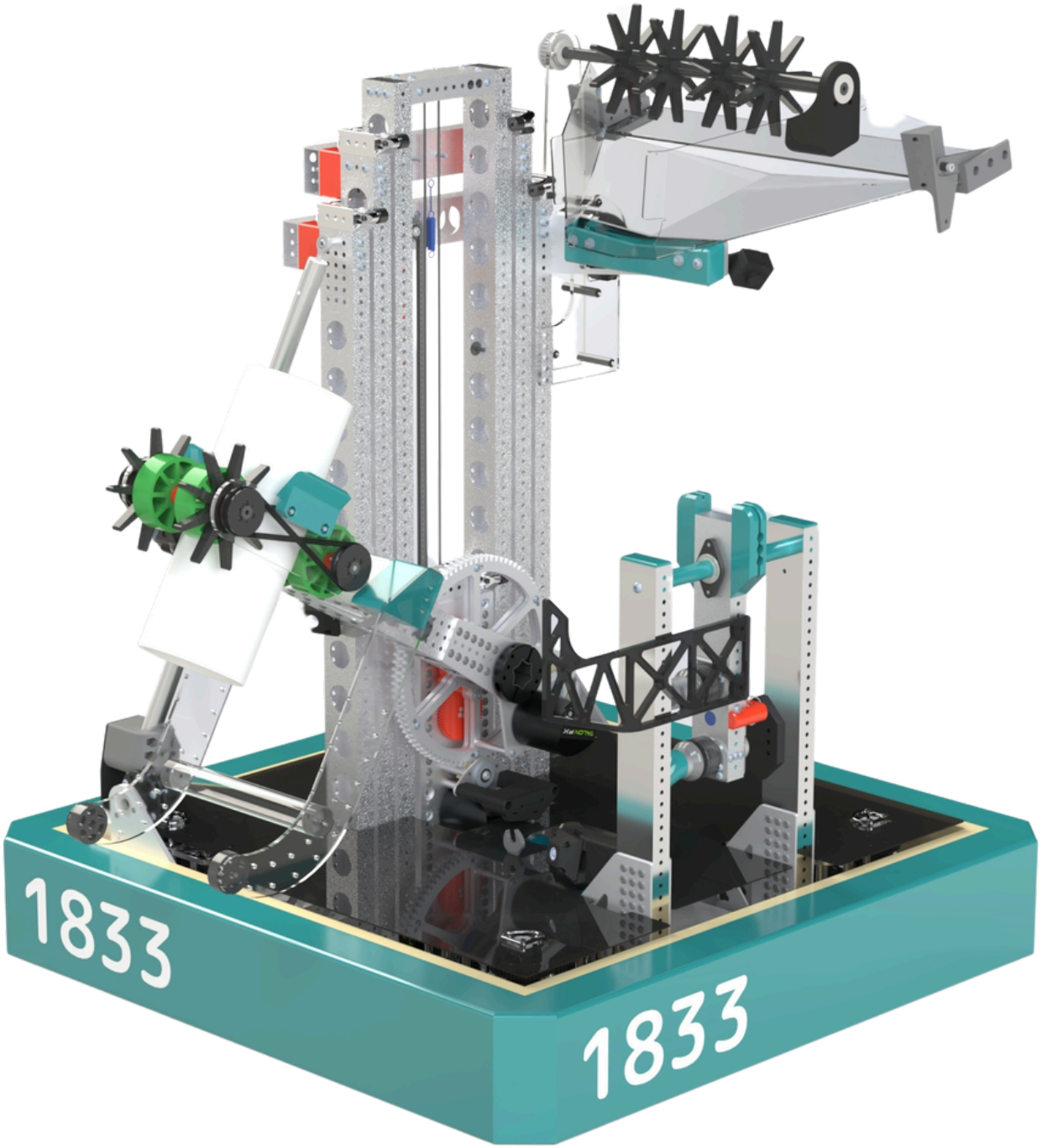


SPROUT

BEAN 1833

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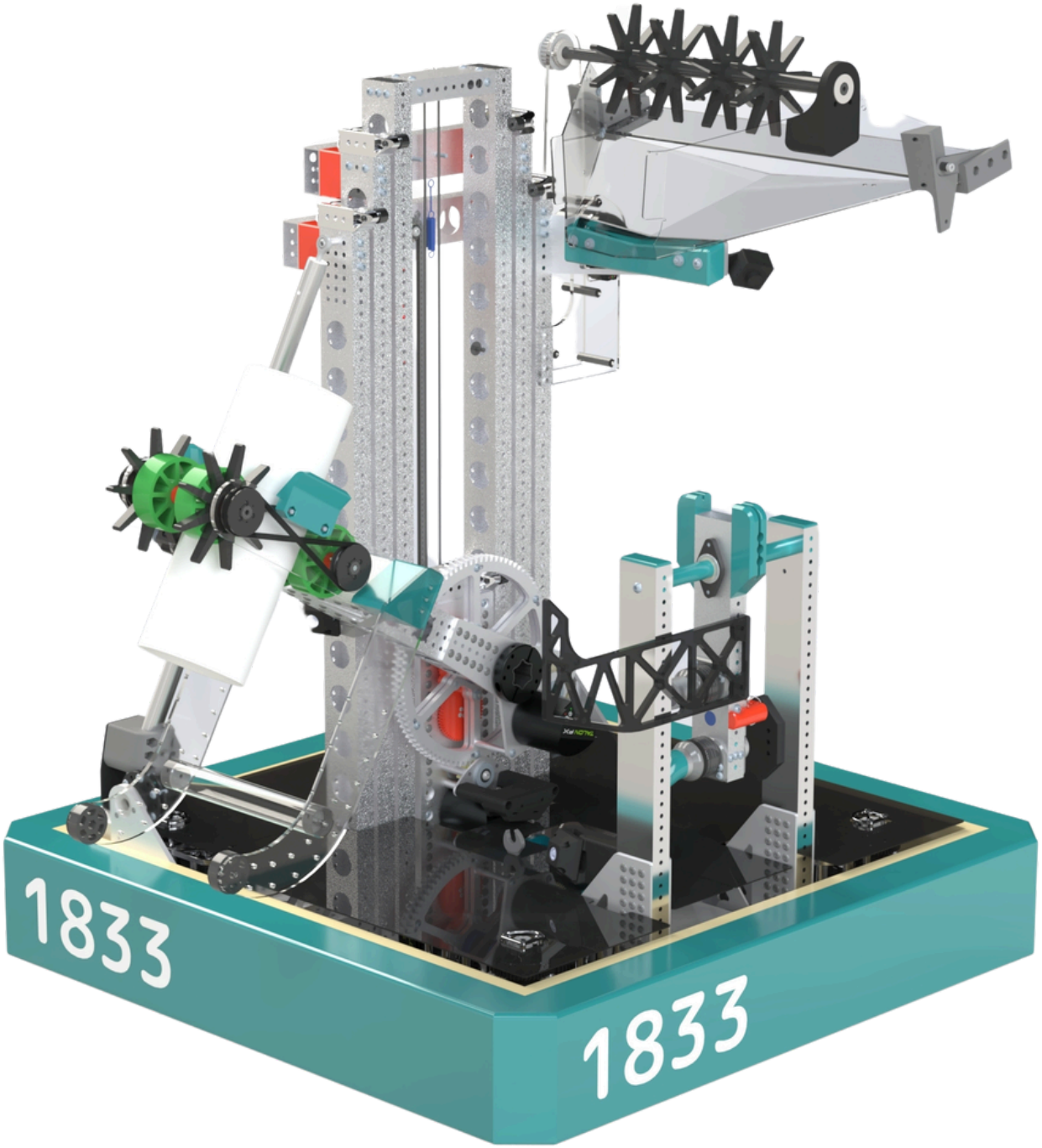
COMPETITION STRATEGY

Early in the season, we made a deliberate decision to focus primarily on coral, recognizing that our alliance partners could handle algae during elimination matches. This specialization allowed us to refine our robot's design and strategy without spreading our resources too thin. In qualification matches, our approach was to leave algae on the ground and focus entirely on maximizing our own scoring potential. By narrowing our role, we could ensure that we were consistently efficient and valuable to any alliance.

Another key realization was the importance of deep climbing for strong seeding in alliance selection. A reliable deep climb would not only help us secure ranking points but also make us an attractive pick for high-performing alliances. With this in mind, we prioritized designing a robust climbing mechanism early in our development process. By the end of kickoff, our priority list was as follows:

1. **Drive** – Ensuring fast, agile, and precise movement across the field.
2. **Deep Climb** – Developing a reliable system to achieve a deep climb for ranking points.
3. **L1 + Move Auto** – Creating a consistent autonomous routine for early scoring and positioning.
4. **Coral Intake** – Designing an efficient intake to maximize scoring efficiency.
5. **L4** – Prioritizing high-scoring objectives to contribute more value to alliances.
6. **L2** – Secondary scoring objectives for added flexibility.
7. **L1** – Ensuring basic scoring capabilities were refined.
8. **Algae Ground Intake** – Exploring ground-based algae collection if time allowed.
9. **Algae Processor** – Investigating potential processing mechanisms.
10. **Remove Algae** – Developing methods to clear the field if necessary.
11. **L3** – Additional scoring considerations.
12. **Net** – Potential utility mechanisms for improved game piece handling.
13. **Coral Ground Intake** – Secondary intake considerations for optimized gameplay.

