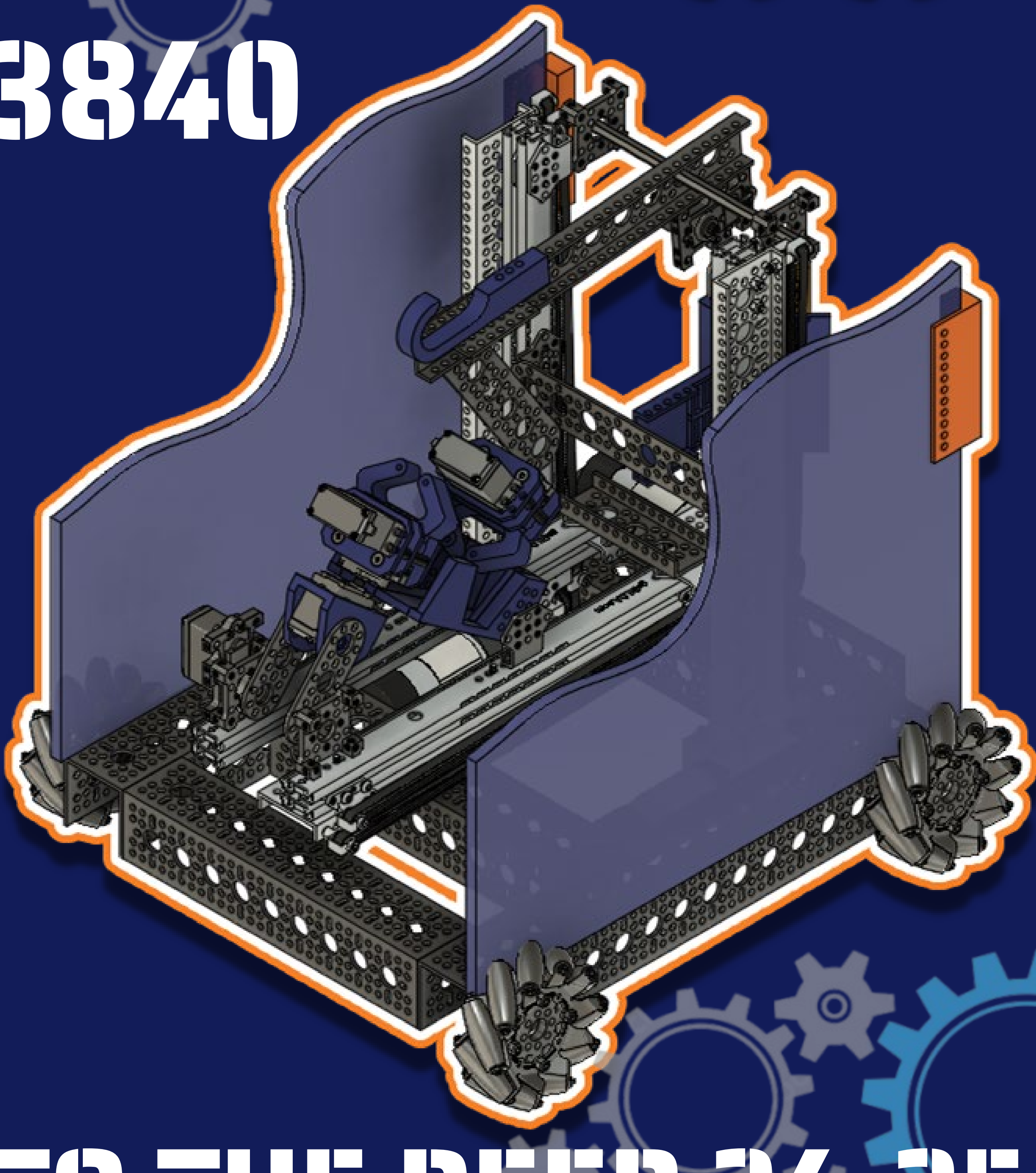
HOWARD DYNAMICS 23840



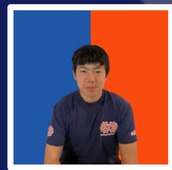
INTO THE DEEP 24-25

INTRODUCTION

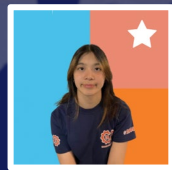
Howard Dynamics #23840 is an FTC team based in **Howard County, Maryland**. We are a team made up with **10 members** and **1 coach**. This is our 2nd year with more than **half** the team being **rookies**!

AARON ZHONG
Grade 11
3rd FTC Season

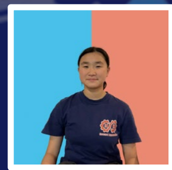
AARON ZHENG
Grade 10
3rd FTC Season



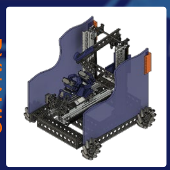
DAVID WU
Grade 10
Rookie Season



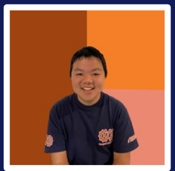
ZARA ZHAO
Grade 10
Rookie Season



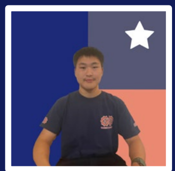
MEGAN WANG
Grade 10
Rookie Season



DYNAMIC MACHINE
2nd FTC Season

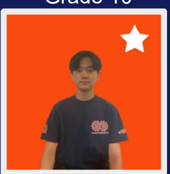


EVAN LUO
Grade 9
3rd FTC Season

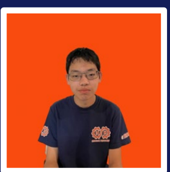


MING SUN
Grade 10
3rd FTC Season

RYAN SHI
Grade 11
Rookie Season



ANDREW HSIEH
Grade 10
Rookie Season



AARON CHENG
Grade 8
Rookie Season

COACHES & MENTORS

COACH: Shan Zhong

This year is Coach Zhong's **second year** of coaching both FTC and this team! While he does not do the work, he does help to keep us **focused** during meetings and throughout the season. He also provides us with **feedback and suggestions,** as well as a **place** to **hold meetings.**

MENTOR: Guihan Wu

Mr. Wu is a quality assurance manager at MacroGenics. He offered **suggestions** for outreach activities to help **mentor our rookie outreach unit**. He also takes what he has learned as a quality assurance manager and **applies it** to the robot itself.

MENTOR: Suzhen Duan

Dr. Duan is an assistant professor at Towson University. As an university level educator Dr. Duan excels in designing **engaging** presentations and **informational graphics**, skills that she taught us through **mentoring** sessions. These sessions have greatly helped with the development of our **portfolio**.

