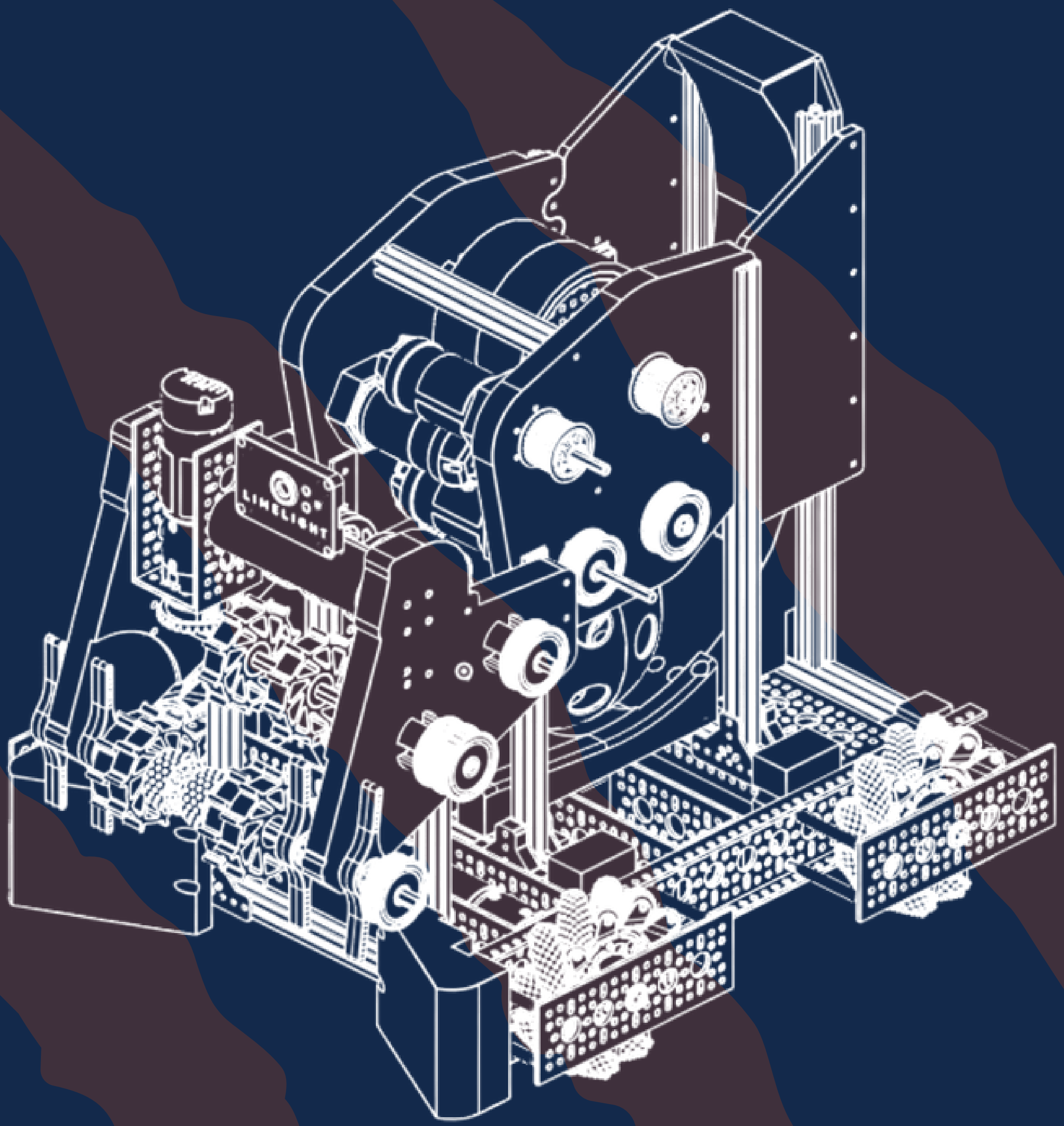
WOLVERINE

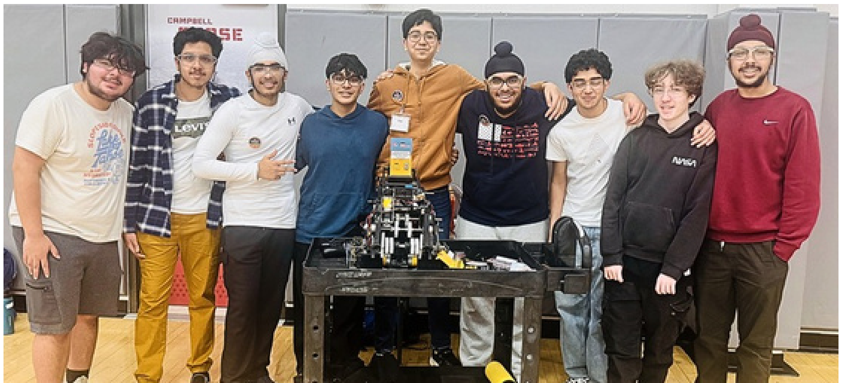


ROBOTICS

TEAM #33791

ENGINEERING PORTFOLIO 2026

TEAM OVERVIEW



We are team 33791, founded **88 days** ago in Frisco, TX!

