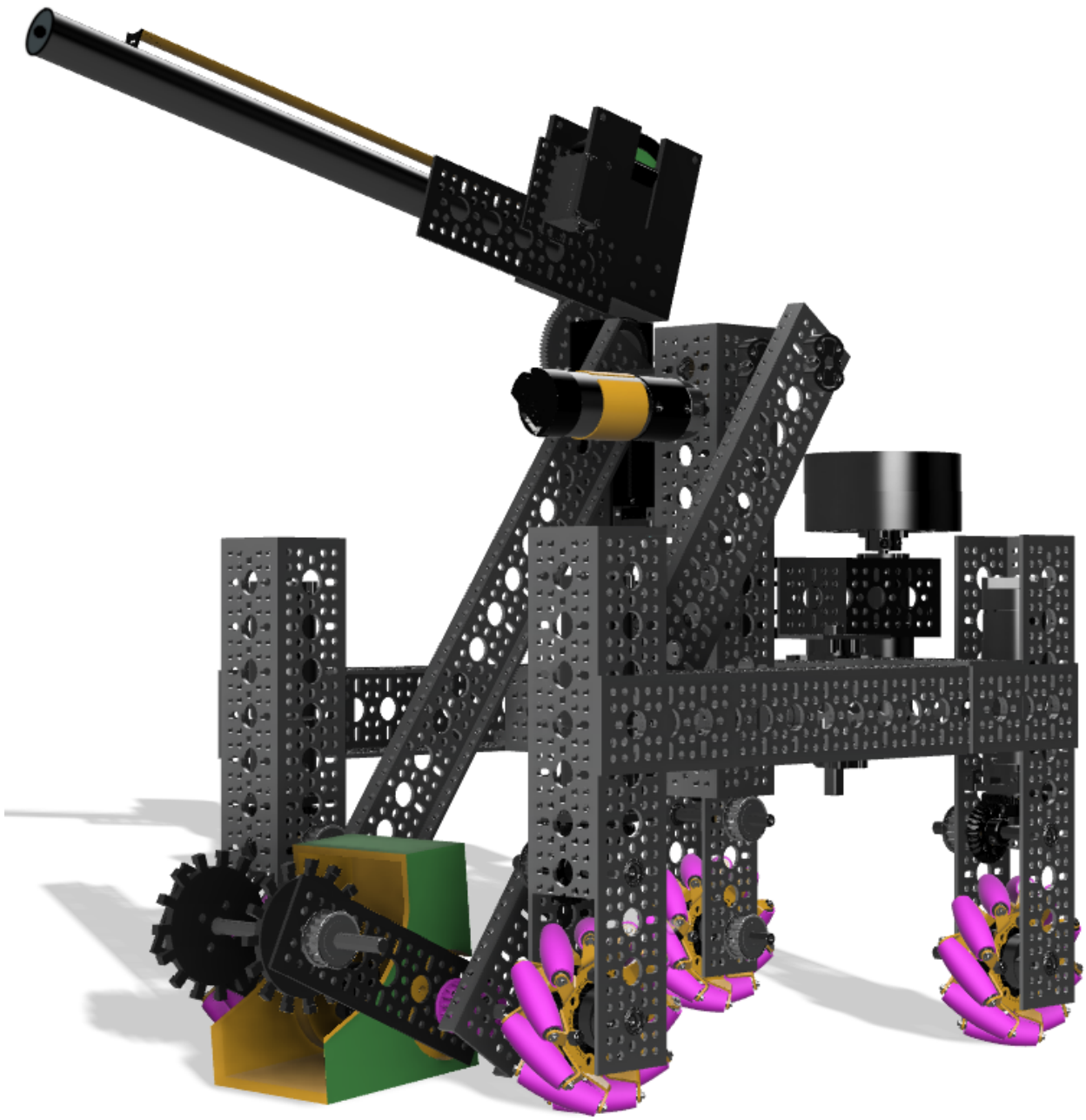
Xavier- 9 • Years in FIRST Alan- 9, Aubree- 7, Chase- 1, Jack- 4, Lance- 7, Luci- 8, Maya- 6

WormGear Warriors

FTC 8620



Meet the Grades: Alan- 12, Aubree- 9, Chase- 10, Jack- 8, Lance- 8, Luci- 9, Margaret- 10, Maya- 9, Shreyas- 8, Sloan- 10, Veda- 9, William- 10

Margaret- 7, Shreyas- 4, Sloan- 10, Veda- 6 William- 1~All students on the WormGear Warriors reside in Edwardsville and attend Liberty Middle School or Edwardsville High. 67% of our members were previously on an FLL team.

TEAM ORGANIZATION And Summary

"Documentation was a struggle for us last season, but we learned from our mistakes and stayed on top of it this year! "

Meeting Safely: Our area, as most others continued to be impacted by COVID-19 this season. Our team decided to practice extreme precaution to ensure the safety of all of our team members and their families, as well as any people our team connected with through outreach.