MENTOR: Roger Zhu

Roger is a computer science major at Carnegie Mellon University and has **experience** with various **programming languages**, including Java. He provides us with constant **insight** and **advice** regarding the **programming** of the robot. Roger also helps us to **debug** the program from time to time when we are struggling.

MENTOR: Jin Tang

Mrs. Tang is a controller at MFI Inc. She provides **insights** and helps us to **manage** our **finances.** She also helps greatly with the organization and the **skill development** of the outreach unit, suggesting ideas for outreach activities.

MENTOR: Dongliang Yang

Mr. Yang is a **mechanical specialist** at the USPS Headquarters Engineering System. He is also the **former coach** of **Worlds team** Advanced Robotics Team #56774, one of the FLL teams under the HCCS. He helped to **provide feedback** and **suggestions** on the **robot's design** and **functionality.**

MENTOR: Yun Teng

Mr. Teng **works in IT** at Leidos. He aided us with the **programming** for both the teleop and autonomous period. Mr. Teng also helped us to **strategize** methods and ways to speed up the autonomous and to make everything **more efficient during teleop**, and assisted in the overall **smoothing out** of the code.

= Programming = Outreach = Lead Member = Co-Captain = Robot Design
= CAD = Hardware = Drive Team = Portfolio

OUR ROBOT: THE DYNAMIC MACHINE

"Dynamic" refers to something that is characterized by constant change, activity, or progress. Thus, we chose the name Dynamic Machine to reflect the **flexibility and efficiency** of the robot. The name also stands as a testimony to the **constant progress** we've made this season so far as a team. This is similar to why we bear the name Howard Dynamics, which represents our origin as well as emphasizes **adaptability** of the team itself.

MISSION

Our mission is to spread **awareness** and encourage **interest** in FTC and robotics, as well as to **inspire young people** to take part in **STEM-related activities**. Through participation in such events, students are empowered to **think like engineers**, thus fostering positive characteristics such as **gracious professionalism**, **strong leadership** and **communication abilities**.

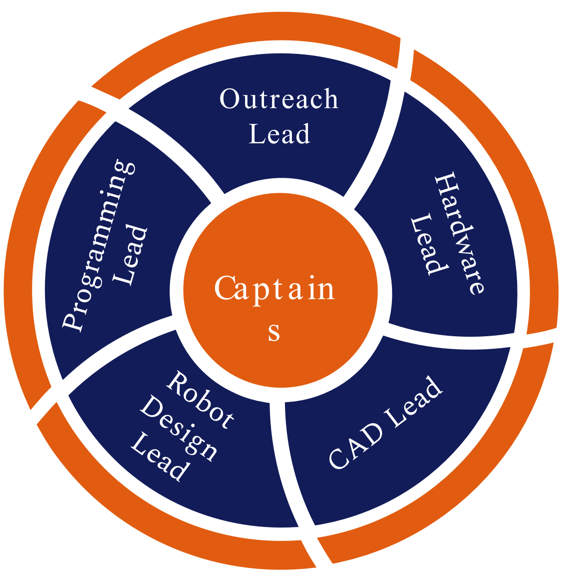
GOALS	HOW WE ACCOMPLISHED THEM
Advocate for STEM and FIRST Robotics	- Held **outreach seminars** at Coderpie and a robotics summer camp at Towson University to **inform** about **FIRST Robotics** and to **encourage interest in STEM** - Open to public seminar at **Clarksville Middle School** - Presented to **kids with special needs** at **CAPA Seeds** - **Co-hosted** and **helped organize** the **Maryland STEM Festival** - Attended **community events** such as the HCCS Hope with Feathers event and the River Hill 4th of July Parade in order to **spread information** about **robotics and STEM fields** - Presented to **PLTW engineering classes**
Establish connections within the FIRST community	- Gave **seminar** to FLL teams, **Buster Botz #61156** - **Mentored** FTC team **Ingenuity #24220** and **No Limits #65542** - **Met** and **interacted** with **4+ FLL teams, 4+ FTC teams,** and **2+ FRC teams** at the **Maryland STEM Festival** - **Workshop** given at the **Season Kickoff Festival**, engaging with **multiple FTC teams** - Constant communication and exchange of ideas with FTC team **Brainstormz #10289, 5th Dimension #23382** and **Robotanicals #23377** as well as FRC team **Squirrels #6863**
Reach out in the STEM community	- Met and interacted with many **STEM experts** at the **Maryland STEM Festival** - Obtained **mentorship** from a **computer science major** from **Carnegie Mellon University** and a **mechanical specialist** from the UPS - **Connected with** and **gained sponsorship** from **Coderpie**, a coding school

TEAM STRUCTURE

Our team structure was created with the goals of **efficiency, organization**, and **communication**.

We have two co-captains, who **run our meetings** and serve as a **point of contact**. Both of our captains have 2+ years of experience in FTC and are always open to **answering questions** and **assisting other members** when help is needed. Additionally, our captains also aid with **delegation of tasks** and **communication** when needed.

Our team has **5 subunits**: hardware, robot design, CAD modeling, programming, and outreach. Each subunit has a **leader**, who manage the group and assigns tasks to others. Leaders are in charge of **updating** the rest of the team **during weekly meeting**s about what each group has **accomplished** throughout the week. Furthermore, whenever one subunit has **questions or concerns** regarding another, the leaders will contact one another, ensuring **smooth communication.**



RISK MANAGEMENT

Our team is willing to **take risks**, but before taking these risks we will also be **prepared for failure.** For example, we suffered a **great loss** soon after kickoff. Our **CAD lead left** for a more experienced, veteran FTC team. A few other members had experience in CAD, but it would be **difficult** for them to take on multiple roles at once. We began to **search** for a new addition to the team. After a while, our outreach lead encountered a classmate who expressed interest in joining the team. Although we **didn't know much** about his **abilities or level** as a CAD modeler, we decided to **give him a chance**, knowing that we still had a **solid backup plan** in case he was not experienced enough. However, he has proven himself to be quite **sufficient** at his job and has even been promoted to our CAD lead.

SUSTAINABILITY

Our team currently has members ranging from **8th grade to 11th grade**, meaning that every member has at least **one more season** before they graduate, with many members having **multiple seasons** left before graduation. Moreover, most of our members have **experience recruiting** others. **7** of our team members this year were **recruited** by preexisting and even new members.

Additionally, being one of the Howard County Chinese School's FTC teams provides us with a **large network** for future recruitment purposes. Furthermore, we have a **significant presence** on Instagram, and **many individuals** have already **expressed interest** in joining our team.