Our robot, **Matchstick**

Judge Highlights

- **Design**
  - Our robot design is driven by **rapid iteration** and learning from failures throughout the season. Match data, subsystem testing, and continuous refinement allowed us to improve **reliability, performance**, and ease of maintenance under competition conditions.
- **Control**
  - Our autonomous and TeleOp scoring are powered by **multiple sensors** integrated through **custom formulas** and iterative control functions. These systems enable consistent scoring while **reducing driver workload** and increasing overall match efficiency.
- **Innovate**
  - By continuously experimenting and adapting our approach, we transformed initial **challenges** into **breakthroughs**. This relentless refinement resulted in faster cycle times, more advanced shooting accuracy, and **improved** movement, boosting our overall performance.

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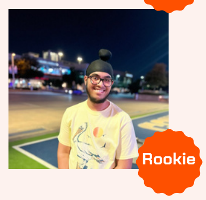
MEET THE TEAM

Hardware Team

Dev Gavande
Captain, Co-Founder, Build Lead, Driver

Sahejdeep Singh
Drive Coach, Software and Build Team

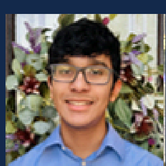
Sripaadh J Kuppusammy
Human Player and Build Team



Manveer Singh Tib
Human Player and Build Team

Piousvir Singh
Build Team and Outreach

Software Team



Abdullah Khaled
Co-Founder, Software Lead

Jacob Esparza
Software

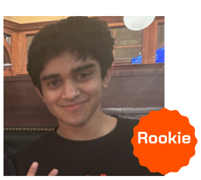
Alexander Fiderfish
Software

Jivansh Pandya
Software

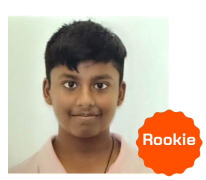
Outreach Team

Abhi Ravulaparthy
Outreach

Kaiden Lee
Outreach



Pratham Erramilli
Outreach



Kavin Murugan
Outreach

TEAM GOALS

Season Goals

- **Continue** implementation of **iterative building process** to continuously improve robot
- Retain **all** team members for next season
- Rapidly **increase outreach radius** to bring STEM to more communities by showcasing **Matchstick** at **at least three events** every two months

Learning From Mentors

Our team learned a lot from working closely with mentors who shared their experience and technical knowledge. During meetings, mentors gave **feedback**, **explained concepts**, and helped guide **software and build decisions**, which improved our problem-solving skills and understanding of the engineering process.

Recruitment Methods

Our team recruited new members primarily through participation in the **Wakeland Club Fair**, where we showcased a competition robot to attract interest and spark engagement. We also recruited through **regular robotics club meetings**, in-school **flyers**, and outreach on **social media** platforms to reach students who were interested but unable to attend the fair or learn about the team in person.

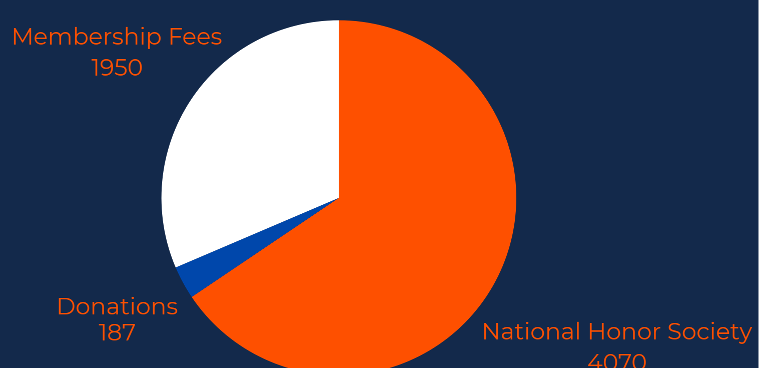
SUSTAINABILITY

AS A SCHOOL-BASED TEAM, OUR TEAM WAS GENEROUSLY FUNDED BY WAKELAND HIGH SCHOOL AND OUR NHS CHAPTER

An 11-Day Start

Originally, our goal was to get our team started for our rookie year in **August 2025**. However, due to logistical roadblocks and administrational challenges, our kick-off was pushed until November 11th—**eleven days before Meet 1**. Therefore, we had limited time to focus on aspects such as sponsorship before our robot was built. However, during this 11-day period, our team was hard at work to finish the code for both phases of the game, as well as finalizing the robot CAD and a functional physical build. Through this short initial ramp-up, our team was able to naturally form roles in addition to learning adaptability in time-sensitive situations.

Rookie Season Fundraising



We are extremely grateful to our school's **NHS** Chapter for providing us over $4000 to get our team started. We plan to expand our **Fundraising ventures** in future seasons and apply for more grants. We have just applied for the **FIT Grant in January**.