Summary:

The WormGear Warriors' mission is to strive for the advancement of STEM through participation in FIRST robotics. The WormGear Warriors are empowering students to become tomorrow's leaders by teaching leadership skills, giving them mechanical, electrical, programming, and presentation experiences while working as a team. We seek out other students to participate in this activity, leading more students to pursue STEM careers.

To assure team sustainability we started our own non-profit organization, Metro Area Robotics Society. This came about when the organization our team originally belonged to decided to focus on FRC. Since many of the members wanted to continue with FTC, we branched out on our own.A primary focus of our team is to ensure a continued flow of new members. This year we added three new members. Two were completely new to FIRST and Stem, one had been in FLL but had not participated in FIRST for a few years.

Team Leads and Co-Captains:

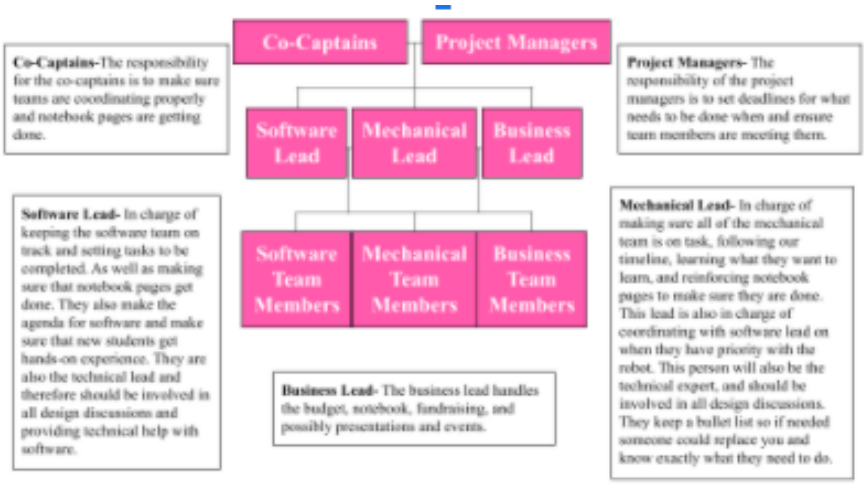
This year our team decided to return to an old team management strategy, which had worked very well for us. Last season our team had some issues with motivation due to quarantine, not having enough team interaction, and overall COVID being discouraging. Our team thought having ambassadors on our team, such as co-captains and team leads would help keep everyone motivated and learning.

- Co-Captains-The responsibility for the co-captains is to make sure teams are coordinating properly and notebook pages are getting done.
- Software Lead- In charge of keeping the software team on track and setting tasks to be completed.
- Mechanical Lead- In charge of making sure all of the mechanical team is on task, following our timeline, learning what they want to learn, and reinforcing notebook pages to make sure they are done.
- Business Lead- The business lead handles the budget, notebook, fundraising, and possibly presentations and events.

We want you to know...

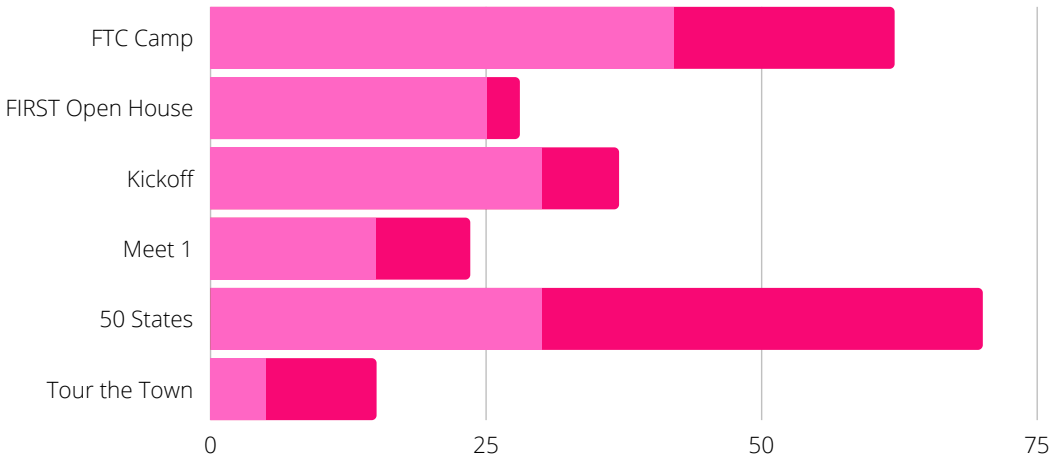
"Our members get to chose their role. Tasks are assigned by personal choice. We assign a pre-existing member to a task, with two newer members assisting."

"As the Outreach/Business Lead, I've learned that organization is the key to success. Even with COVID, we were able to manage our time well while make lasting connections, through our 50 States plan."