TIMELINE

June-Aug

PRESEASON
- First Meeting
- Assigned roles
- Brainstormed and hosted outreach activities
- Social media accounts

Sept

SEASON REVEAL
- Attended kickoff
- Began to brainstorm robot design ideas and started CAD designing

OUTREACH
- Fundraiser at food fair
- Kickoff workshop

Oct

OUTREACH
- Began to mentor Ingenuity

BUILD + CAD
- Figured out design
- Began to build
- Finished up the CAD model of robot

Nov

PROGRAM/DRIVE
- Finished build
- Began to program
- Practiced driving
- 10-12 samples in the high basket during teleop
- 1 sample autonomous + parking
- 1 specimen autonomous + parking

Dec

COMPETITION
- Final touch ups to robot
- Created portfolio
- Rehearse presentation
- 1st, 2nd, and 3rd Qualifier
- Chesapeake Championships

Jan-Feb

REVISIONS
- Improved specimen delivery
- Removed corner protection
- 4 samples/spec. auto

OUTREACH
- CAPA Seeds outreach
- CMS outreach
- 2 new mentors

FUTURE PLANS AND OBJECTIVES

OBJECTIVE	HOW WE PLAN TO ACHIEVE
Sustain Our Team	- After the season ends, contact **individuals from outreach** events as well as **hold events** to spread recruitment information - Grow our **online presence** in order to **reach more individuals** and **garner more interest** in the team
Grow and Expand Our Outreach Network	- Continue **outreach** and **connection** with our **mentors and sponsors** - Continue to do **presentations** at local **STEM camps** or **classes** - **Start** and **mentor** at least one **FLL team** - Reach **outside** of **Howard County** and **Maryland** to other **STEM camps** and **classes outside** of the **county/state** - Start a **collaboration** with an **institution** such as the Anne Arundel Library System

STEM FESTIVALS

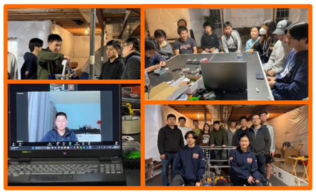
- We attended both the Maryland STEM Festival and the HiTech STEAM Carnival, where we met and talked to **various experts in STEM fields**.
- We were one of the **host teams** of the **Maryland STEM Festival**, and helped to **co-organize the entire event**.
- We even had the opportunity to talk with **real life NASA astronaut Donald A. Thomas.**

FIRST CONNECTIONS

- Communicate with and trade ideas consistently with FTC teams **Brainstormz #10289, Robotanicals #23377,** and **5th Dimension #23382**
- Virtual meeting with **5th Dimension #23382** to discuss and exchange ideas
- Communication and idea exchange with FRC team **Squirrels #6863**
- Scrimmage with **Gear Rotation #18442**, **Alphabots #26115** and **S.T.A.T.I.C. #18996**
- Held **CAD workshop** at Johns Hopkins APL for season kickoff
- **Interacted** with **4+ FTC teams,** and **2+ FRC teams** at the **Maryland STEM Festival**
- Interaction with **FIRST community** on **Reddit & Discord**
- Host a Discord server with **over 11 teams**

STEM MENTORS

- **Virtual and in -person sessions** with mentors Roger Zhu, Yun Teng and Dongliang Yang
- Roger and Mr. Teng helped with the **debugging and smoothing** out of the code
- **Speed up** autonomous and **efficiency** of teleop
- In-person sessions with Mr. Yang, gave us feedback on the **claw design** and to **change the gear ratio** on arm
- Change **macros for efficiency**



	CAD	HARDWARE	DESIGN	PROGRAM	OUTREACH
GOAL	All of our CAD members are **rookies**; thus, they must be trained to **adequately model** parts of the robot and 3D **print** them	One of our team members was a **total rookie**; we needed to train him to be able to **build** and **maintain** the robot for competitions	Train rookie member to be able to use the engineering design process, **evaluate trade offs** and **scoring routes**.	Gain a deeper understanding on how to use **roadrunner** in addition to **PID tuning.**	Outreach unit completely new; train rookie members on the **basics** and what **tasks are included** to get them started.
PLAN	Veteran **Fusion certified** members will **train** the rest; members will also all get 3D **printers** to work with.	Experienced hardware lead will train rookie on **installation** of parts and **maintenance** of the robot	Experienced design lead will **guide** member through **design process** and **route drawing**	Find a **mentor** to **teach** us on how to do PID tuning for better motor control.	Find a mentor to teach the **basics of outreach** so that members can **learn to do it** on their **own.**
STEPS TAKEN	Veteran members walked others through the **steps necessary**, all 3 CAD members bought a 3D printer to **practice** with and **use**	Hardware lead **delegated** and **walked through** tasks; also provided rookie with a **checklist for maintenance** for competitions	Robot design lead has **guided new member** through **creating scoring routes**, how to perform **trade off analysis** and use the EDP.	Obtained mentos **Roger Zhu, a CS Major at Carnegie Mellon University**, and **Yun Teng**, who is in **IT at Leidos** to assist and give feedback	Obtained **mentor Jin Tang**, who helped outreach subunit to get **started** on the **completion of tasks**

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Website: howarddynamics23840.weebly.com
Instagram: @howard.dynamics
YouTube: @HowardDynamics

STEM CLASSES OUTREACH

- Held **free presentations** and **demonstrations** for students at **Towson University** and **Coderpie**
- Encouraged students to participate in **FIRST robotics** and take **interest in STEM**



FIRST CONNECTIONS

- Seminars to FLL team **Buster Botz #61156**, educating them about FTC
- **Mentored** FTC team **Ingenuity #24220** with in-person **CAD workshops**
- **Mentored** FLL team **No Limits #65542**, helping them with their **presentation and innovation project**

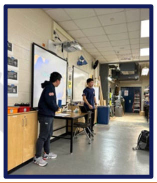
CAPA SEEDS

- Outreach seminar to **kids with special needs**
- **Presentation** and videos of the **season theme** and our **matches**
- **Live** robot demonstration


PLTW ENGINEERING CLASSES

- Presented to **PLTW classes** at Marriotts Ridge High School, Centennial High School, and River Hill High School
- Gave an **overview of FTC** and **encouraged them to join in coming seasons.**





COMMUNITY OUTREACH

- Attended **community events** such as River Hill 4th of July Parade, HCCS Hope with Feathers festival, HCCS Lunar New Year Festival
- Spread **information** and **encourage participation** in FIRST robotics and STEM activities

