ENGINEERING DESIGN DOCUMENT

"It's not about the game, it's about the journey"

FIRST® ROBOTICS COMPETITION

DESTINATION:

DEEP SPACE

Contact Information

email: info@highlandersfrc.com
website: www.highlandersfrc.com

Presented By BOEING

THE HIGHLANDERS

FRC Team #4499

DESTINATION: DEEP SPACE

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2019 SEASON ENGINEERING DESIGN DOCUMENT

ABOUT US

Our team doubled since 2018 when we had 6 team members. Many of us our new to FRC, FIRST and Robotics. We range from 7th grade to 12th grade.

STRATEGY

We decided to focus our robot to score on the low goals only. We will manipulate the hatches and cargo. We will plan to reach Hab 2 and maybe Hab 3.

GRAVASTAR

1. **ROBUST**
   Build a robot that is designed to compete the game, but be made to withstand the game.
2. **RELIABLE**
   Build a robot that will compete and score goals round after round and througout the tournament season.
3. **CYCLE ROBOT**
   Create a robot that can cycle the cargo and hatch fast, efficiant and reliable.
4. **CUSTOM DESIGN**
   Create a design for our team to push our creative designs while learning from our mentors and alumni along the way.

Website : www.highlandersfrc.com

Location : Fort Collins, CO

THE HIGHLANDERS

KICK OFF AND PROTOTYPING

The Highlanders spent kick off reading the rules, stratagizing and understanding our teams resources and abilities. We decided to focus on a low cycle robot.

HAB 2

HOW?

Since we decided to do a low cycle robot, we needed to be fast, efficient and reliable. We decided we also wanted to start on HAB 2 and end on HAB 2, therefore our drive train needed to handle the impact. Since our 2016 robot could handle Stronghold we wanted to use a similar design of pnuematic wheels, but use 8 wheels instead.
We wanted to dsign an arm that could do cargo and the hatch, but as we designed we realized we could not optimize enough for both so we separated the mechanisms.
In Order to reach these goals, we also knew that camera vision and computer vision will be extermly important, so we want to implement this for our season.

HATCHES-LEVEL 1

REACH GOALS?

We would like to get to HAB 3 after we optimize our current mechanisms.

CARGO-LEVEL 1

THE HIGHLANDERS

6 years @ Championships

2 Regional

DEAN'S LIST

Finalist

2 Regional Chairman's

---

2 Rookie All-star

2 Regional Finalists

Galileo Gracious Professionalism AWARD

1 WORLD CHAMP Division Win

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66 Expo booths & demos

2 Engineering Inspiration

2 Regional WOODIE FLOWERS

1 Engineering Excellence

2018 World Championship Finalists

THE ROBOT GRAVASTAR

CHASSIS

Modeled after the West Coast Chassis design with our own custom chain-in-tube .

ARM

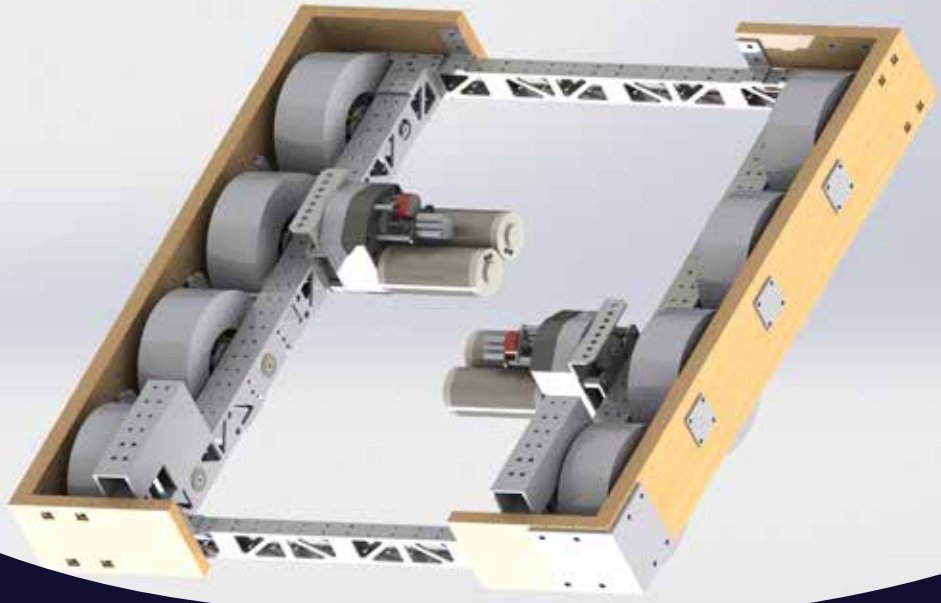
We desigined our own custom gear box that will control our arm mechanism.

VISION

We implemented our own custom solutiont to track reflective tape and program an auto targeting solution.