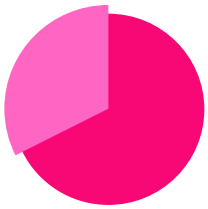
OUTREACH

MAIN EVENT Hours



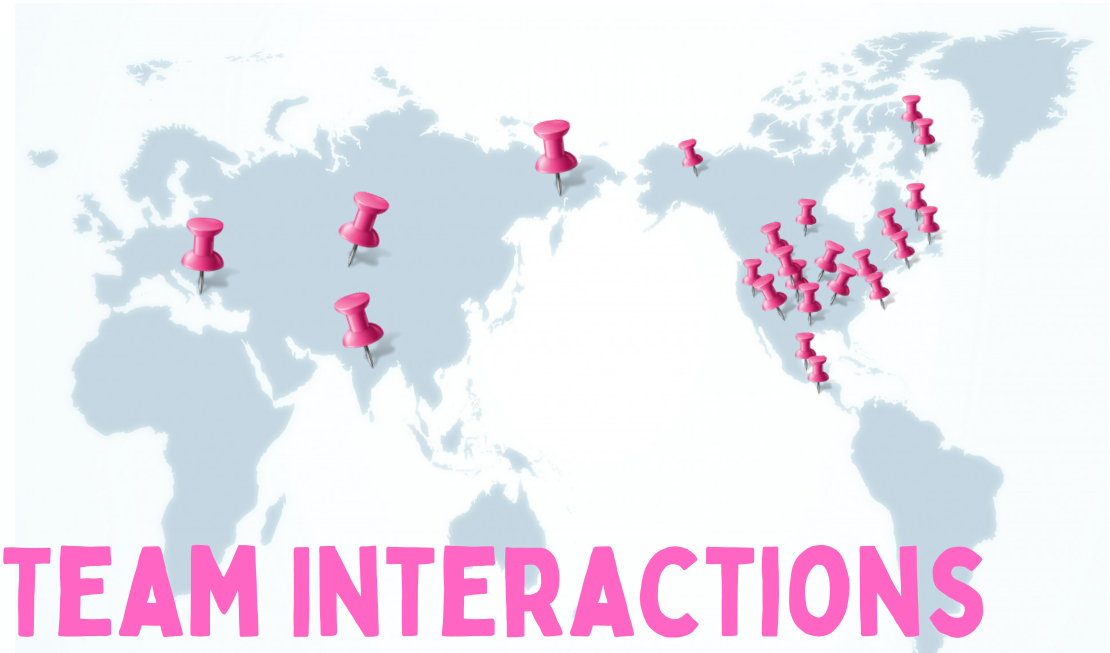
"The Outreach events were my favorite team activity this year. We reached over a thousand people through multiple events: such as Kickoff, 50 States, and more!"

IMPACT



129 impacted outside the USA

1,567 impacted within the USA



7112 HOURS

TEAM INTERACTIONS

"we've been able to meet with teams from all over the country through the 50 states program. We asked these teams what they would be comfortable teaching another team, and what would they want to learn from another team. We want to connect these teams to help more people learn more about software, mechanical, and presentation."

MONTHLY MILESTONES

MAY

- FTC Open House
- Visiting the County Courthouse

JULY

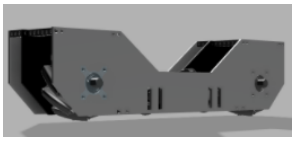
- Granite City Lights Festival
- Iowa Invitational: We competed in a remote competition where we won the Connect award.
- Recruitment training

SEPTEMBER

- Worked with Dr. Klingensmith to connect with SIUE and host Meet 1 and Kickoff
- Kickoff - Our team planned and hosted the first kickoff in our region that 10 teams attended!
- Deans at SIUE- We were able to meet with the Deans of SIUE through Dr. Klingensmith, through this we were able to host kickoff and meet 1.

NOVEMBER

- Meet 1!
- Volunteering at meets
- Hosted Meet 1 @ SIUe
- Alumni visit and give input on robot design.
- Blue side detecting duck and team element correctly



JANUARY

- 50 States Plan is launched, we meet with one team from each state.
- Receive contact from teams in Germany and India.
- Chicken-Salad-Chick Fundraiser connects us with 1000 community members and raises $300.

JUNE

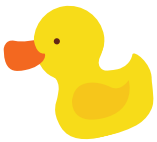
- FTC Camp- This summer we hosted a week-long camp with 20 attendees, 5 were invited onto our team.

AUGUST

- Chris Zimmerman visit- civil engineer who helped us with logistics of a new base design.
- Tour the Town pt. 2
- Dave Oates- explains business professionalism to our team.
- Zach Waters- helped train our new recruits in Java.
- Robot drove a spline.
- Decided on new team organization system - team leads, project manager, co-captains, etc.

OCTOBER

- Teleop Basics
- Planned Vision Code
- Created app
- Had a good start of roadrunner tuning
- Created prototype for duck spinner
- Robot Base assembled



DECEMBER

- Meet 2!
- Reece Watson- Electrical engineering major helps us with software organization. Warehouse task is completed in Auto.
- New arm and intake.

FEBURARY

- Youtube- Our team used YouTube this season to post our robot matches.
- Intelligencer (Newspaper) publication- We were interviewed by an author of the Intelligencer and were published in the Intelligencer Edwardsville Newspaper.