CLARKSVILLE MIDDLE SCHOOL

- **Open to public** robotics **demonstration** and **presentation** to students
- Students expressed **interest in joining** FTC in coming seasons
- Gave out **contact info**

1700 PEOPLE IMPACTED | **400** MILES TRAVELED | **430** HOURS VOLUNTEERED | **510** FOLLOWERS

FINANCES

Fundraising - HCCS Grant	$2800
Fundraising - Sponsoring Companies	
8/28/24 DMV United Realty	$200
8/28/24 OSP	$200
10/23/24 ThorLabs	$500
10/23/24 Raytum Photonics	$100
10/23/24 Coderpie	$150
Fundraising - Food Fair	
9/28/24 HCCS Hope with Feathers Festival	$461
1/26/25 HCCS Spring Festival Event	$1200
Team Contributions + Student Awards	$1,100
Total Revenue	$6,660

We plan on applying for the HCCS grant and at least **2 new grants** every year. We also are building **long term partnerships** with the companies such as DMV United Realty, ThorLabs, etc. We will continue to host and attend **events to fundraise** for the team. We also **track expenses** for both parts and food (meeting snacks and competition food). In terms of next year, we are setting aside **10%** of our funds this year to start us off for next year. Additionally, we **reuse as many components** of the robot when possible, as well as **3D print** as many parts as we can, which helps to save money. At the end of the season, we plan to hold a review to **evaluate fundraising success** and **identify areas for improvement**.

LESSONS LEARNED

- With younger children, their **attention span** is **shorter**. Thus, we created **two versions** of the slideshow presentation: one for **older kids** and one for **younger kids**. The one for older kids contained more **in depth explanations** while the one for younger kids was briefer and included **more videos**.
- After our first outreach event, we learned that some of our members' **presentation skills** could **use improvement**. Therefore, our outreach lead hosted a **presentation workshop**, teaching us how to **create slideshows** to keep the audience **focused** and **tips and tricks** on public speaking.

CREATIVE MARKETING

At the beginning of the season, we wanted to create something for others to remember us by **after our outreach sessions**. We decided to combine two of the things that we are **most known for**: our orange logo and our love for 3D printing. Thus, our **fidget spinners** were born. **100% 3D printed**, engraved with our **team number**, and bearing our **signature orange**, these spinners are a **creative way** to help others **remember us**.

THINK

ENGINEERING DESIGN PROCESS

● = Before 1st qualifier ● = After 1st qualifier ● = After 2nd & 3rd qualifier

IDENTIFY THE PROBLEM

- Attended kickoff event where the new season was revealed in a livestream
- Scoring: hooking specimens onto bars and/or placing samples in baskets
- Set goals to design something that not only meets **objectives** in mind but also was **unique and efficient**
- After on our first qualifier, we identified problems with our claw, specimen scoring system, and various other parts of the robot.
- We further modified different components of our robot to optimize scoring and robot route

BRAINSTORM, DIAGRAM, OR PROTOTYPING SOLUTIONS

- Kickoff hosted breakout rooms to **discuss ideas and problem solve** solutions for this season, including ways to reach the high basket and the higher specimen bar
- Came up with **two intake ideas** : passive grabbing and rolling intake
- Design group developed strategies for **efficient scoring** during both autonomous and teleop
- We went through this step again specifically for the claw shape and came up with 3 other models.
- Further changes to claw model were made so that samples couldn’t be grabbed the wrong way, as this was a problem we encountered during competition.

SELECT BEST SOLUTION AND PLAN

- Held meetings to **compromise and finalize** designs, analyzing plausible solutions
- Weighed the **pros and cons** of each intake and outtake design
- After discussion, we eventually settled on the **roller design** paired with a bucket for our intake
- Using testing data from the testing stage to support our deliberations, we settled on our current designs.
- The roller design continued to perform efficiently on the field and was modified as needed.

BUILDING AND TESTING SOLUTION

- After printing designed parts, motors and programming used for testing **revealed flaw**s in the bucket and roller design
- Thus, through reevaluation and discussion, we tested using the **same process**and settled on a **claw and tray intake** as our final design
- We extensively tested the different claw shapes and various specimen scoring system variations in test runs.
- We also implemented a sample shield to “shield” off samples from getting stuck into the robot, as this sometimes happened during runs where the sample dropped into the robot instead of the high basket.

PRESENT SOLUTION

- Our team attended **outreach and community events** to receive **feedback** from **teams and STEM professionals** , driving our redesigns.
- We are **presenting our solution** again here at the competition.

REPEAT DESIGN PROCESS

- As mentioned above, **repeated design, testing, and prototyping** refined our **final** scoring system.
- We will repeat this process as we gain more experience from observing designs from other teams.
- We did end up repeating the process, see above.
- Further iterations of the scoring system were synthesized to ensure specimens could be ushered in smoothly and efficiently

THINK

LESSONS LEARNED

INTAKE

For our first iteration of the intake, we chose to use a rotor basket. While this design is effective in taking samples in, it suffers severely on the method of propulsion. In order to drive the wheel to put the samples in, a belt was needed to connect the servo with the drive shaft. A basket intake also require excessive space, which could be used for electric and protective components. Therefore, as stated before, we changed to a claw design operated by only two servos that is capable of rotation along the x and z-axis.

PROTECTION

We initially used a slide-on corner protection. However, we soon realized that it would exceed the size for a robot, so we scrapped that in favor of a corner protection that slides into the motor housing to truly minimize space.

SCORING CHART

	TASK	POINTS	EARLY SEASON PLAN	MID-SEASON PLAN
AUTO	samples in net	2	NO	NO
	samples in low basket	4	NO	NO
	samples in high basket	8	yes (Auto V1 - 1 samp.)	yes (Auto V2 - 4 samp.)
	specimen on low chamber	6	NO	NO
	specimen on high chamber	10	yes (Auto V1 - 1 spec.)	yes (Auto V2 - 3 spec.)
	Observation Zone Park	3	yes (Auto V1)	NO
	Ascent (Level 1)	3	NO	NO
	No Park	0	yes (Auto V1)	yes (Auto V2)
TELEOP	Samples in net	2	NO	NO
	Samples in low basket	4	NO	NO
	Samples in high basket	8	yes	yes (10-12 samp.)
	Specimen on low chamber	6	NO	NO
	Specimen on high chamber	10	NO	yes (6-8 spec.)
ENDGAME	Level 3 Ascent	30	NO	NO
	Level 2 Ascent	15	NO	Maybe
	Level 1 Ascent	3	NO	NO
	Observation Zone Park	3	Maybe	NO
	None	0	yes	yes