Our goal was to be the most effective dedicated coral robot on the field. We aimed for cycle times under six seconds, ensuring that we could keep up with high-speed gameplay and contribute meaningfully to any alliance. By refining our intake and drivetrain early, we positioned ourselves to be a strong contender in both qualification and elimination matches. Throughout the season, our iterative design process and continuous strategy adjustments allowed us to adapt to the evolving meta, ensuring we remained a top competitor.



SPROUT

BEAN 1833

DRIVETRAIN

The objectives for our drivetrain were to be able to drive fast, have stability and quick maneuverability, and make sure it's easy for electronics to mount and have a protective panel to cover them in case of stray coral.

Drivetrain Considerations:

Swerve Drive:

- Pros
  - Robot Mobility: Swerve drive can move in every direction without having to perform many intermediate time-taking tasks. This also allows the robot to move in different positions quickly and easily.
  - This not only allows for more maneuverability in teleop but also in the autonomous period as there are programs that have been developed specifically for controlling swerve drivetrains efficiently in teleop.
  - Part Availability: COTS (Current Off The Shelf) variants are readily available, making it easier to build in a short time.
  - Team Experience: We ran this drivetrain type last year and are thus significantly experienced with how to develop it mechanically, electrically, and programmatically.
- Cons
  - Complexity: The code for swerve drive is slightly more complicated to code and maintain.
  - Cost: The swerve modules themselves are expensive, making the price a major factor in the drivetrain design.

Tank Drive:

- Pros
  - Robot Mobility: It's easier to make the robot go forwards and backwards in a straight line (don't need to worry about drift).
- Cons
  - Underpowered: This causes the robot to move slow and accelerate poorly. It also causes difficulty in moving at low speeds.

DRIVETRAIN

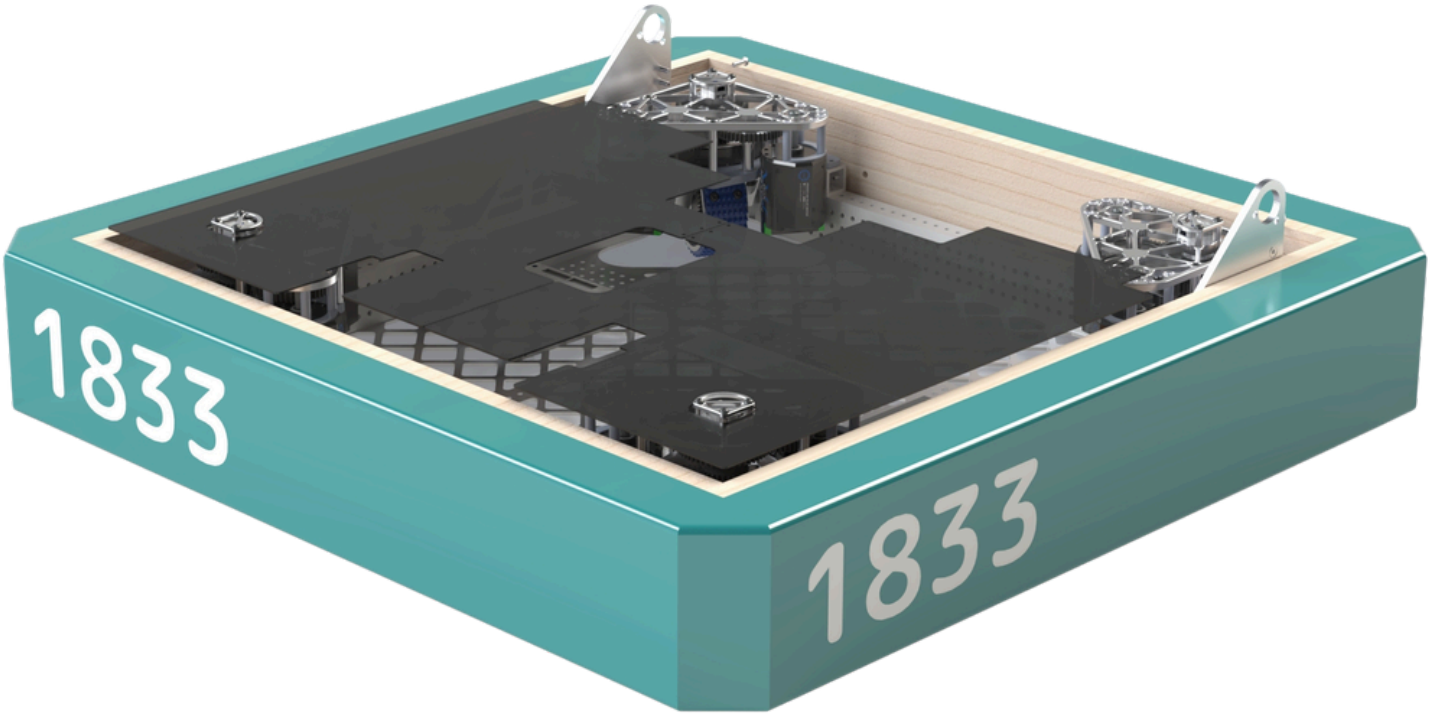
West Coast Drive:

- Pros
  - Omni-Directional Wheels: The ability of the drivetrain to move in all directions allows the robot to keep the wheels themselves stationary even when turning.
  - Less programming: Because of the mechanical simplicity of the drivetrain (no need to turn), code doesn't need to account for multiple different types of actions, reducing the complexity of the code.
- Cons
  - Maneuverability: Because of the drivetrain's inability to turn, the robot as a whole would have a harder time not tipping over.
  - Defensive Capabilities: The drivetrain inability to turn causes the robot to have a hard time defending as well as being easy to play defense on.

Swerve Drive:

After much consideration, we decided to pursue a swerve drivetrain this year, specifically COTS MK4i's with Krakens for the driving and steering motors and L1 gear reduction. We decided that our experience with a swerve drivetrain last year gave us the opportunity to work out most of the kinks associated with this type of drivetrain, and the game this year heavily incentives maneuverability and very quick driving (which swerve is the single most proficient driving at). Avoiding both defense and other teams' robots as we cross the field and try to get very quick cycles is of utmost priority. The driver last year also became very proficient at swerve driving, and keeping the same drivetrain allows us to need less driver practice early in the season.

DRIVETRAIN



- Designed with a mix of ⅛” wall 2x1 and 1x1 tubes to achieve an effective 3x1 height difference without the full weight of an actual 3x1 tube. This allows us to lower our robot's floor to about ½” above the ground, and thus lowers its center of gravity.
- It uses a solid, one-piece aluminum bellypan to add rigidity to the drivetrain and mount the elevator 2x2 and climber 2x1 support tubes.
- The corners are filled by SDS Mk4i Swerve Modules powered by 2 Kraken X60 motors. These modules are on an L1 gear set, with an 8.14:1 final ratio to allow for quick accelerations and higher torque against defense.

CORAL INTAKE

Our final objective for this season is to create a mechanism to quickly intake and gain control of a coral to allow it to be placed on the reef in L1, L2, L3, and L4 while also minimising cycle time.

Intake Considerations:

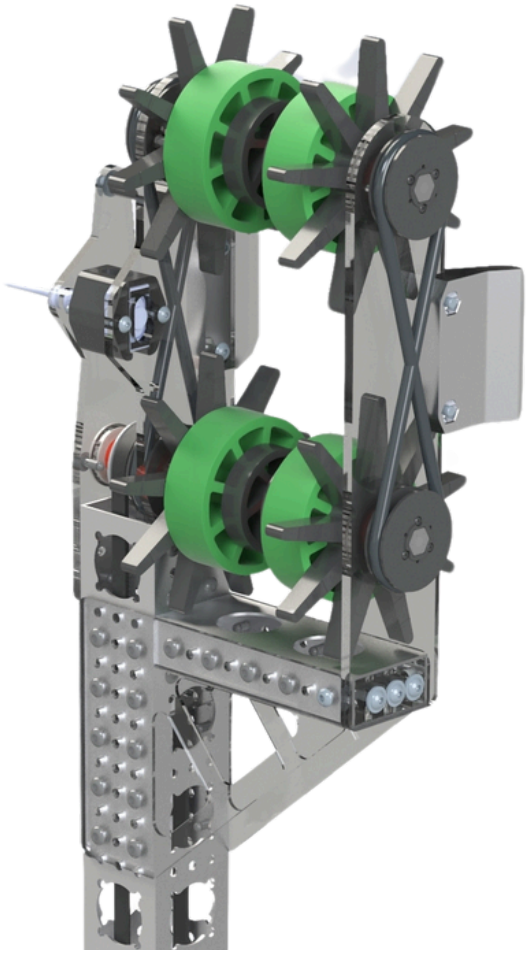
V1 Flex Wheel Coral Intake:
Our first iteration of the Coral intake uses a combination of round flexible rubber wheels and star shaped rubber wheels. They are powered by a motor housed in the base of the shoulder and work to pull in a coral and push it out to score.