MECHANISMS

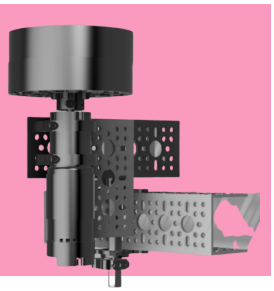
DUCK: DUCK SPINNER

ITERATION 1

- simple servo mounted at back of robot with two wheels

ITERATION 2

- utilizes GoBilda motor instead of servo
- spring loaded which allows more room for error



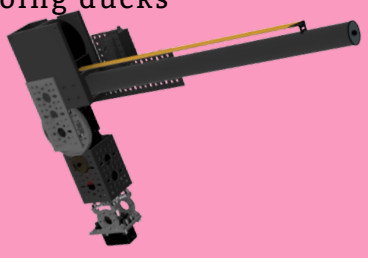
TOUCAN: CAPPING

ITERATION 1

- a tape measure that was actuated by a small wheel and mounted on a turret-style servo block.

ITERATION 2

- A fishing pole that is actuated by a tape measure and a servo with a wheel on it
- Allows us to extend in endgame while doing ducks



SENSORS

Our robot, Wall-E features **16** sensors. These sensors enhance our autonomous, allowing us to score 2-3 additional blocks, and optimize the Tele-op driver control period. Three **ultrasonic sensors** allow our base driver to press a button and automatically go to a position allowing Wall-E to drive between the warehouse barriers and field perimeter. **Magnetic sensors** allow our duck spinner to be spring loaded and to home our arm. **Encoders** replace dead wheel odometry. **Color-distance** helps the drivers determine what has been collected.

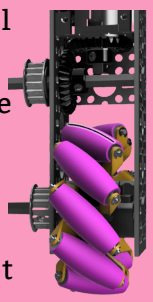
FLAMINGO: DRIVE TRAIN

ITERATION 1

- We tested three different chassis' and decided to mesh a few together
- The motors and wheels are condensed into one GoBilda channel and raised vertically rather than horizontally.

ITERATION 2

- Vertical mecanum drive that utilizes GoBilda motors inside of the channel to save more space
- Stacked on top of everything to leave open space for an intake and fit between the warehouse barriers and perimeter
- Motor is attached to a bevel gear that meshes with a second bevel gear, whilst spinning a pulley that utilizes timing belt to spin.



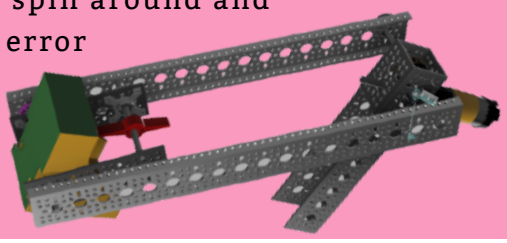
GOOSE: COLLECTION/ DELIVERY

ITERATION 1

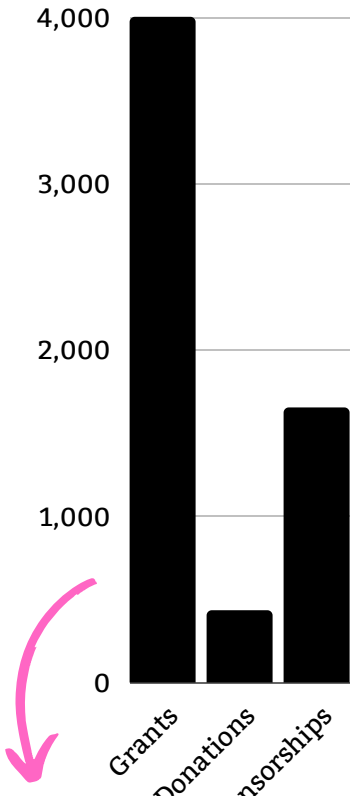
- an old claw style arm designed to easily pick up objects

ITERATION 2

- Chain bar link, similar to 4 bar link, keeps the collection box parallel while also raising to the levels of the Alliance hub.
- Uses three GoBuilda motors that are mounted from a central channel, saving space
- Uses two worm gears to be able to completely spin around and less room for error



INCOME & SUSTAINABILITY



M.A.R.S.

NON PROFIT

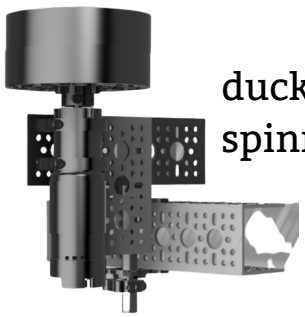
7 years ago, our coach founded Metro Area Robotics Society (MARS) to continue our team. The non-profit allows for us to accept donations and advertise in ways that would not be possible otherwise.