THINK

TRADE OFF ANALYSIS

Pros v. Cons → Robot Protection → 2 Stage Slide v. 4 Stage Slide → Claw v. Basket Dilemma

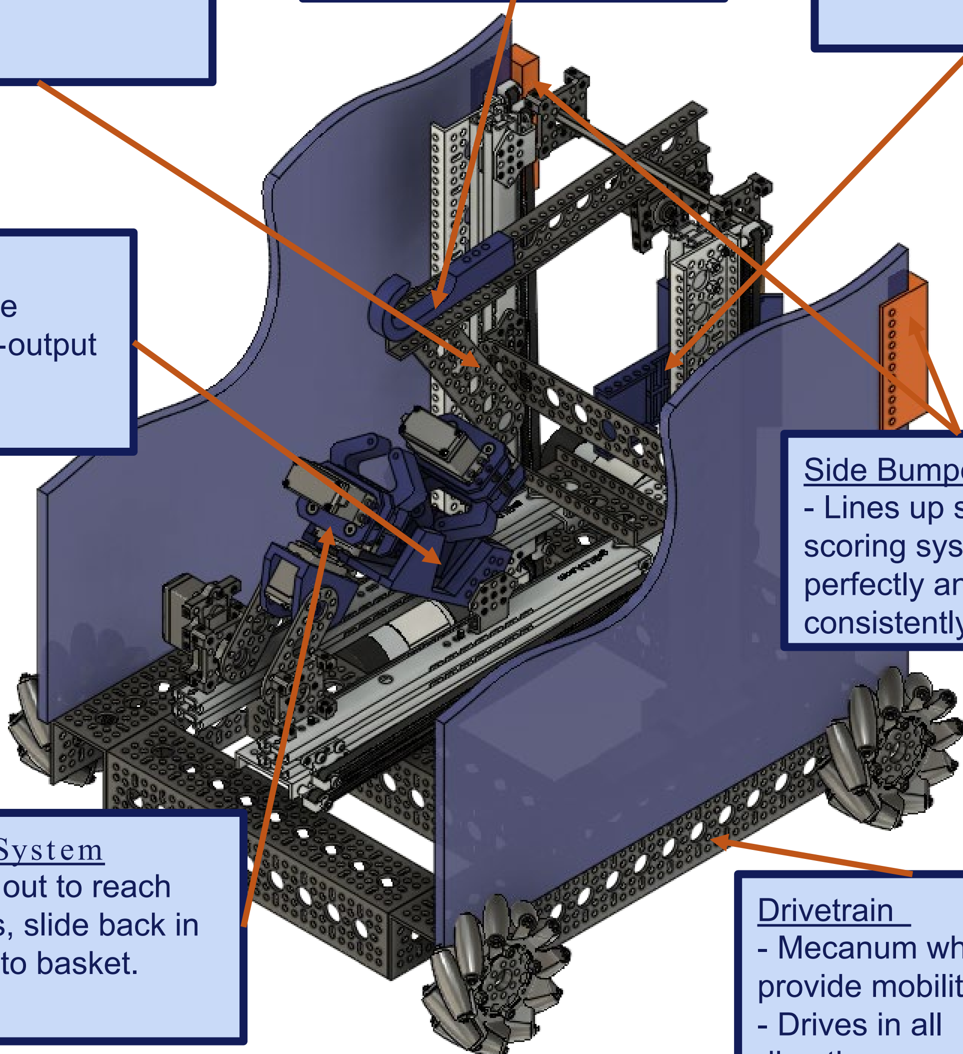
	3D PRINTED	CNC METAL	2 STAGE SLIDE + 2 STAGE ARM	4 STAGE SLIDE + 1 STAGE ARM	CLAW	BASKET + ROLLER
PROS	- **Faster** to produce. - Cheap. - Easy to **iterate** and **adapt** to design.	- **Stronger** and able to be made **thinner** . - More **aesthetically pleasing**.	- **Cheaper.** - **Faster** to extend. - **Lighter** overall.	- Reaches **higher** . - **Simpler** design.	- More **precision** and **accuracy.** - More **compact**. - **Aesthetically** pleasing.	- **Less** complex. - **Faster** intake and scoring. - No **specific** parts required.
CONS	- **Weaker** and **easier to wear** out. - Have to be made **thicker** and **bulkier.**	- Harder to **update**. - More **expensive.** - **Little tolerance** to design changes.	- More **Complex**. - **Harder** to control and code.	- More **Expensive**. - **Slower** to extend. - More **complex** initial assembly.	- More **complex**. - Require **specific** parts. - **Harder** to control.	- Less **precise**. - **Takes up** way too much **space**. - Too much material **costs**.
FINAL CHOICE	3D Printed	-	2 Stage	-	Claw + Claw	-

MATHEMATICAL ANALYSIS

We have used math to measure specific lengths for the parts of our robot. For example, we have measured the specific length for the wheel protection so our robot can fit in the **18x18 inch limit** . We have also measured the length of our arm to lift samples into the high basket. We have also used **trigonometry** to measure optimal length of a unit hexagon for a part of our robot. Since the external angle of a unit hexagon is **60 degrees**, **sin(3)/60=sin(B)/90** and B is **~3.46 inches**, which is the length of one side of the hexagon. For our specimen autonomous, we incorporated a **diagonal drive** using the **pythagorean theorem** to find the **hypotenuse,** the distance to drive **diagonally** . We had to strafe for ~12 inches and drive forward for ~24 inches, so to get the hypotenuse, we did **12^2+24^2=c^2** to get **~26.83 inches** to set as our encoders ticks.