Team Sustainability Goals

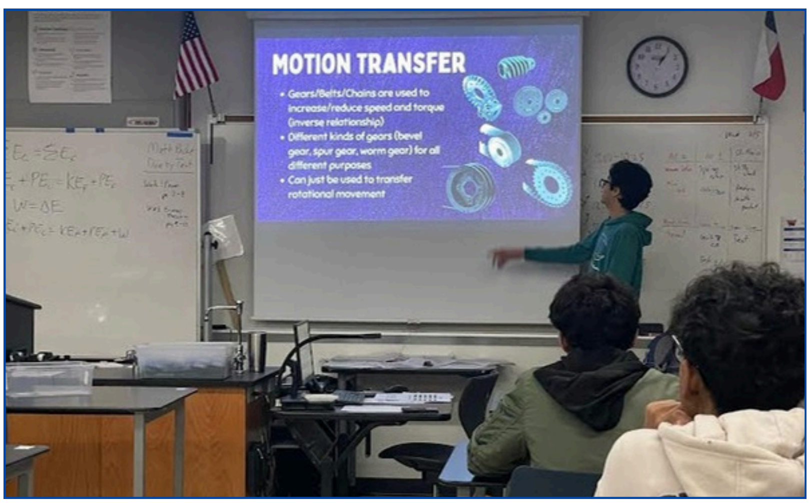
- **Retain** the team members that we gathered this year, and help develop skills for longer-term performance
- Participate in outreach activities with **middle and elementary school** students
- Potentially help establish **FLL** (elementary level) and/or a **sister FTC** (middle level) team
- Propagate **FIRST and its core values** through **robotics workshops** at the Wakeland High School campus or through **showcasing our robot** at local **public events**.
- Reach out to local businesses, as well as larger corporations, to acquire larger sponsorships to **consistently improve** our robot design.

STUDENT DEVELOPMENT

TO GAIN POPULARITY FOR THE ROBOTICS TEAM, WE CREATED THE ROBOTICS CLUB, PARTICIAPTED IN CLUB FAIRS, AND EVENTUALLY TRANSITIONED INTO A TEAM.

Club Fairs

In Fall of 2025, our robotics team was able to gain members through our **participation in the club** showcase for our school. In this event, we showcased a robot from a **different event** to draw members.

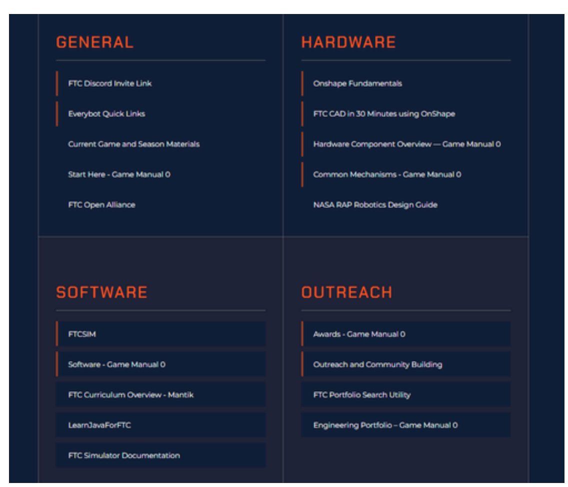


Team Meetings

Once a committed team was established, we conducted **regular meetings**, where we provided an overview of robotics **sub-systems**, hardware basics, explanation of the Decode game, and league meet reviews.