SIUE

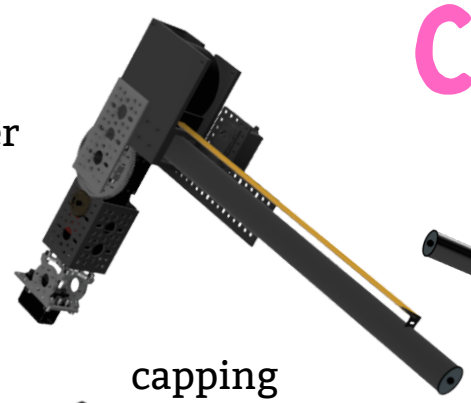
MENTORS, EVENTS

Our connection with SIUE (our local college) has been a heavy focus for our team this season. For a few seasons we have had a professor from the college heavily invested in our team, helping us with software and project management. From this connection stemmed a connection with the deans and engineering department at the college. Our team has previously participated in IGE day (introduce a girl to engineering day). This season our kickoff was hosted at the college, and we scheduled three meets there as well. From hosting these events our team was published in SIUE's newspaper, and we have sparked further interest about FIRST at the college. The university has offered to host any events we plan on doing in the future as well.

CAD MODELS

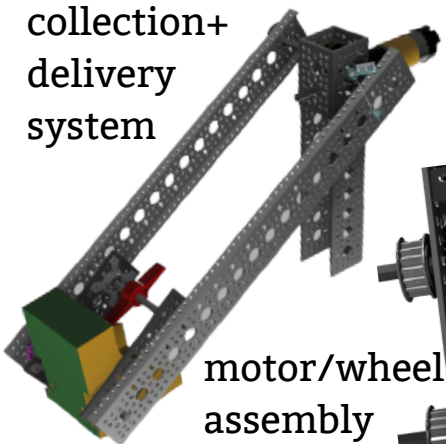


duck spinner

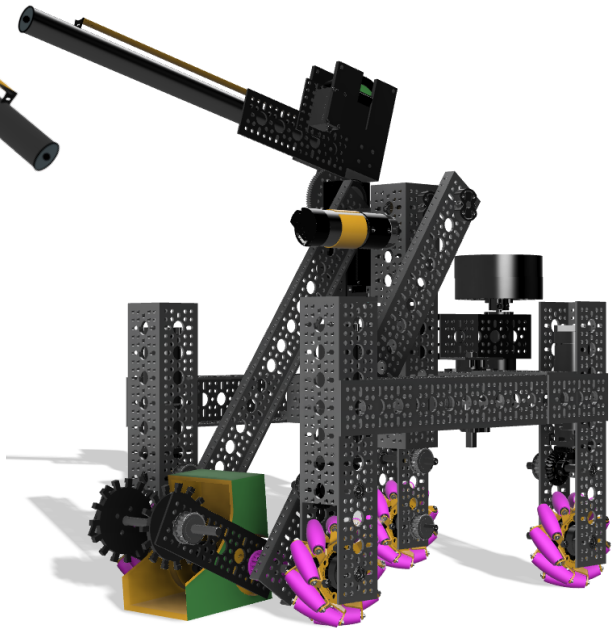


capping mechanism

collection+ delivery system



motor/wheel assembly



whole robot: WALL-E

SOFTWARE

SENSORS

- We use **encoders** on all four of our drive motors. This allows the **path-planning** and localization code we implemented to always know where our robot is on the field.
- On our arm, we use **magnetic sensors** as well as **encoders** to "home" the arm at the beginning of autonomous and drive to set positions throughout the rest of the match.
- On the duck spinner, we use an **encoder** to keep the speed consistent. We also use a **magnetic sensor** in autonomous when driving **backwards** into the carousel. As soon as the sensor engages, the robot stops driving backwards and turns on the wheel to spin the duck off.
- In the box for our collection, we use a **color/distance sensor** to detect if there is freight in the box. This sensor stops the intake from spinning and signals a light to turn green. When there is no freight in the box, the light is red.
- We use three different range sensors as well that help us **control the distance** of the robot from the wall when driving in and out of the warehouse. We also implemented a complicated position correction that utilizes these sensors. The warehouse heading/position error correction is detailed in the software flowchart.

DRIVER CONTROLLED ENHANCEMENTS

- In the **endgame** when we spin ducks, we do not want them to fly off of the carousel. Given this, we **created code** to **gradually accelerate the duck spinner as the driver is holding the button**. It starts at a given minimum speed, and each time through the TeleOp loop, it increases the speed by a number determined by our drive team. It also has a maximum speed set, so it will not go too fast and completely fling the ducks off.
- We also have our base driver controls set up so that if they **turn the robot to be facing away from them and press the "x" button, the robot gyro resets** and the robot will always go away from them if they push the stick away from them.
- The sensor on the box in addition to the light would also fall into this category.
- We also use the encoders on the arm and box in order to drive the arm to several set positions including one for each shipping hub level, a collection position, and two different capping positions. We also do not have to home the arm in TeleOp if it is run directly after an autonomous program. Using FTC dashboard, we are able to pass the heading at the end of auto into the TeleOp code, thus making the arm pre-homed in a sense.
- We also have manual driver controls for our **tape measure capping** mechanism.

CODE ORGANIZATION

MODULAR CLASSES

In the past, our code has been cluttered & difficult. We used a hardware map and a separate "autonomous methods" class that held every function we used. This year, we decided that we wanted our code to be cleaner & easier to make adjustments to. We decided to make a class for each robot component that contains its motors, sensors, servos, and methods; then instantiate each of those classes into a full robot class. This robot class then gets instantiated into the op modes. This modular code was very helpful in the addition of our new arm. This was because we simply took out the GrabberArm class and added in the BoxArm class.