ABOUT GRAVASTAR

The Highlanders are proud to introduce our 2019 robot: GRAVASTAR. We decided to design a robot that we could machine, program, and implement with our team, resources and knowledge. We decided to push our machining by creating our own custom gear box for our cargo arm and improve our skills with detecting reflective tape using custom vision code. We also decided to reach HAB 2, but hope to have the time to design for HAB 3. Since we have a team of 11 team members, many are new to robotics and FIRST, so we had to reduce our expectations and focus on what we could be good at. We also decided to prioritize drive practice so we can be prepared for our tournaments.



THE CHASSIS

ABOUT

We designed our 2019 robot using the West Coast Chassis design. We decided to use chains over belts and place the chains within the chassis tubes. We decided to use 8 pnuematic wheels with a 1/8th inch drop center for the 2 middle wheels. We also decided to use rivets to attatch most of the chassis, but went with bolts in our gussetts. The other custom design we implemented was our own weight savings design. This helps us conserve weight and creates a creative machined design.

WHEELS

We chose to go with 8 pnuematic wheels to take the impact of the different steps.

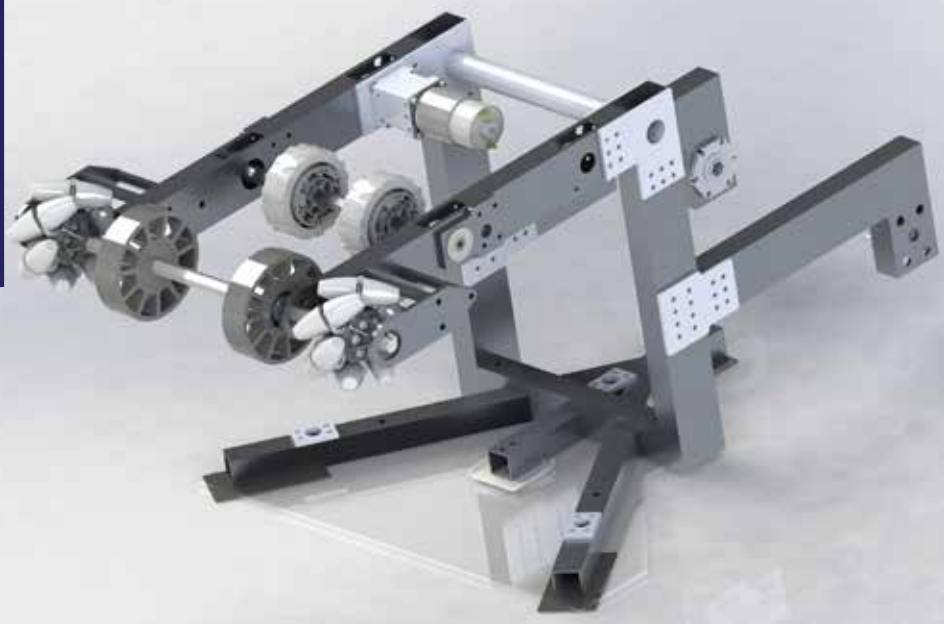
CHAIN IN TUBE

We decided to deisng the drive train chain in our chassis tube. This will protect the chain from hitting the HAB levels.

CUSTOM WCC

We went with a West Coast Chassis design, but implemented it our own way.

THE ARM AND INTAKE MECHANISM

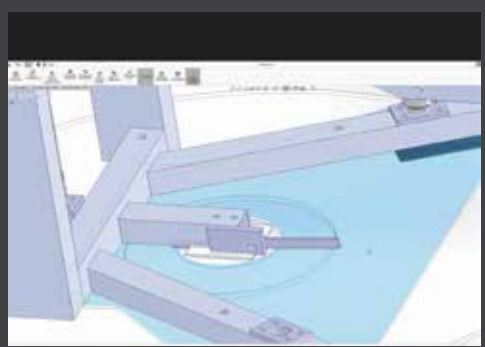


CUSTOM GEAR BOX

We designed this gearbox so that it was strong, easy to maitenence and be structural. We also decided to use mini-cims to also aid in us to use our arm for HAB level 2 and 3.

CARGO INTAKE

We designed the intake to collect the ball from the sides using Colson and Mecha-num wheels, this helps pull them in from the sides. To shoot, we use a 9:1 gear ratio, with belts in the intake tubes.



HATCH PICKUP

This was our initial hatch mechanism. After we continued testing we realized that this solution would not work fast enough for what we wanted, so we completely re-design it.

ARM IMPROVEMENTS

Our competition robot will compete with a gear box that has 175:1. We improved this design from past experience and made adjustments that will allow us to maintence it easier and tighten all connections regularly.

CUSTOM
GEAR BOX

VS Code

python

COMPUTER VISION/PROGRAMMING

VISION TRACKING USING REFLECTIVE TAPE

CAMERAS

It was clear that this year we would need to have driver vision, but we had a limit of 4Mbit, so that would require us to manage our FPS/resolution and compression. To accomplish this we are using the JeVois camera and custom code.