DESIGN

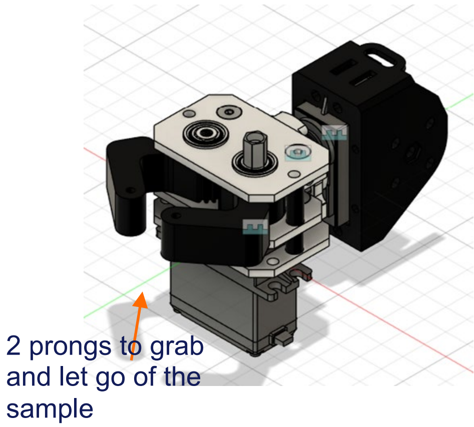
INTRODUCING:
THE DYNAMIC MACHINE

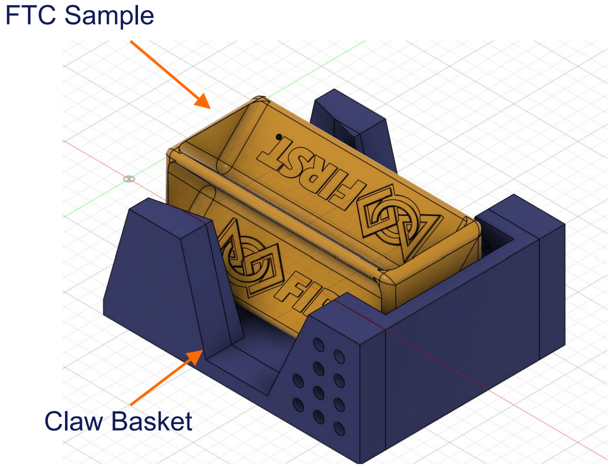


DESIGN

CLAW

- The claw is our **intake** and **output**.
- Primarily powered by a single **torque servo**
- Design's derived from the intake by **10298 (Brainstormz)**
- It's purpose is to **grab samples** and **transport them to another claw**, which we would then use to **deposit the sample in the baskets**
- The claw has **multiple degrees of movement freedom**
- The claw is our **third version** of the intake!



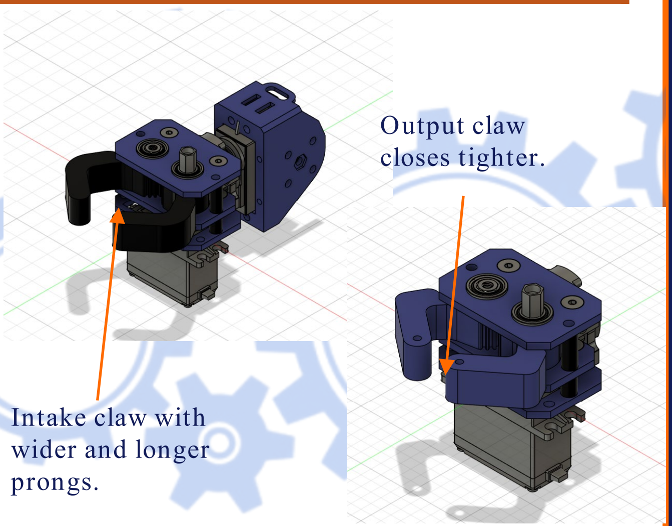


CLAW BASKET

- The claw basket is used as an **intermediate between our intake and output**
- During one of our testing sessions, we discovered that the **transition of the sample between two claws** left a **significant gap in between**, which inhibits its function to grab effectively
- To combat said issue, we made a **basket** in order to **stabilize** the sample for transportation into the second claw
- It **utilizes gravity** to ensure that the block is **always vertical** when facing the second claw

INTAKE VS OUTPUT CLAW

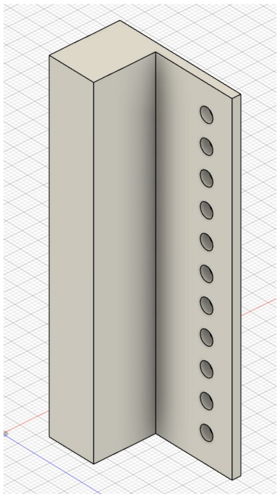
- The claw prongs are **slightly longer** on the intake claw compared to the output claw.
- The intake claw needs to be **able to reach down** to the ground and pick up samples, so the claw **opens wider**.
- The output claw needs to be able to **hold the sample tight** as it scores, so its prongs **closes tighter**.

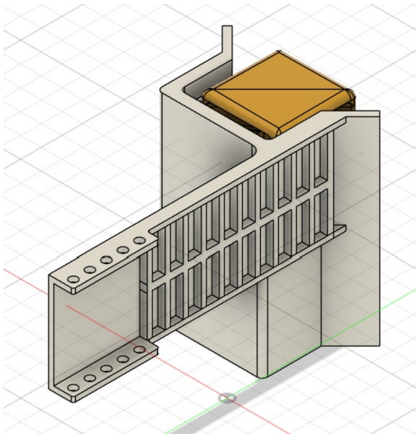


DESIGN

SIDE BUMPER

- The side bumper is used as a **boundary** for the **sides** of the robot
- The bumper serves a function similar to the corner protection; it prevents **walls and other surfaces** from **damaging** the panels of the robot.
- **Holes** are also implemented on the bumper so that it can be **fastened** onto the panels on the **sides** of the robot.



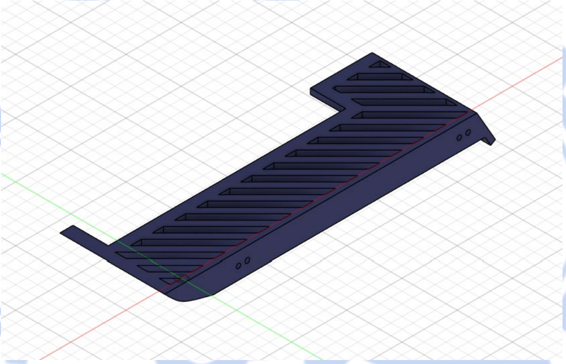


SPECIMEN SCORING SYSTEM

- This system enables the robot to **score specimens**
- A little **bump** inside the holder combined with the **flexible plastic material** allows the system to **firmly hold the specimen** while allowing for easy scoring.
- The system is **fully passive** without the aid of any motor or servos
- The side flaps turns **precision** from a **necessity to a marginal factor**
- The specimen can **slide easily onto the lower bar** even when the robot misses as the **flaps guide the robot onto the bar**

SAMPLE SHIELD

- This part **prevents sample from getting stuck** in our robot.
- If a sample get stuck, **we can't pick up another sample** per game rule.
- This part allows the missed samples to **slide off instead of getting stuck** , mitigating an **important risk.**
- The part is also two-piece for **ease of manufacturing.**



INNOVATE

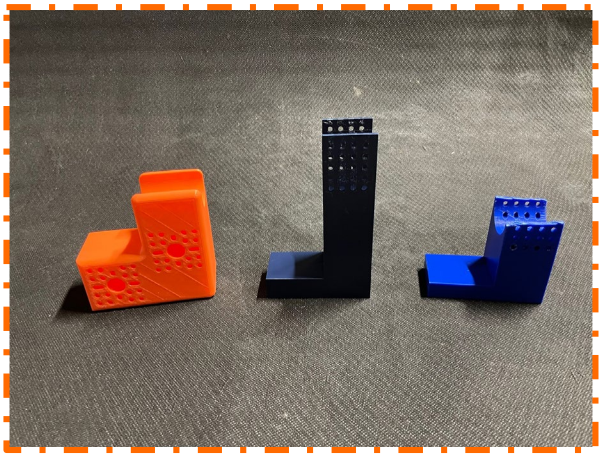
DESIGN RISK MITIGATION

- We chose a **two staged folding arm** over a single stage arm as a single stage arm could swing with too much momentum, **potentially destabilizing and tipping** the robot over.
- We added bumpers to **prevent damage** to the panels of the robot.
- To prevent our specimen scoring system from overshooting, we **extended the holder piece** so that it would be perfectly lined up when it is bumped against the bar.
- We added a 3D printed shield to **stop samples from falling inside** the robot and **disabling** our scoring.
- We made a checklist of **all maintenance items** for in between matches to keep our robot at **top efficiency**.