- Pros:
  - Sturdy Design that is able to withstand getting hit when extended out of the robot
  - Allows for iterative testing of different flex wheel patterns
  - Simple Design allows for quick repairs during competition
- Cons:
  - Mechanism is heavy and moves the robot center of gravity up. This also limits the rotational speed of the arm and shoulder, making cycles longer.

V2 “Lego Hand” Coral Intake (Still In Design Phase):
The purpose of the second iteration of the Coral Intake is to reduce weight and complexity to allow for faster arm rotation, elevator movement, and in turn shorter cycles. It will use a passive claw to grab coral once it has entered the robot.

- Pros:
  - Extremely Light and Simple Design
  - Shorter Cycles
- Cons:
  - Relies on Passive Methods to Control the Coral
  - Requires Redesign of the Coral Funnel and Elevator Carriage Mounting

CORAL INTAKE



- The coral intake motor is mounted on the arm and serves as a small counterbalance.
  - It is connected to a 4:1 gear ratio before a 1:1 belt ratio that travels the length of the arm.
- The Intake rollers are comprised of star wheels and Andymark green-compliant wheels, which we have found are exceptional when gripping coral.
- A CANRange sensor is used to determine when the robot has secured a piece and also helps position it in the intake.
- A coral ramp is fitted to the elevator, and allows for a wider intake angle at the human player station, permitting fast loading times and reducing the need for perfect accuracy when intaking.

SHOULDER

We aimed to work on the integration of a shoulder subsystem so our robot could extend beyond its frame and place game pieces accurately, rather than having to use a spit-out system.

Shoulder Considerations:

Shoulder Subsystem (Placing):

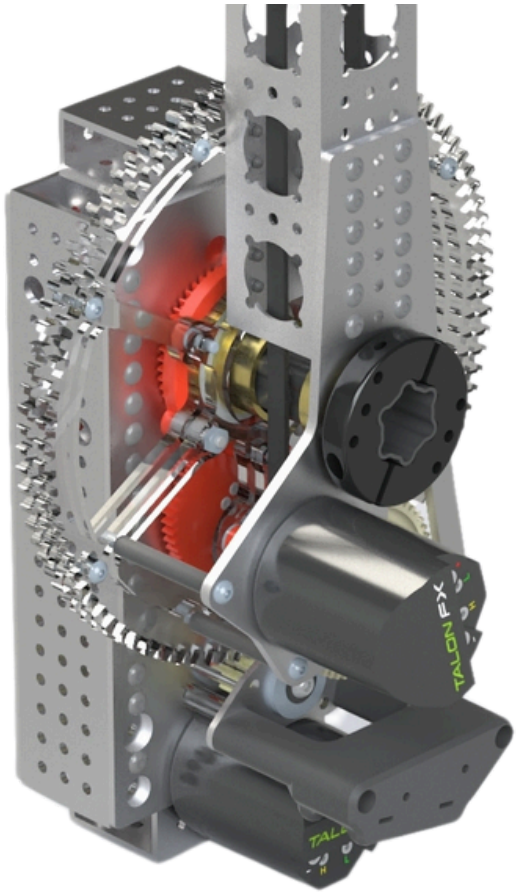
- Pros:
  - Greater Reach and Accuracy: The shoulder subsystem enables the robot to extend outside of its own frame, providing the ability to place game pieces in specific locations that would otherwise be hard to access. This is important for accuracy-based tasks, such as scoring in specific zones (e.g. Reef, L4), where accuracy matters more than speed.
  - More Precise Placement: By placing pieces instead of spitting them out, we have a lot more control where each piece lands. Spitting can make pieces scatter or miss targets, but placing is much more controlled and consistent, thus making it a more strategic choice, especially in games that favor precision like this year.
  - Avoiding Misplacement: Spitting out pieces is more likely to result in misplacement, particularly when trying to shoot over defense or into tight, smaller scoring areas. The shoulder subsystem prevents this risk as it allows us to gently place game pieces with greater precision/accuracy, even under high-pressure situations.
  - Strategic Control: Since many teams may be spitting out pieces, the advantage of placing them, while possibly slower, gives us a strategic advantage by ensuring we can consistently score in the right spots without the unpredictability of missed shots or disorganized placements.