Key Algorithms

ROADRUNNER

This season, we implemented acme robotics' roadrunner library. This path-planning and localization code allows us to use our motor encoders to turn the field into an x/y grid, with the origin as the center of the field. This allows for very quick autonomous paths and easy path translation between alliance sides. This code also allows us to move in very complex paths in order to avoid our partner, opponents, and other obstacles.

VISION CODE

We also wrote our own vision code. Using the camera on our robot in addition to vuforia, we take a picture of the barcode. We then divide this picture into three different pictures (one for each possible barcode position). Our code then counts the number of yellow pixels in each position, based on the RGB value for each pixel. The position with the most yellow pixels is then determined to be the one with the team element on it, and the robot drives to the shipping hub level that corresponds with it.

GOOSE (ARM)

Due to our use of a worm gear and motors, we had to figure out a way to get to the correct positions to deliver, collect, and cap. The magnetic sensors on the box and arm allow us to run each motor until those sensors engage, and reset the encoders there. This makes that engaged point consistently zero, and allows us to give the encoders exact numbers to run to. This makes our arm incredibly consistent. We use a finite state machine to switch between manual control, homing, and set positions.

DESIGN PROCESS

LIST REQUIREMENTS
In this step we list the measurable and testable requirements for our component/design. Each requirement is then placed into our decision matrix if there are multiple designs possibilities and the design fulfilling the most requirement stays with our robot

WEAKNESSES
In this step we break into groups to come up with sketches of different ideas for the component. Then we think of 2-3 designs.

RESEARCH
In this stage we research real world solutions to our problem as well as look to see what other teams have done in the past to solve a similar issue.

PROTOTYPE
In this stage we take some of the ideas we came up with in brainstorming and build them out of materials such as cardboard and duct tape.

DESIGN
The design stage includes physically building a model of the brainstormed idea. This typically consists of the aspect that will later be applied to the game.

REFINE
We make any improvements to our design we find necessary to meet the requirements/ better our design. This stage is tested 2-3 times for a design.

TEST
In this stage we test the prototypes against the requirements to determine which of our prototypes would be most worthwhile to fully design and produce.

PLEASE SEE EXAMPLES OF THIS PROCESS THROUGHOUT OUR NOTEBOOK!

Software

PROBLEM
This season consisted of implementing our localization method, RoadRunner. After Qualifier, we noticed many basic issues such as navigation accuracy.

ENDEAVOR
We took out all of the crazy turns that we had been doing, so that it wouldn't lose as much of its position. We also added range sensors to update the position after collecting a block in the warehouse.

IMPACT
After troubleshooting a couple of oversights we had regarding the range sensors, the position update works as we had intended and we get a consistent two additional blocks in auto.

outreach

PROBLEM
COVID shut down our community, limiting our access to engaging with other people. With the challenges that came with the virus, we were unable to meet in person at times.

ENDEAVOR
We reached out to many teams over social media and developed the 50 states plan. The idea behind the plan was that our team would meet with at least one team from each state to better both our knowledge and theirs.

IMPACT
We were able to reach over 50 teams! We helped teach team Kappa Xi team from Mexico how we fundraise and the Winter Soldiers from WI brainstormed capping solutions with us.
.

SOMETHING UNIQUE ABOUT US: WE USE OUR DESIGN PROCESS FOR *EVERYTHING*, INCLUDING OUTREACH, STRATEGY, AND AWARDS. WE'LL SHOW YOU AT OUR PIT!

Mechanical

PROBLEM
Our wheel assembly, while capable of going around and over the pipe, was not properly. This caused some parts to wiggle and fall out, leaving our robot malfunctioning and/or causing stress to other parts.

ENDEAVOR
Designing a new stack up that uses custom spacers could potentially prevent movement within the mechanism. The design would be compact and ensures that our wheels will always function.

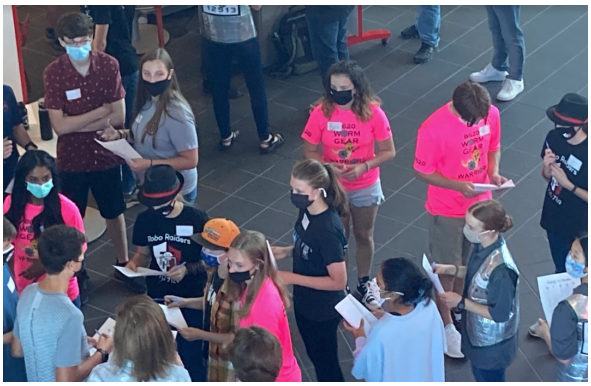
IMPACT
The mechanism has yet to break and has fulfilled the requirements listed for iteration two.

OUTREACH

KICKOFF/ MEET 1

SIUE

SEPT. & NOV.



We **ran** an FTC kickoff event. This kickoff was amidst the pandemic and the first in our region. We had just over 100 attendees, which was an amazing turnout. Our **connections** with SIUe were significant in making the event occur. The event was entirely student **led**. We also **ran** and hosted Meet 1, which was a notable success. We organized the event as a team and reached **150** people.