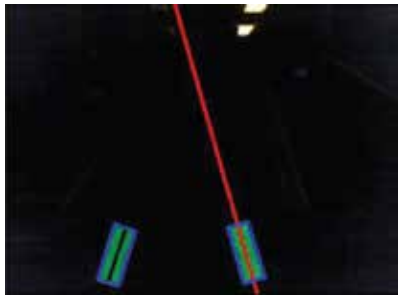
VISION TRACKING

We prioritized the ability to recognize the reflective tape using the JeVois camera and integrated CV code. We wrote custom Python code to detect the targets and calculate distance and angle to send to the RoboRio for an auto-score solution.

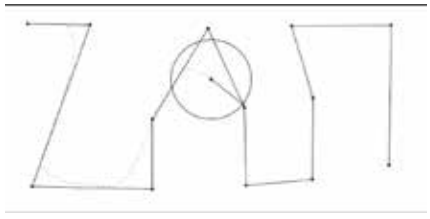
VSCODE/PURE PURSUIT

In order to create a driver assist “auto-score” button, we used a pure pursuit algorithm that creates a “look ahead” point at a configurable distance from the robot. This creates the speed and direction spline the robot needs to move to the target.

AUTO SCORING

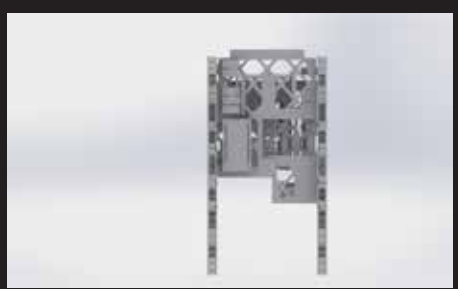


PURE PURSUIT



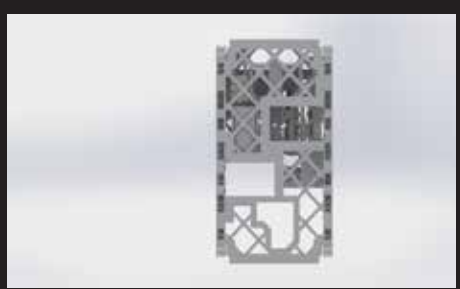
3D PRINTED MOUNTS

ELECTRONICS BOARD DESIGN



TOP VIEW

We placed our air tanks, pneumatic manifold, solenoids and RSL on the top shelf of our electronics board.



BOTTOM VIEW

We placed our PDP, canifier, VRM, PCM on the bottom of our electronics board.

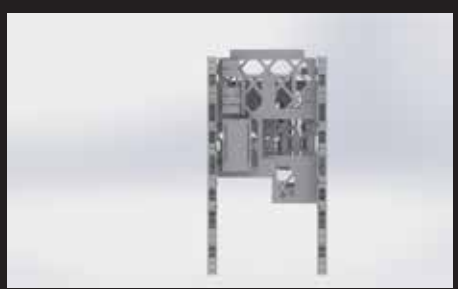
PLASMA JET

All of our electronics boards were cut out on our team-designed CNC plasma jet.

ABOUT OUR ELECTRONICS

We focused on having our electronics boards completly designed and layed out in SolidWorks. We even made a custom back board with our robot name: GRAVASTAR.

ELECTRONICS BOARD DESIGN



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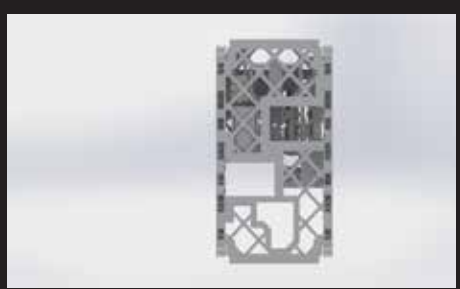

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HATCH MECHANISM

The Highlanders decided our first Hatch mechanism that used velcro to pick up from the ground and from the feeder station, it would not work consistently enough. So we had to go back to the drawing board.

HATCH GRABBER

CAMERA MOUNT

HOW?

We decided that with our new hatch mechanism it would need to have cameras mounted on top for both directions of the robot and it needed 2 degrees of freedom, forward reach and horizontal grabbers. These grabbers were made from custom 3D printed carbon fiber that is reinforced with aluminum brackets. We also have a piston that will push our mechanism over our bumpers so we can reach the rocket. We decided to brace this mechanism with two beams that are supported by the chassis for additional support.

EFFECTIVENESS?

We plan for this to be fast, efficient and effective. With extensive CAD design we hope this will be able to manipulate the hatches for our expected 7 second cycle times.

OUTREACH

11 STUDENTS

2/3 ASSISTED
ALUMNI
42% MENTOR
HR

2 FOURTH OF JULY **PARADES**
5000 PEOPLE

STARTED
8 FLL 1 FLL Jr
1 FTC

10 FLL **1 FLL Jr**
MENTORED

IT'S NOT ABOUT THE **GAME**

IT'S ABOUT THE **JOURNEY**

2 **ROBOT** DISGUISE **DAYS**

GRADUATES
100% Attend **College**
STEM Ma-

6 **Youth Summer Camps in** **3** Years

ONE ALUM JUDGED AT
3 REGIONALS AND
3 CHAMPIONSHIPS

3rd YEAR **SUPPORT** of LOCAL STEM EVENTS