SHOULDER

- Cons:
  - Greater Mechanical Complexity: Adding a shoulder subsystem brings in additional components to the robot, such as motors, joints, and linkages, which contributes to the design's complexity. It requires careful planning to ensure smooth operation and to prevent failure.
  - Weight Considerations: The shoulder subsystem contributes to the weight of the robot, and this may affect the overall balance and space available for other subsystems (e.g., intake, drivetrain, etc.). If not properly addressed, this could affect the robot's ability to move or the speed of the robot's movement.
  - Slower Action: Placing pieces is generally slower than spitting them out, this could be an issue if speed is required in specific tasks. However, we have concluded that precision is more valuable for our particular strategy, especially when placing pieces in critical scoring areas.
  - Stability Issues: The long reach from the shoulder might create stability issues if not properly designed, especially if the robot has a high center of gravity. This needs to be looked over in the robot's overall structure to ensure it doesn't tip over during critical moments in the game.

Our Decision: Shoulder Subsystem (Placing):
Following the strategic benefits, we established that placing pieces using the shoulder subsystem would be the most predictable and accurate performance, which aligned with our priority on accuracy. While spitting out pieces might seem faster, we found that placing them ensures better control and reliability, particularly when targeting specific areas like the L4, L3, L2, or L1 on the reef. The shoulder subsystem allows us to reach outside of our robot's frame, reaching and placing pieces with accuracy, which is very important for our game strategy. Although this design adds some mechanical complexity, we believe that it was worth the sacrifice. We believe that the potential for misplacement when spitting, especially in high-stakes situations, was too great, and the increased accuracy from placing pieces provided an advantage over other teams that spit out pieces.

SHOULDER



- Powered by a single Kraken X60 motor on a 67.5:1 ratio.
- The ratio uses 2 custom-machined “Mega gears”, which are 92T 10DP gears, made out of 7075 aluminum. They are clocked approximately 1 tooth offset to eliminate backlash and ensure a smooth power transfer.
- The encoder is connected by a 3d printed gear, directly driven by the arm, and like all CANcoders on our robot, is enclosed in a custom “BEANCoder” housing, which contains 2 Molex 2x2 micro fit connectors, to enable easily replaceable encoders in the event of a failure.

ELEVATOR

Our final objective for this season is to create an elevator that can reach out to the point where it can release game pieces at any level of the Reef, namely L1, L2, L3, and L4 during Teleop and Endgame.

Elevator Considerations:

Collapsing Stages:

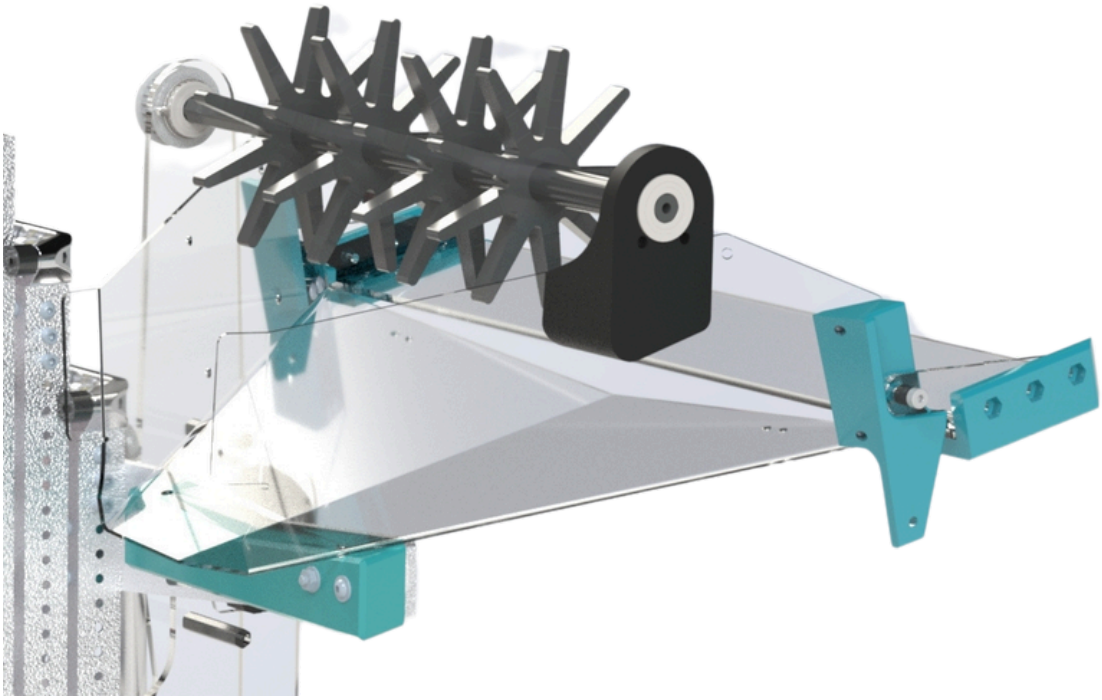
- Pros:
  - Reaches Level 4: The manipulator can reach as high as Level 4 of the Reef, which enables us to score on the topmost platform, something that is crucial in order to gain as many points as possible during playoffs.
  - Quick: The elevator mass is mitigated to allow for rapid accelerations upwards.
  - Reliable: Through testing, we have proven the design to be reliable in extensions and we have made many upgrades to its robustness.
  - Simple: The elevator design is based off of many proven box tube elevators previously used in FIRST competitions.
- Cons:
  - Potential trade-offs: The design complexity can affect the size of other subsystems, e.g., the intake, drive train, or climbing mechanism, that can limit our capability of doing other things with optimum efficiency.
  - Heavy: Although our lightening efforts were great, the sheer mass of the elevator is still rather high, and limits our speeds when the elevator is extended.

ELEVATOR



- The elevator is a 3-stage cascading elevator, securely mounted to the drivetrain through the use of aluminum tube struts, and a 1/16” wall 2x2 at the base of the elevator.
- It is powered by 2 Kraken X60 motors on a 4:1 gear ratio. This mathematically allows the elevator to reach the maximum extension in less than half a second.
- The rigging is attached to the back of the elevator and is entirely custom-designed
- It uses custom machined pulley blocks that bolt directly into the tube faces on the stages.
- It uses a custom pin method to secure the rope to each stage and carriage, allowing for easy assembly and rerigging should that be required.
- Springs provide variable tension so that students may lift the elevator from the carriage, without releasing too much tension on the slack side of the rope.

FUNNEL



- The Funnel is constructed from one piece of polycarbonate, milled and bent into its current form, allowing for a lightweight and robust construction.
- Along with this, a one-time drop down panel is mounted to the back of the funnel to reduce the gap between the loading station and the robot, which allows us to still intake even with a coral in the way.
- The funnel roller is attached by a combination of 3d prints and polycarbonate plates, and is powered by a Kraken X60 on a 2:1. This roller allows us to intake at higher speeds by gaining control of the coral faster.

CLIMBER

Our objective with the climber was to create a mechanism that allowed us to deep climb sub-10 seconds and didn't risk damaging the rest of the subsystems or electronics.

Climber Considerations:

Current Design vs. Alternative Design

Current:

- Pros:
  - Easy to use: The design is straightforward, making it simple to implement in Endgame.
  - Lightweight: The lightweight structure provides the desired robot mobility throughout the Teleop duration and encourages battery effectiveness.
  - Easy to remove: In case we need to adapt to game strategies, the climber can be easily removed to provide room for extra components or repairs.
- Cons:
  - Less safe: The redesigned climber is less secure in climbing the barge or in the final few seconds of Endgame, which may lead to a less predictable climb.
  - Requires practice: The success of this climber requires precision, which means driver practice is required to make it better.
  - Needs a very experienced driver: To make the most out of the current design, we need a very experienced driver who has the exact timing and coordination during Endgame.