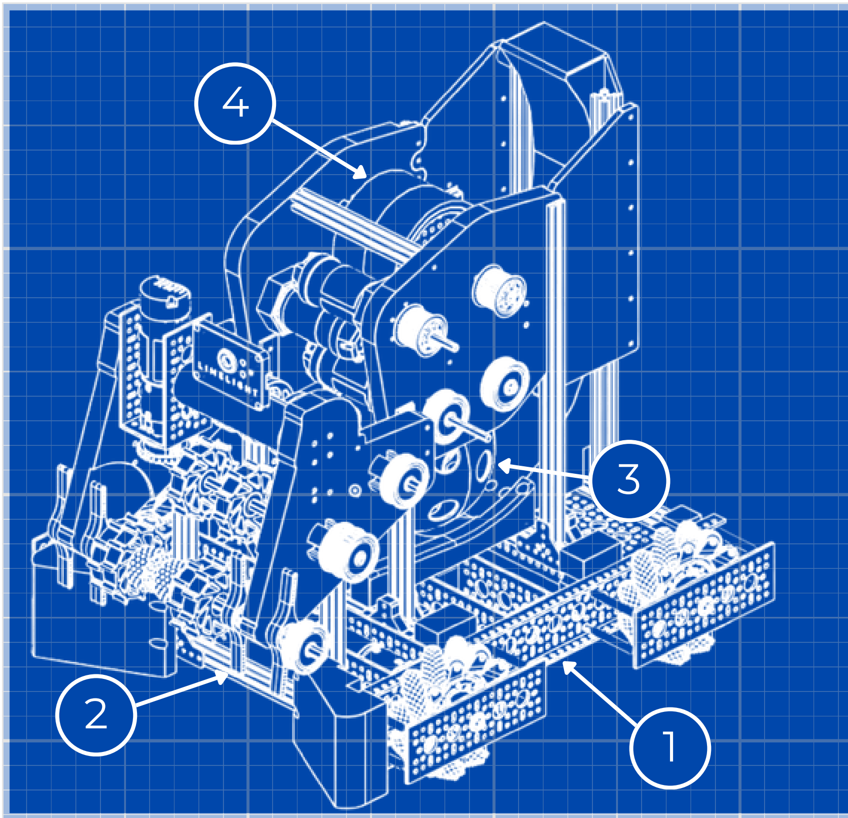
Online Resources

To help our new members into being able to contribute to the team, we provided resources to learn how to **CAD on OnShape**, which is a cloud-based platform that facilitates collaborative design. Additionally, we directed them to look at **engineering drawings** for different parts such as extrusions and screws to familiarize themselves with not only the parts but also to read an integral part of **engineering illustration**. These steps were necessary to help our members become active members and leaders of the **Wolverine Robotics** team.



MATCHSTICK

DESIGN OVERVIEW



KEY ROBOT FEATURES

1. ALL-METAL OFFENSIVE DRIVEBASE
2. MULTI-ROLLER, FUNNELING INTAKE
3. DUAL-MODE, HIGH COMPRESSION INDEXER
4. DUAL-MOTOR, TRIPLE-FLYWHEEL SHOOTER

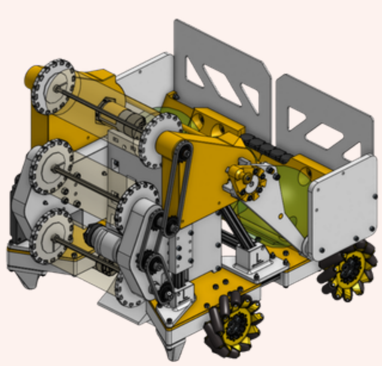
WOLVERINE ROBOTICS

FTC 33791: MATCHSTICK

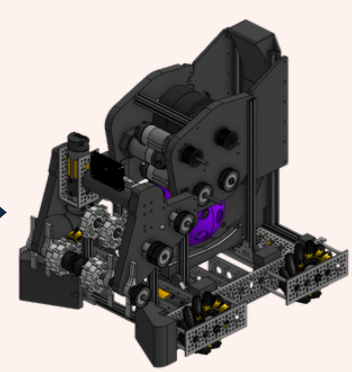
PREPARED WITH THE HANDS OF MANY BUILDERS	A3	33791MKII	V2	1
SECOND VERSION	V2		33791-0-2	SHEET

Iterative Design

Matchstick synthesizes our **past experiences** from League Meets 1 & 2 with **new, innovative solutions** to create a robot that balances **simplicity** with **robustness**.



League Meet 1 & 2



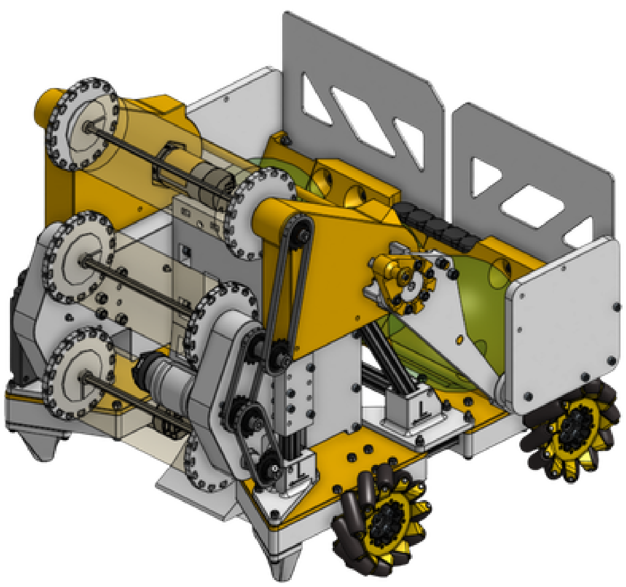
League Meet 3 and Beyond

ITERATIONS: EVERYBOT

Why We Started With The EveryBot

- Simple design
- Easy to modify
- Fast to produce in a short time-frame.

Though not the **best** robot, the **EveryBot** was crucial to the team's performance in the first two league meets due to it being simple and fast to build and iterate on within a short time-frame.



Key Features v1

The key feature for our version one robot was its **shooting**. Specifically, the robot was able to shoot a minimum of one artifact and a maximum of **two** artifacts **quite consistently**. However, there was not enough **torque** to shoot **three** artifacts, which was the maximum amount of artifacts this robot could hold. Additionally, the use mecanum wheels allowed for **smooth maneuvering**, which proved to be extremely important for defense. The chassis was also mainly **3D-printed**, making it light.