TOUR THE TOWN

Our team decided to "tour" our town in order to spread word of our team, and the ideas of FIRST throughout our community. This day we received around **1,000** dollars in donations through our GoFundMe. We also reached nearly **300** community members. The people we talked to ranged from business owners to pedestrians at stop lights or on the sidewalks. From this event we gained a few contacts for **mentors**, one of which has helped us with refinement of our designs.

OPEN HOUSE & CAMP

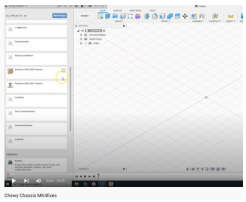
This summer our team organized and **hosted** an open house. This open house had nearly **30** attendees. At the open house we gave the attendees a dip into STEM and the FIRST program. Later in the summer we organized and hosted an FTC summer camp with over **15** attendees. The point of this camp was to teach the students (ranging from 3rd grade to 10th grade) skills they would utilize on an FTC team. From this camp we selected **4 members** to join our team. Having the students go through the camp process proved useful because they jumped right on board with our team since they had already received training in all areas of FTC.

The picture shown on the top left is students performing their judging presentation. On the bottom left, one of our members teaches another CAD.

PHANTOM HEART STANDS

SIUE

Our students had the privilege to meet two graduate students at SIUE, who are working for safe ways to keep phantom hearts in place while undergoing MRI and ultrasound scans. We were able to build a stand for them with the dimensions given and used **Fusion 360** to do so. We also taught each student how to use the application. They've invited us to sit-in on their lab experiments.



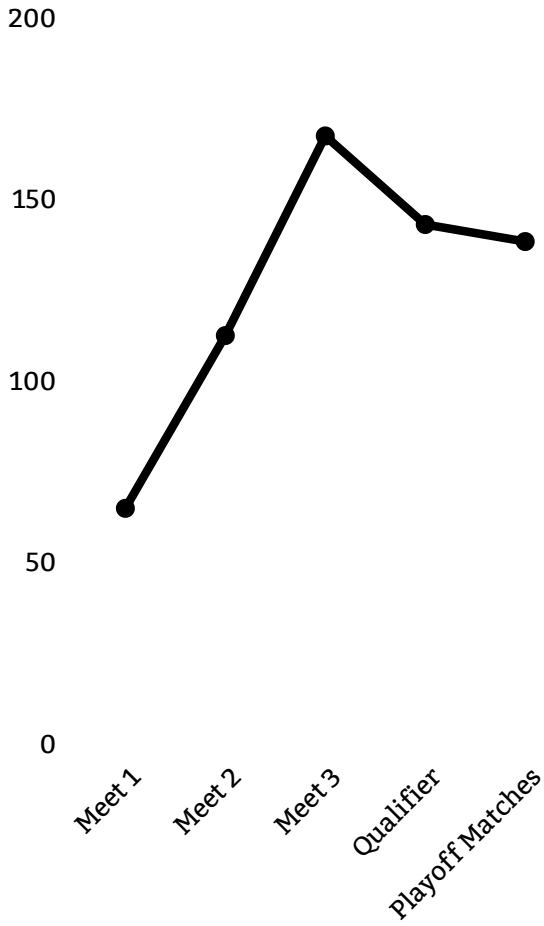
SOCIAL MEDIA UTILIZATION

Our team heavily utilized social media this season. With COVID, we turned to YouTube to publish **public resources,** such as our CAD tutorials. We have **reached 1,000+** people through our social media accounts. With Facebook, Twitter, Instagram, Tik Tok, and YouTube we launched our 50 states plan, allowing us to meet with teams from each state and beyond. As of Febrary, March 2022 we have **reached 900** FIRST members.

OTHER EVENTS

- Youtube- Our team used YouTube this season to post our robot matches.
- Intelligencer (Newspaper) publication- We were interviewed by an author of the Intelligencer and were published in the Intelligencer Edwardsville Newspaper..
- Volunteering at qualifier - We helped set up and tear down qualifier.
- Chicken Salad Chick Fundraiser- Our team raised $300 from selling Chicken Salad, and reached nearly 1,000 community members.
- SIUE newspaper publication- After hosting kickoff and meet 1 at SIUE their newspaper reached out to us for a publication.
- Northern/southern division advancing teams collaboration- Leading up to state we participated in a small scrimmage with the other teams in our area that advanced to state.
- Volunteering at meets- Our team has volunteered at meets where we set and tore down the meets.
- Hosting meets- We held meet 1 at SIUE, and were even planning to host meet 2, but it got rescheduled due to a tornado.
- Visiting the County Courthouse- One of our students was invited to the county courthouse over the summer, and while there our student was able to connect with 8-10 of our county judges.
- Iowa invitational- Over the summer our team competed in a remote competition where we placed well in robot and won the Connect award.
- Helping the Granite City Band- We helped two teams in Granite City design a robot for their marching band by providing knowledge on LED lighting and supplies.