CLIMBER

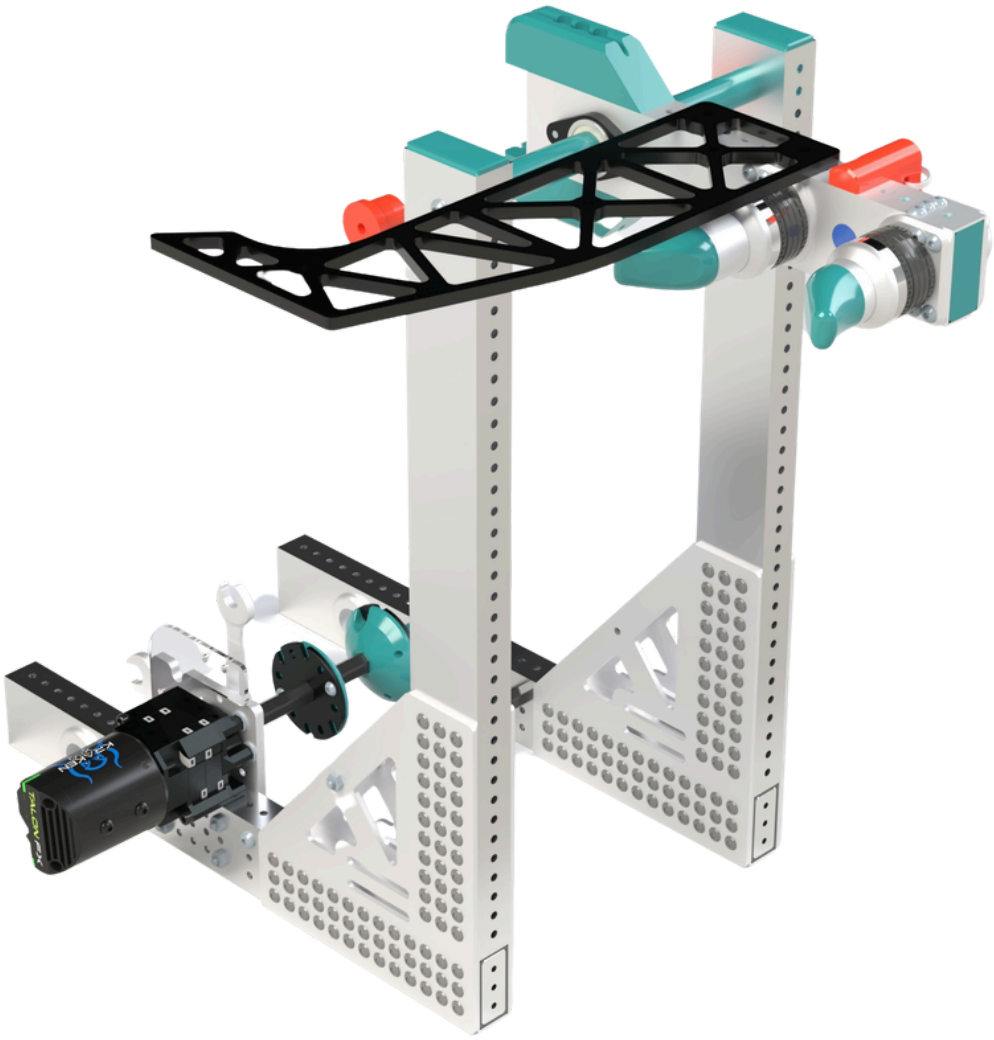
Climber Considerations:

Current Design vs. Alternative Design
Every bot design:

- Pros:
  - Less skill needed: This new climber design would be less demanding to drive and less punishing, lessening the requirement for driver skill in Endgame.
- Cons:
  - Needs more space: This setup occupies more space on the robot, which may clash with other essential subsystems such as the coral intake.
  - More mechanically complicated: The added parts and sophistication might make the design harder to assemble and service, possibly causing problems in competition or slowing down our pit crew's speed at making quick changes.
  - Heavier: This design has a larger volume of parts and would likely be heavier than our current design.

Our Decision: Current Design
We chose to keep the same climber design after careful consideration of our objective to keep our robot mechanically simple yet able to execute all the necessary tasks during Teleop with a consistent Endgame routine. The complexity of the alternate design can result in too many mechanical problems. We believe that the trade-off of requiring a skilled driver is acceptable, and our focus on simplicity allows us to remain adaptable, making it easier to adapt to problems during the competition. Additionally, the design is currently modifiable easily and lightweight, allowing for faster cycle times and quicker adjustments during the game.

CLIMBER



- The climber mechanism is powered by one Kraken X60 coupled to a 25:1 MAXPlanetary gearbox.
- The output powers a winch mechanism that pulls the climber toward the center of the robot
- The initial design was based on the 868 Ri3D climber, but we made some upgrades to the gear ratio, motor choice, and climber geometry to improve both durability and ease of use on the field.
- It utilizes 2 aluminum round tubes fitted with Cat-Tongue tape to improve grip.