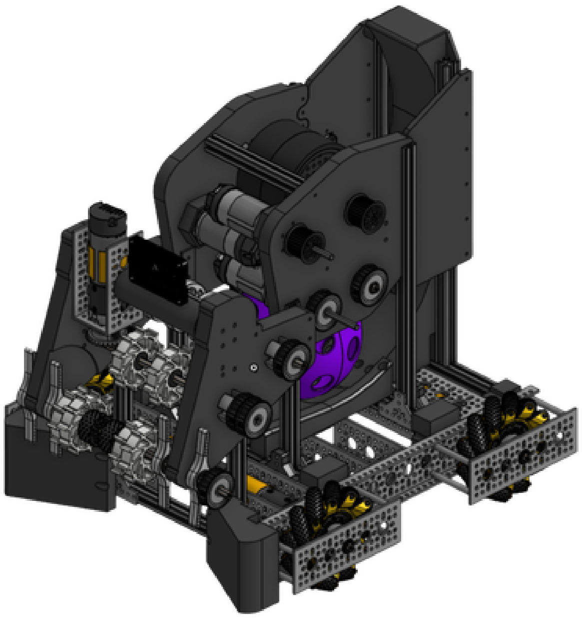
Everybot v2 Updates

The **initial** gap in our robot for meet one was that we did **not** have an **intake system**. Therefore, in the interim period between meet one and meet two, our team was hard at work to get resources and start building the intake system. Unfortunately, the intake system **failed** on the day of the meet, which was a large factor which pushed us to design a new robot for meet three: **Matchstick**.

Meet 1 Meet 2

Build V1 Everybot Build V2 Everybot Build Matchstick

ITERATIONS: MATCHSTICK



Meet Matchstick: Our Improved Robot!

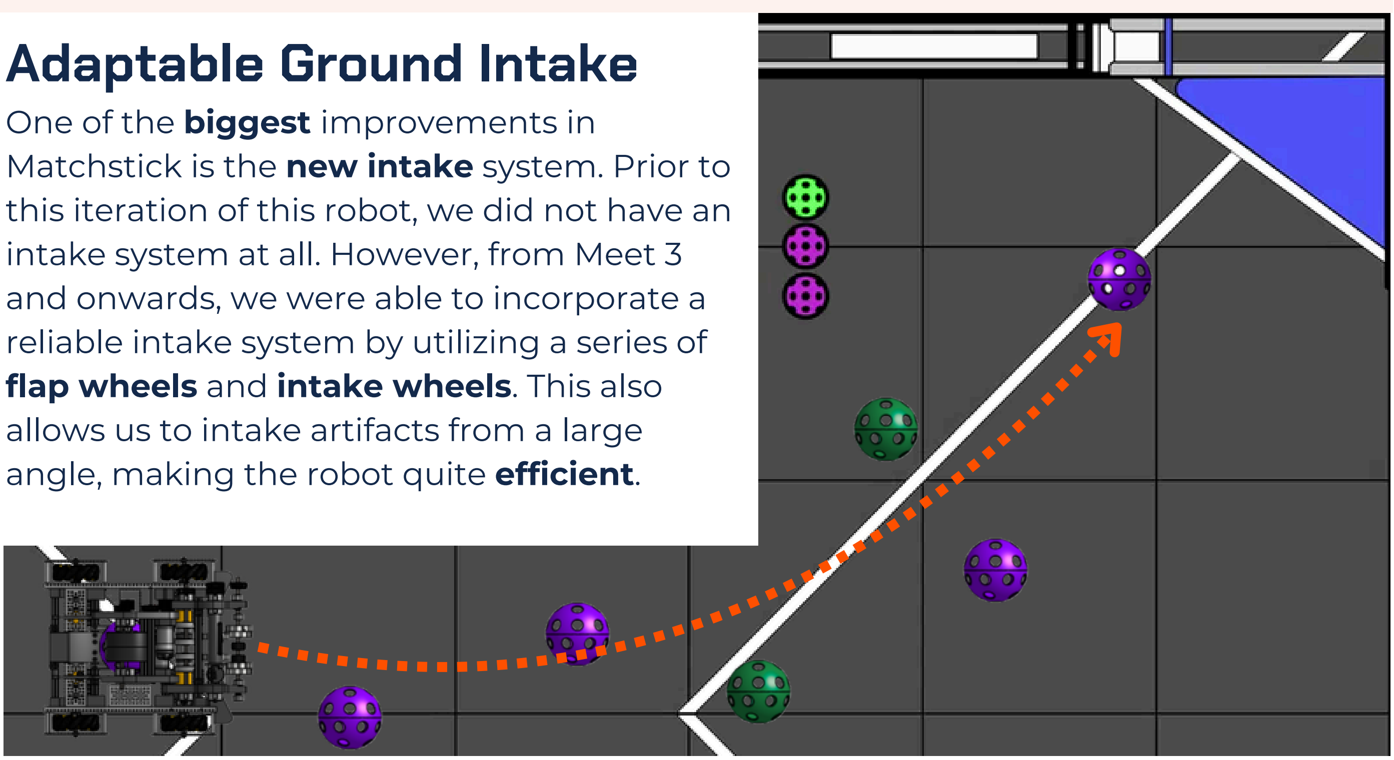
After our Meet 2 performance, it became clear that we needed a **more reliable** robot design. As a result, we developed Matchstick, incorporating new features in both the chassis and the tele-op and autonomous modes.

