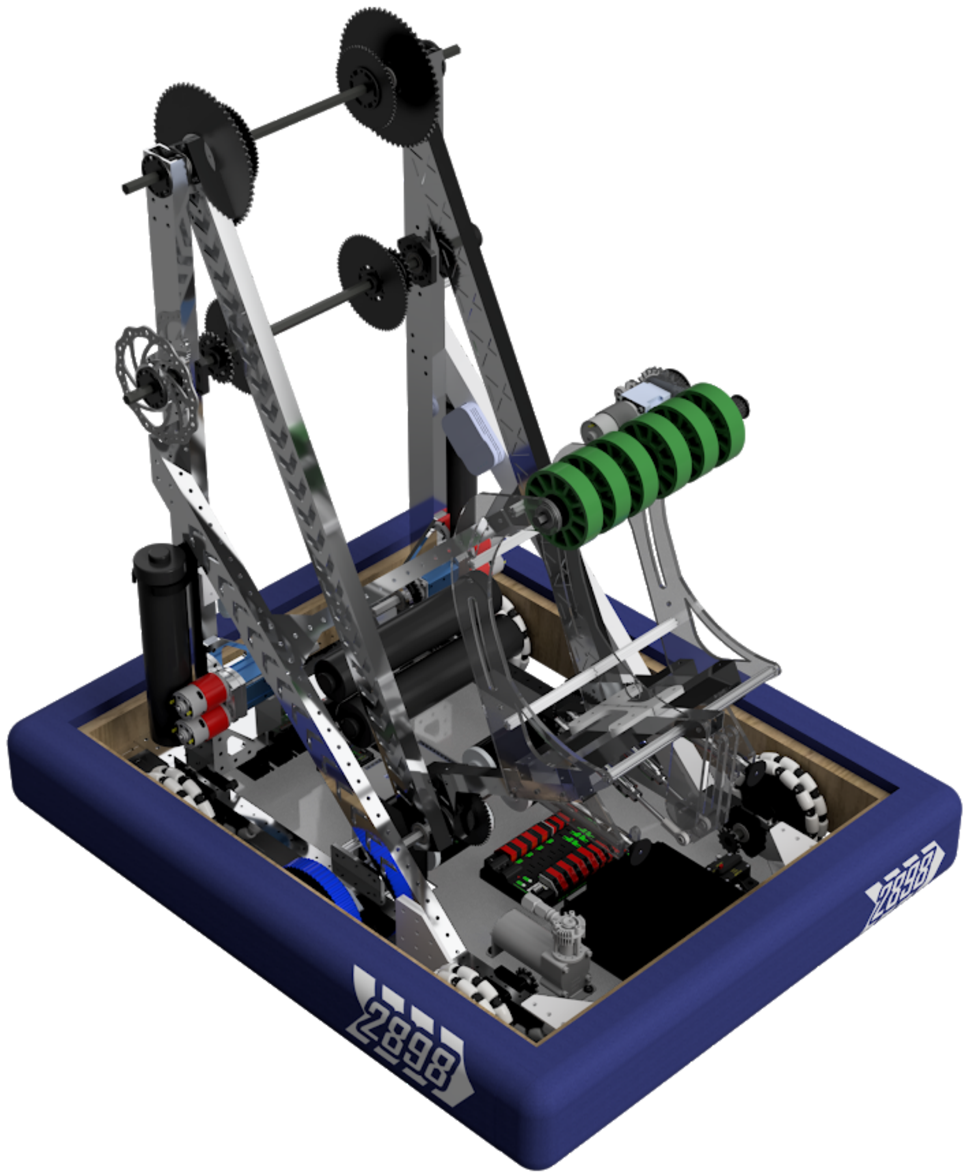
THE FLYING HEDGEHOGS 2898



ARMSTRONG

TECHNICAL BINDER 2019

2898

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STRATEGY

GAME ANALYSIS

This year's Challenge had several major tasks: the manipulation and placement of *two* game pieces (hatch panels and cargo) and a platform climbing element. To determine our strategy and objectives for this season, we had to weigh the value of each potential action against our build capabilities and resource constraints. Our primary goal was to identify a simple strategy that would be reliable and within our means to build, but still competitive. For our team, this meant prioritizing some of the game's tasks and forgoing others.

