping or breaking
- We need to be able to drive under the Control Panel
- Climbing with no means of leveling ourselves

4607's Robot Mechanism Priority List:
- Drivetrain
- Intake
- Indexer
- Shooter
- Climber
- Color Wheel (not a priority)

4607's Drivetrain Description:
- 4 x 6" Blue Nitrile and 2 x 6" Omni Wheels
  - Omnis in the "back"
  - No drop center
- 18 fps in high, 7 fps (traction limited) low

- 34" long by 26" wide

4607's Intake Description:
- "Touch it, own it"
- Full width, centering
    - Think 254 in 2016
- Consistently feed indexing mechanism

4607's Indexer Description:
- Never jam
- Hold 5 balls
- Inside frame perimeter
- Contain balls at all times
- Easily maintained
    - Belt replacement
- Remove balls while powered off
- Feed shooter quickly and consistently

4607's Shooter Description:
- Infinite position hood
- Capable of scoring in the Outer Port from anywhere on the field
    - In particular we want to score from
        - Fully contained within the Trench Run
        - Bumpers over the Target Zone
        - From the opposite side of the field from the Ports
- Repeatable/High Accuracy scoring
    - High accuracy meaning high probability/consistency
- Shooter inside frame perimeter
- Vision targeting
- Automated hood position
- Shooter positioned at the back of the robot
    - Minimizes chance of being blocked and provides the best angle for shooting from the Target Zone

Climber Description:
- Must fit under 27" height limit
- Must be capable of reaching the Generator Switch at its highest point and lowest point
- 14" of climb travel
- Capability for solo balanced climb (high priority)
- Capability for leveling system on climber (low priority)