Key Features

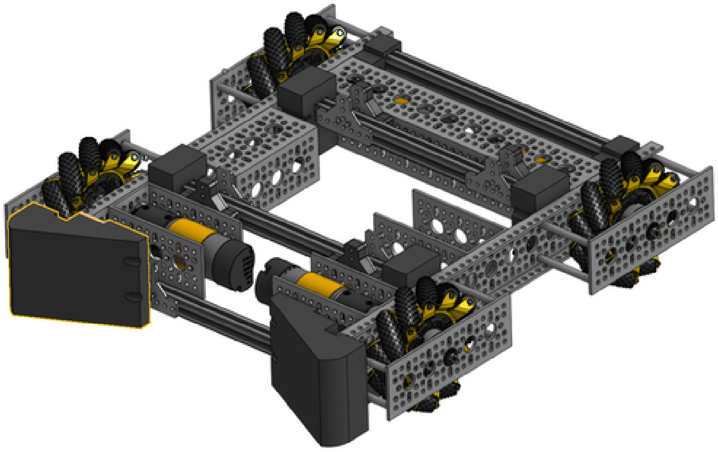
The key feature for our version one robot was its **reliable shooting**. Specifically, the robot is able to shoot **three artifacts** into the goal **consistently**. Furthermore, this iteration of the robot has a **high throughput**, which increases the amount of tasks that the robot can complete given a time-frame. We also made changes to the chassis, as we migrated away from 3D printed parts to a **metal chassis**, which provides more **structural integrity** and opportunity for **defense**.

Adaptable Ground Intake

One of the **biggest** improvements in Matchstick is the **new intake** system. Prior to this iteration of this robot, we did not have an intake system at all. However, from Meet 3 and onwards, we were able to incorporate a reliable intake system by utilizing a series of **flap wheels** and **intake wheels**. This also allows us to intake artifacts from a large angle, making the robot quite **efficient**.



CHASSIS



Direct Drive

A key feature of this chassis is that it has a direct drive functionality. This development is significant, as this **eliminates the use of gears or belts**, which increases efficiency and precision. Furthermore, by connecting the motor directly to the mecanum wheels, we are able to achieve **higher torque efficiency**.

Full Metal Chassis

As mentioned previously, one of the biggest improvements that was implemented in Matchstick was the transition from a 3D-Printed Clamshell chassis to a **metal chassis**. Though this meant that the robot would be heavier, a metal chassis also provides better **structural integrity**. Furthermore, this also meant that we could add more parts to the chassis, without worrying about the robot's ability **bear the load**.

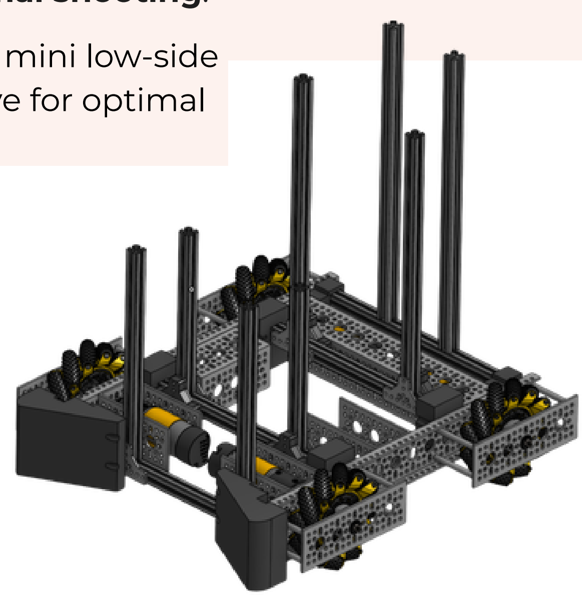
Seamless Integration with Subsystems

The chassis **integrates** 4 horizontal extrusions with **attached T brackets** to make sure we can attach subsystems easily and **modularly** with just a few screws. It is made fully of COTS parts besides some brackets holding extrusion. There is also space allocated for **2 swingarm goBilda odometry pods** to integrate with the pinpoint odometry computer. Additionally, the shooter is able to be situated efficiently in the middle of the apparatus for **optimal shooting**.

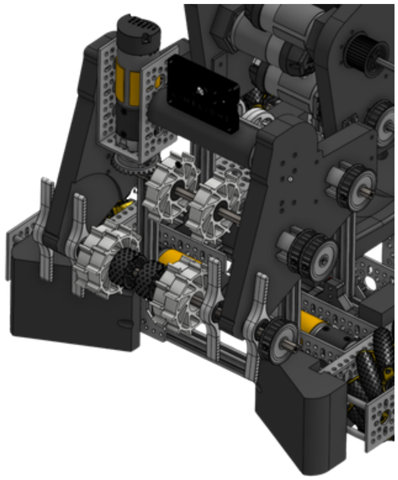
Further, we were able to attach a **Limelight** to the mini low-side C-channel on the intake side, which was imperative for optimal placement and tracking.

Intake Wedges

This design incorporates **custom deflection wedges** to direct artifacts towards the **center** of the robot's intake. The placement of our wedges along with flap wheels **diminishes lateral scatter**, which increases probability of successful capture.



INTAKE



Key Design Features

A key feature of our intake was the **tapering** of the compliant wheels and flaps. This was important because it allowed for **morphing** to the shape of the artifact and efficient pick up. Additionally, this mechanism allowed for continued contact with the artifact. The transfer to the indexer is done with a **312 RPM motor** with a **1:2 gear ratio**.