POINT VALUE ANALYSIS

To help us discuss our game strategy, we identified all possible point-scoring opportunities and quantified the value of each action with a point value matrix, taking raw point value, estimated success rate, and time into account.

SANDSTORM	POINT VALUE	CHANCE	# of Times	TOTAL POINTS
Sandstorm 1	3	1	1	3
Sandstorm 2	6	1	1	6
Hatch	2	0.7	2	2.8
Cargo	3	0.6	2	3.6

TELEOP	POINT VALUE	CHANCE	# of Times	TOTAL POINTS	MAX POINTS
Hatch	2	0.8	8	12.8	36
Cargo	3	0.65	8	15.6	54
HAB 1	3	1	1	3	12
HAB 2	6	0.7	1	4.2	12
HAB 3	12	0.5	1	6	12

RP	Points	Chance	# of Times	Total
Rocket	1	0.7	1	0.7
Win	2	0.5	1	1
HAB	1	0.8	1	0.8

STRATEGIC DESIGN

STRATEGIC DESIGN MATRIX

After briefly entertaining the idea of being a cargo/hatch panel specialist, we decided that we wanted to manipulate both game pieces. From there, we identified the two primary strategies that we considered to be within our build capabilities, using the strategic design matrix below. We weighed these two options by quantifying and discussing factors like feasibility, reliability, potential point value, and pros/cons.

Robot Type	Feasibility	Chance of Success	Max Point Value	Estimated Point Value	Notes
Hatch + Cargo Lvl 1 + Lvl 3 climb	0.6	0.9	88	79.2	No 4th RP, climb RP matters less in playoffs, only one robot on an alliance can climb to lvl 3
Hatch + Cargo Lvl 1,2,3 + No climb	0.7	0.7	120	84	Overall very competitive, would be valuable to any alliance. Can leave space for climber addition

STRATEGY CONCLUSION

In summation, while a level 3 climb + level 1 hatch/cargo robot would help us rank high at our events, a robot that could place game pieces at all three heights would make more points available to us and would definitely be useful on any alliance.

After a few days of discussion, we came to the conclusion that an optimal match strategy would be to perform a two-hatch panel auto and, in teleop, run hatch panel and cargo cycles at all height levels. We decided not to prioritize the climb-based ranking point, and instead focus on winning matches by placing as many game pieces as possible.

PRIORITY LIST

Drive Base

- Highly maneuverable, easy to adjust position
- Optimize cycle times
- Extended base length to leave space for arm
- Can drive off hab platform 2 / robust