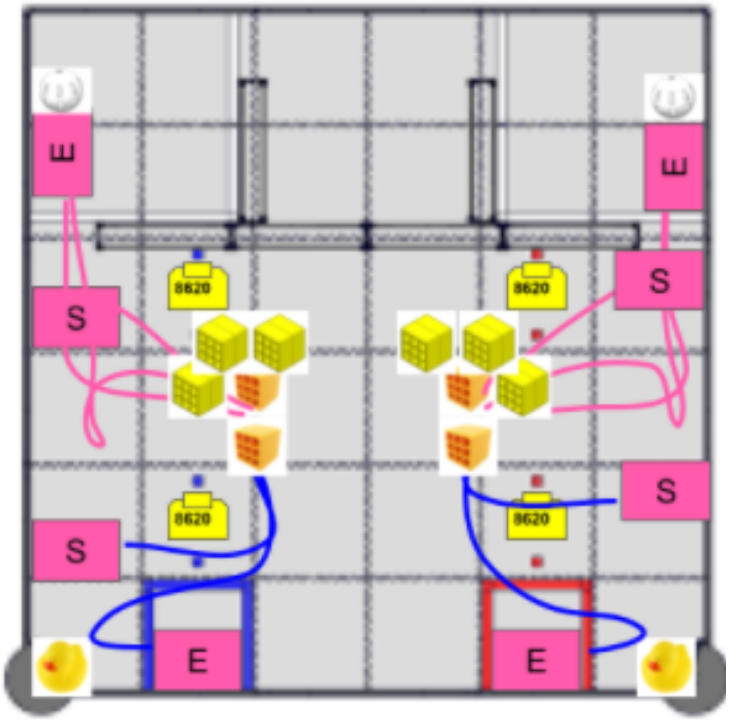
MATCH BREAKDOWN

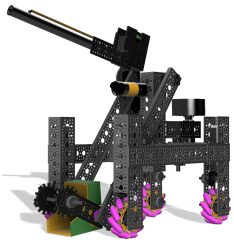


AUTONOMOUS

We are able to scan the barcode, deliver the preload, and depending on which auto we run: spin ducks and park in storage, or collect additional blocks and park in the warehouse. Each autonomous side (red and blue) has two different paths.

Roadrunner has allowed us to change our points in auto quickly and accurately. When we receive our alliance partner, we scout and discuss autonomous paths to make sure they do not conflict. And if they do, we are able to quickly change it. This process takes about 5 minutes.





Why WALL-E?
The robot initially began to be called WALL-E for the way it looked, but also ran into many *walls*.

CONNECTIONS

ENGINEERS

- Dr. Klingensmith - Dr. Klingensmith, an engineering professor at SIUE, has helped us with software on our team.
- Chris Zimmerman- Chris is a civil engineer currently in the workforce. He has taught us some of the knowledge to design parts of our robot such as our collection arm, and the base of our robot
- Zach Waters - Zach is a former software student, and a current engineer that we introduced to FIRST and learned more Java skills from.
- Drew Stover- Currently majoring in civil engineering, Drew has helped us begin to introduce FIRST in other areas.

BUSINESS/OUTREACH

Dave Garthe- Founder and CEO of his own company, Mr. Garthe visited our team to give input on our robot and share marketing skills throughout the community with fellow business owners.
Dave Kloostra-The Principal and Senior VP of Operations and Logistics of LowMuTEch has helped us learn about presentations, public speaking, and using the time we have in presentation wisely.
Senator Rachelle Crowe- Our 56th District Senator has helped us with learning how to fund Team Kappa Xi, in Chihuahua, Mexico.
Cara Lane- Mrs. Lane is a public speaking and english literature teacher at Edwardsville High school who has helped us to improve our public speaking skills and refine our presentation for this season.
Haritha Kommineni- helped us with touring small businesses and how to market ourselves.
Hannah Lukowski- Owner of multiple restraunts, Mrs. Lukowski helped us fundraise effectively.

MENTORS

Parents: as many teams alike, we utilize our parents as mentors. They make up 33% of our current connections.
SIUE Admin: With close relations to the SIUE School of Engineering, we're able to host activities there and meet with graduate students. This is where we acquire the Phantom Heart Stand project, see more above.
Business Professional Outreach Project: Through marketing in downtown, we were able to meet over 200 business professionals. This led to future connections within the STEM community. Many owners were able to give us presentation tips and even point us to STEM professionals,
Alumni students: Many of our team's founding members are currently in their last years of college or have graduated. We utilize these professionals because they are able to give good advice on FIRST issues from experience. These alumni also prove useful helping our team improve by bringing real world solutions they have learned.

ALUMNI

This season our alumni have played a major role in **mentoring** our team. Our we had a total of **5** alumni come help us with various things this season. From volunteering to helping us refine our designs, the connection we have have with our alumnis has helped greatly this season. Caleb Blair and Garret short have helped us to **refine our designs**, Dustin Franke has utilized his skills as a machinist to help us **streamline** our designs, Reece Watson has helped us to organize our code, and Mary Buchanan has given us help to **organize** our notebook.