Limelight

Our design also incorporates the **Limelight**, which is a pivotal component for shooting. However, we mounted it near the intake, in a mini **low side C-channel**, rather than near the shooter to **reduce vibration**. Reducing vibration is important because it increases its accuracy in tracking the April tags.

Centering Mechanism

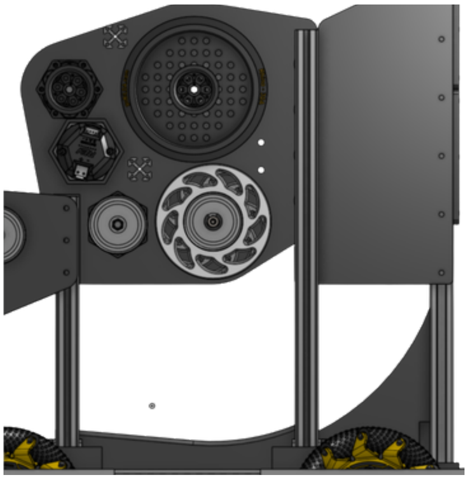
In order to make sure that the artifact that we pick is correctly sent into the indexer, we used a **tapered design** for compliant wheels and flap wheels. Additionally, the intake wedges are set at a **30 degree angle** in combination with tapering rollers to get the artifacts centered every time.

Infill Plates

Traditionally, the standard 20% infill plates would have been used. However, we decided to use **30% infill plates**, as they provide **protection** against harder impacts. The higher infill density allows for the impacts from **collisions** to be **absorbed and distributed** better. This **reduces** the likelihood of **cracking** or **failure** due to repeated impacts while still keeping the robot at an acceptable weight. Importantly, this decision also balances durability with weight constraints, ensuring the robot remains robust without exceeding mass limits or compromising maneuverability.

Pros of Higher Infill Percent	Cons of Higher Infill Percent
• Structural Integrity • Withstands Collisions • Resists Cracking	• Heavier • More Expensive

INDEXER



- **Independent control** using separate indexer motor.
- Compliant large-diameter wheels provide a **consistent** method of moving artifacts.
- The **high compression** geometry used in the indexing system **stabilizes artifacts** prior to the shooting.

Separate Motor

The indexer has its **own motor**, which can run **independently** from the intake and shooter. The separation provides an opportunity to precisely time when artifacts are moved. It also provides **less chance** that the artifacts will jam. If the indexer is reversed or stopped, this operation **does not affect other systems**.

Dual Compliant Wheels

3 inch diameter compliant wheels are used on the indexer to provide greater area for the artifact to be in contact with, which results in better **grip, consistent feed rates, and eliminates slippage** during high speed indexing, particularly when indexing multiple artifacts quickly.

High Compression

The indexer applies **controlled pressure** to each artifact that travels through the system and this forces the artifacts into a **centered position** which is stable for when it enters the shooter; this results in **less "bouncing" or misalignment** of the artifact within the shooter and therefore better accuracy and consistency with each shot.