Arm

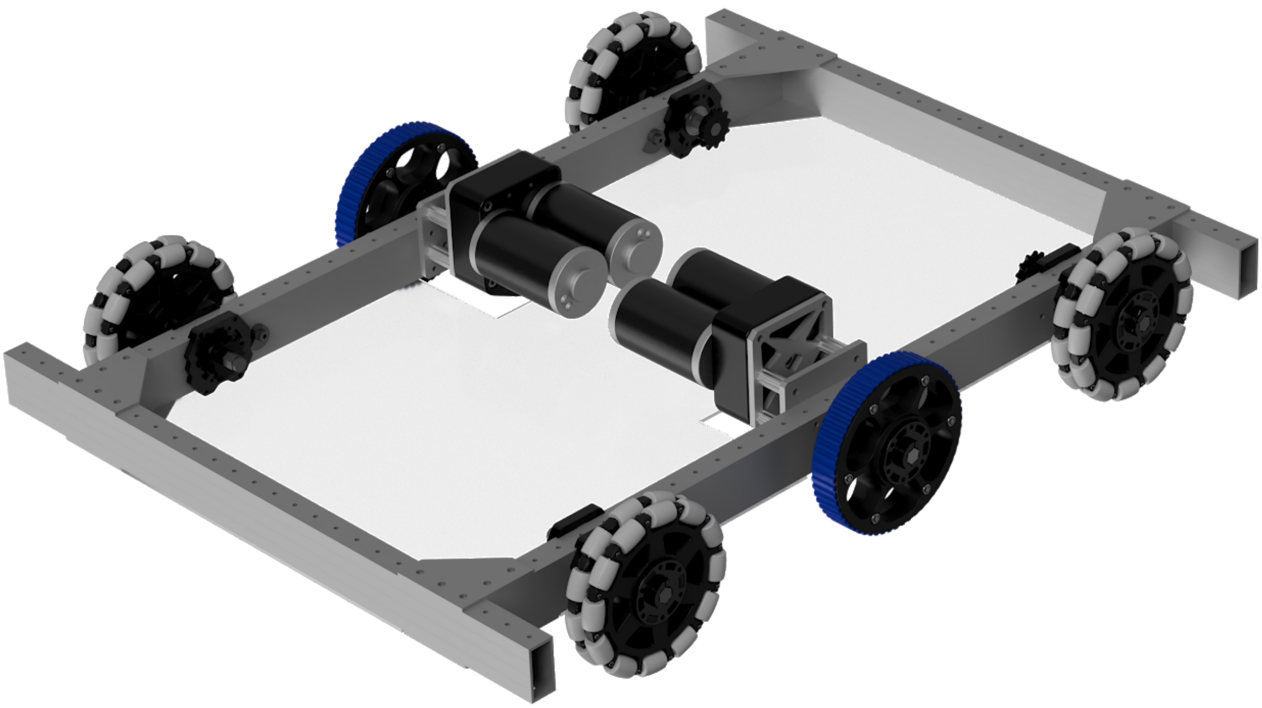
- Keep it light + fast
- Must retain the angle of the manipulator
- Needs enough height to reach top level of rocket
- Reduce strain on stalling motors as much as possible
- Setpoints for hatch panel and cargo lower level, mid level, and top level

Manipulator

- Both game pieces, one mechanism
- Keep it light (on end of arm)
- Widen acquisition area as much as possible
- Allow for angular displacement and misalignment
- Hold game pieces securely

MECHANICAL SUBSYSTEMS

DRIVE TRAIN



Chassis

- West Coast Drive - *1/32”* Center Drop
- Sliding bearing blocks for easy chain tensioning
- 4 x 6” Omni Wheels to aid with maneuverability
- 2 x 6” Blue Nitrile Plaction Wheels to grip floor
- Large, 6” wheels - easier to drive off elevated hab platforms
- Vex Pro Single Speed, Double Reduction Gearboxes (2 per side)

ARM ASSEMBLY

Design constraints

- Dimensions (affects max reach height and frame perimeter breach)
- Material (affects strength)

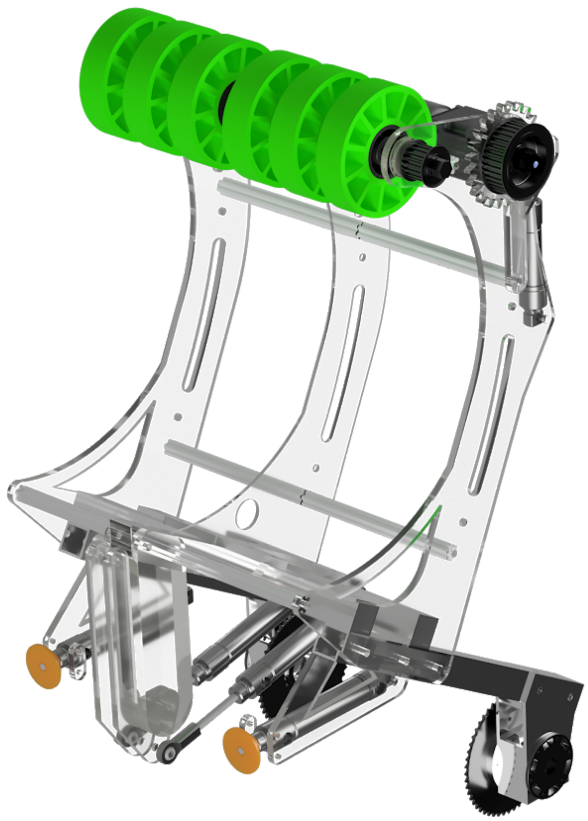
Superstructure

- Virtual 4-bar mechanism constrained with two lengths of 25 chain, for manipulator angle retention
- Widened two-sided design for strength
- Angled chassis-mounted supports
- Two runs of cross-mounted 1/8” steel cable for arm rigidity (not pictured)