OUR ITERATIONS

INTAKE DESIGN

- First Three Iterations: Size of the bucket **increased** to **fit the size** of the sample. **Holes** were added on the third iteration to help with the **attachment** to the robot.
- Fourth Iteration (and later): We realized the **downfalls** of the bucket system, so we **chose a claw** instead, later iterations have different claw shapes for better functionality.

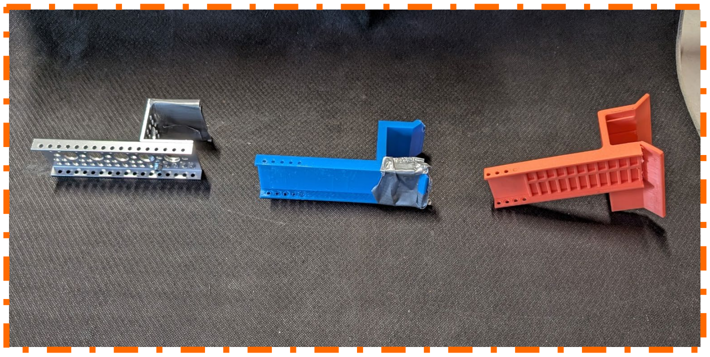


CORNER PROTECTION

- First Iteration: **Too heavy** and **too wide**. Dimensions and hole placements were **inaccurate**, **Impossible** to attach.
- Second Iteration: **Thinner and narrower**, but the design became **too narrow** and was **too long** for the robot. The **hole placement was fixed**, although there were unnecessary hole.
- Third Iteration: **Shorter and wider, more stable** while **offering more protection**.
- Final Decision: Due to spacing issues, the corner protection is no longer part of the robot.

SPECIMEN SCORING SYSTEM

- First Iteration: made up of gobilda parts, **functional** but **not reliable**.
- Second Iteration: same dimensions and functionally as first iteration, but 3d printed to **reduce weight**.
- Third Iteration (and on): added ribings and higher infil for better **durability** and ridges for better **grip strength**, minute size changes to **improve functionality**.

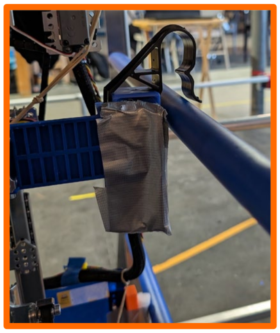


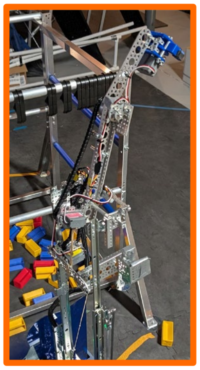
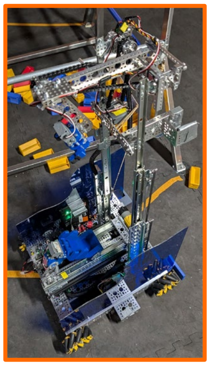
INNOVATE

WHY IS OUR DESIGN UNIQUE?

SPECIMEN SCORING SYSTEM

- It is **fully passive**, with no motor needed to operate it.
- This makes the process extremely **simple and reliable** due to the lack of electronic parts.
- This reliability and simplicity gives us **an edge over other teams**.



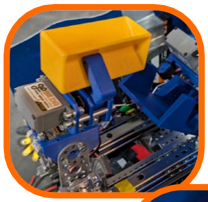




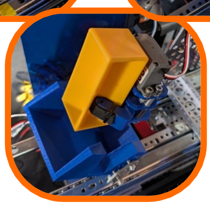
2 STAGE ARM + 2 STAGE SLIDE

- We chose this over a simple 4 stage slide plus 1 arm combination.
- The two stage arm **does not pose risk** of tipping the robot over.
- **Very fas**t whilst still allowing us to **reach high places.**

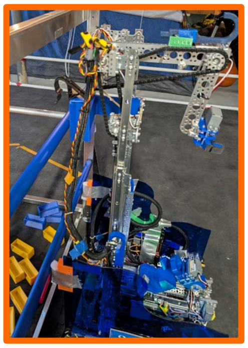
CLAW TRANSFER BASKET

- Holds the block in place while the sample **transfers** between intake and output.
- Makes the transferring of samples between the intake and output much more **seamless and efficient** .
- Makes the transfer process extremely **reliable** and **consistent**.









FLEXIBILITY

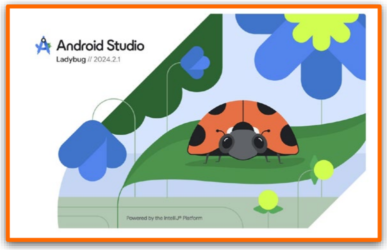
- Our robot has the capability to score **both samples and specimens.**
- Both systems are **reliable and efficient** , capable of scoring a lot of points.
- This gives us **flexibilities** in strategizing with alliance partners during autonomous and teleop.

CONTROL

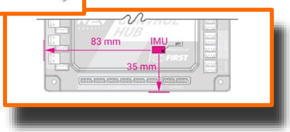
DEVELOPMENT TOOL

For programming our robot…

- We program using **Java** as opposed to blocks
  - More **Flexibility**
  - **Faster** Programming
- We use **Android Studio** instead of OnBotJava
  - More **Advanced**
  - Better **Debugging** Capabilities
  - Integrates with **GitHub**



SENSORS



On our robot, we use **two different types of sensors** .