Drive system

- Powered by 4 x 775pro motors, 2 per side, creates 117:1 reduction with Dual Sport gearbox
- Two stages of chain to reduce risk of single-motor torsion
- 585:1 total gear reduction from all 4 775 pro shafts to arm rotation
- Disk brake used to hold the arm in place, reducing burnout risk of 775pro motors
- Armacoder allows for the programming of preset arm positions

Manipulator Assembly - Cargo // Hatch Panel Intake



Cargo intake design

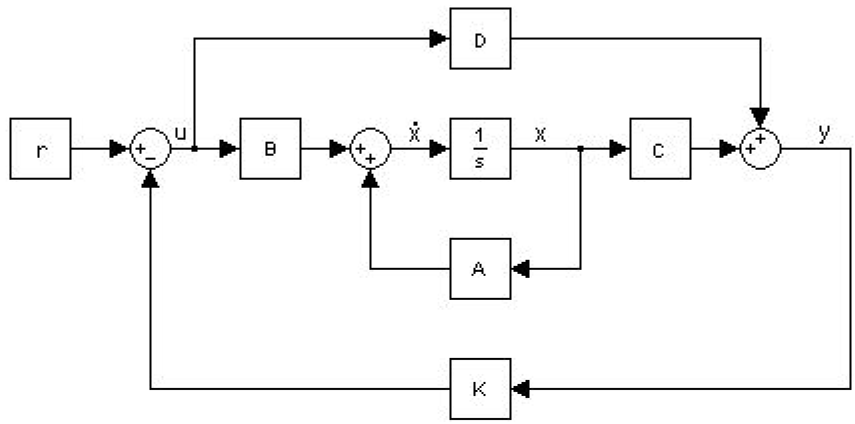
- Bare-bones skeletal design, 3 layers of polycarbonate plating
- Designed to hold only ~50% of the ball - allows for better visual alignment
- Driven by single BAG motor with a gearbox reduction of 4:1, then belt 1:2 reduction to make a total of 2:1 output reduction
- Outtake brake built into motor output to keep the ball from falling out, actuated by 1/2” stroke pneumatic actuator
- Automatic intake sequencing, motors backdrive cargo into manipulator until current draw exceeds a threshold, then lock engages

Hatch panel intake design

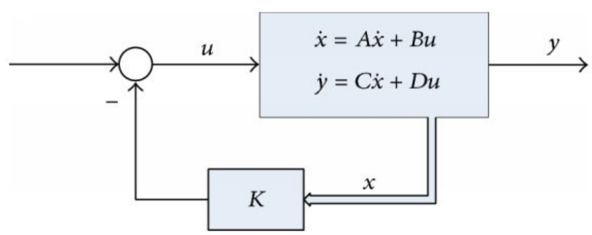
- “L” clamp mechanism driven by dual 2” stroke pneumatic actuators
- Once clamp head is recessed inside hole of hatch panel, mechanism actuates and clamp secures the hatch panel
- Hatch panel mechanism stays perpendicular to the ground
- Forward-facing twin pneumatic actuators eject the hatch panel, eliminating the need for a perfect alignment
- This allows us to be misaligned by up to ~80 degrees as long as one side of the hatch panel is close to or is making contact with the target

PROGRAMMING FEATURES

- **State-Space Controller**
    - More control over our system
    - Gives more accurate, reliable, and robust control parameters
    - Also known as modern control theory



- **LQR**
    - Control system uses two matrices to pick optimal gain for the system.
    - Q and R matrix defines how aggressive the controller will be.
    - No tuning whatsoever
        - Control system picks optimal gain for you



- **Other Features**
    - Kalman Filter
        - Removes noise, inaccuracies, and time delay
        - Predicts where the system is using a series of data
    - Gravity Feedforward
        - Linearizes the system
        - Treats arm as a linear system
    - Two State Feedforward
        - Mathematical “guess” of what the system needs
        - Allows feedback system to handle unknowns/inaccuracies