- **IMU Sensor**
  - Built into the control hub
  - Helps with **turning accurately** to angles
- **Encoders**
  - Built into motors
  - Helps with **tracking distance traveled and slides location**

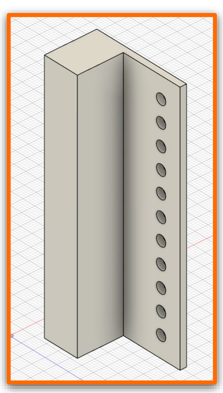
DRIVER CONTROL ENHANCEMENTS

To assist our drivers with driver control, we made the following enhancements:

- **Macros**
  - **Top slide macros**
    - Sets the position of the top slide to the position of either the top basket or lower basket
    - Utilizes **encoders** to accurately set position
  - **Bottom slide macros**
    - Sets the position of the bottom slide to the position of fully extended or retracted position
    - Utilizes **encoders** to accurately set position
- **Use of two controllers**
  - Controls are evenly **split between two gamepads**
  - **Gamepad 1** is able to **drive**, while **gamepad 2** is able to control **servos** and **slides**
  - Allows **easier coordination** and **reduces workload**

HARDWARE/MECHANICAL CONTROL

- Wheels are **attached directly** onto the motors to **avoid precision issues** potentially caused by a gear, belt, or chain connection.
- A **one to one gear ratio** is used on all arm rotation joints for more **precise control**
- At the rear end of the robot we **installed bumpers** that creates the **right amount of space** for the **specimen scoring system** so **control is simplified**
- The specimen scoring system is **fully passive** and **reduced** the **amount of code** to be written and **simplifies control**



KEY ALGORITHMS

gyroTurn(speed,angle);
- Turns to a given angle at the given speed
- Utilizes **IMU Sensor**

strafe(power, count);
- Robot strafes for a certain encoder count at the given power
- Utilizes **encoders**

testClaw(position);
- Robot opens and closes front claw for a certain encoder at the given power
- Utilizes **encoders**

autoRotate(power, time);
- Robot rotates front claw up and down to pick up samples
- Utilizes **internal timers**

autoGreen(position);
- Robot opens and closes inner claw for a certain encoder at the given power
- Utilizes **encoders**

autoYellow(power, time);
- Robot lifts up or down arm one at a given power for a certain time
- Utilizes **internal timer**

autoPink(power, time);
- Robot lifts up or down arm two at a given power for a certain time
- Utilizes **internal timer**

bottomSlideTest(power, pos);
- Robot extends and retracts horizontal slide for a given power
- Utilizes **encoders**

topSlideTest(power, pos);
- Robot extends and retracts vertical slide for a given power
- Utilizes **encoders**

drive(power,count);
- Robot drives for a certain encoder count at the given power
- Utilizes **encoders**

Internal Timing
- A timer to allow continuous rotation servos to only rotate for a certain time period

Threading
- Allows **parallel processes** to run
- More efficient and saves times

CONTROL

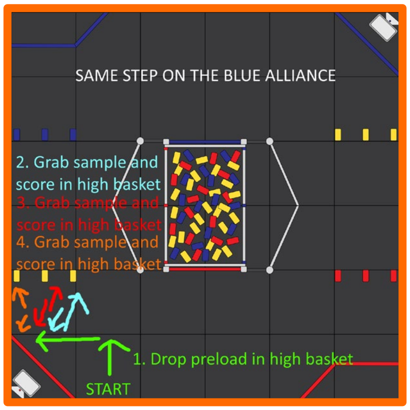
AUTONOMOUS OBJECTIVE

Our objective for the autonomous period is to **score as many points** as possible while being **consistent** in the allotted time frame **in conjunction** with our partner and **without disrupting** both of our autonomous runs by colliding paths.

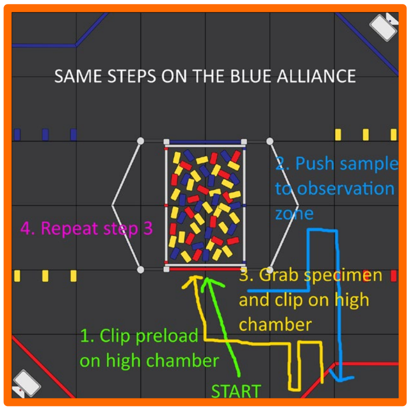
AUTONOMOUS STRATEGY

Our strategy was to create **two different paths** for the **two starting positions** with a thought in mind of what our partner might do. For the side close to the baskets, the robot moves to drop a preloaded sample and 3 other samples **into the high basket**. For the side away from the basket, the robot moves to **clip a pre-loaded specimen onto the high bar** and then moves to push one **team-colored samples** on the ground to the **parking zone,** then clips 2 more specimens on the top bar.

SAMPLES AUTO



SPECIMEN AUTO



PROCESS & LESSONS LEARNED

We used the **engineering design process** in order to develop our autonomous. First, we **identified** our **autonomous objective** and **purpose**. To the left, you can see our autonomous objective. After we got our objective, we **brainstormed** and **diagramed potential strategies** to achieve our objective. We decided to use **two different strategies** for two **different start locations** and began planning how we would program these autonomous programs. We came up with a **meeting timeline** and became to **program** and **test** our solution. After **rigorous testing**, we **presented** our solution at our **first competition** during our matches. From our first competition, we **learned a lot of things** that we will **keep in mind** for our **second iteration**, our current iteration of our autonomous programs. From our testing and first competition, we learned that:

- **Object detection** is really important
- **Speed** and **precision** are important
- **Parking is not worth doing** for 3 points
- **Parallel processes** can optimize our code

For our second iteration of our autonomous, we worked on making our code more **consistent**. We used our second and third qualifier to improve our autonomous and test for consistency. We **removed parking** from both our strategies to score **3 samples** and **3 specimens** respectively. We were able to add **threading/parallel processes** to fit **one additional sample** in our sample auto, scoring **4 samples**.

TESTING & RELIABILITY

In order to test for consistency and reliability, we did **many test trials** of our autonomous programs. Our samples autonomous has a **53% full success rate, 40% partial success rate**, and 7% complete fail rate. Our specimen autonomous has a **73% full success rate, 20% partial success rate**, and 7% complete fail rate. Although a **complete fail is rare** and our autonomous will **produce points most of the time**, we will work to make our programs **more consistent** through the use of **additional sensors** in the future, such as a **camera** and **distance sensors** for **object detection**. Object detection is really important to **locate samples** in our samples auto and to **align with the baskets**.

SAMPLES AUTO

TRIAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SAMPLES SCORED	4	4	4	3	2	0	1	3	2	4	4	4	4	3	4
POINTS	32	32	32	24	16	0	8	24	16	32	32	32	32	24	32

SPECIMEN AUTO

TRIAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SAMPLES PUSHED	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
SPECIMENS SCORED	3	3	3	2	3	3	3	1	3	3	0	3	3	3	2
POINTS	30	30	30	20	30	30	30	10	30	30	0	30	30	30	20