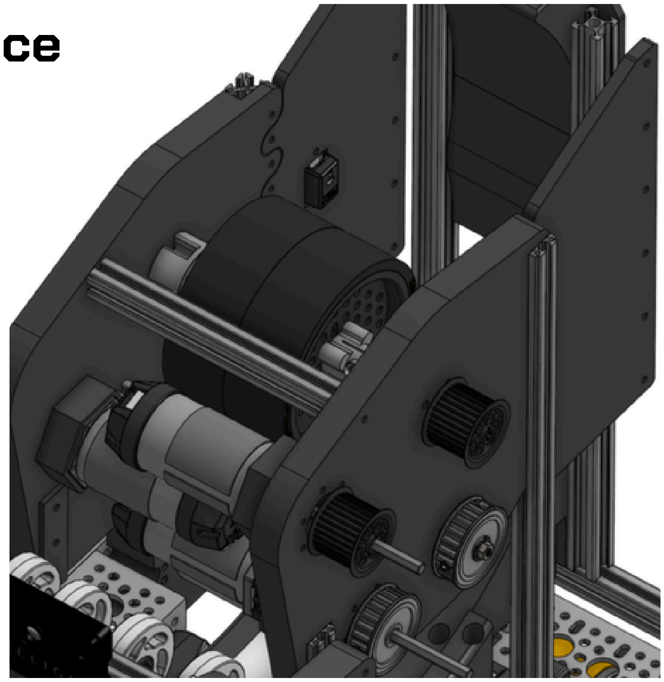
Design Impact

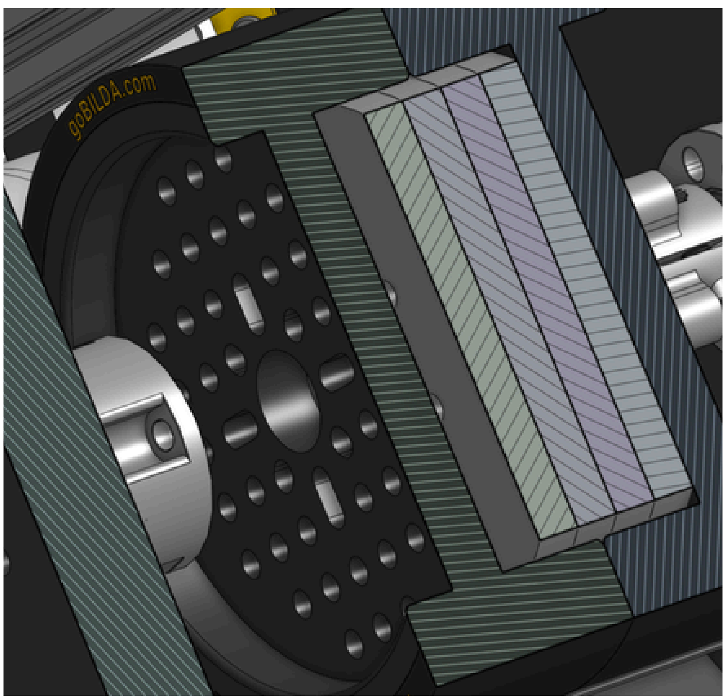
This indexing design allows for **rapid, reliable, and consistent** artifact cycling along with reliable shooter performance. The indexing design accomplished this by using **independently controlled motors**, increasing wheel **contact**, and **controlling compression** that will minimize jamming of the artifacts while providing a higher level of **consistency** in scores during both Autonomous and TELEOP parts of matches.

SHOOTER

Control and Firing Performance

Closed-loop PID control regulates flywheel speed to minimize recovery time between shots and maintain consistent RPM. This allows the system to fire **all three artifacts** in succession within **0.95 seconds** without significant speed drop. Adjustable RPM settings enable **reliable performance** across both close and far shooting zones while maintaining repeatability and control.





Drive & Power Transmission

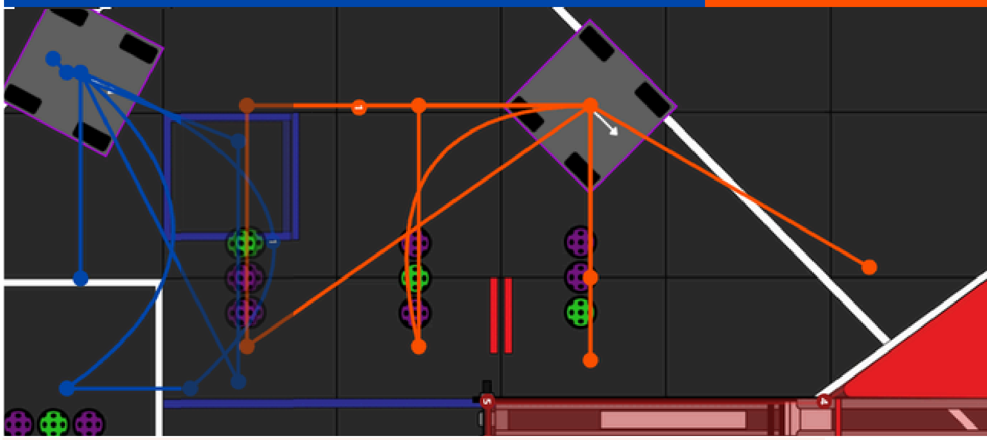
Dual REV HD hex motors drive the shooter through **dual GT2 belts** with a **3 mm profile**. The belt-driven design reduces backlash and distributes load evenly, ensuring smooth operation at high speeds. **Quadruple bearing support** improves shaft stability and reduces mechanical losses under load.

Flywheels And Compression

The system uses **72 mm diameter steel flywheels** with a combined mass of **1.24 lb**, housed inside **96 mm goBILDA 30A durometer Rhino traction wheels**. This setup balances high rotational inertia with strong surface grip, allowing **efficient** energy transfer, **reduced recovery time**, and **consistent** exit velocity during rapid firing. A fixed hood design provides **consistent compression** for both close- and far-range shots. Distance is controlled through RPM adjustment rather than mechanical changes, improving **reliability and launch repeatability**.

PATHING AND AUTOMATION

FAR ZONE: 9 BALLS, LEAVE, 38-42 PTS | **CLOSE ZONE: 12 BALLS, LEAVE, 41-45 PTS**



We have **multiple autonomous routines** so we can adapt to our alliance partner's playstyle while contributing to our alliance's success.

The Pathing Dilemma

Originally, we used **encoder-based** autonomous pathing, but quickly realized that it was **unreliable** and **inconsistent**. Therefore, we chose to switch to **PedroPathing** for multiple reasons: **dynamic adjustments** using multiple feedback controllers, **intuitive path creation** that worked seamlessly, and **reduced jerkiness** that previously hampered auto reliability.

Dead-Reckoning Wheel Odometry

Our team fuses goBILDA's **pinpoint IMU** rotational information with our **swingarm dead wheels** at a sample rate of **1500Hz** to ensure precise positioning during autonomous.
This solution outperforms alternative options, such as the **SparkFUN OTOS**, reducing our position's drift over time from 1% to **0.002%** for a **500x** increase in precision.

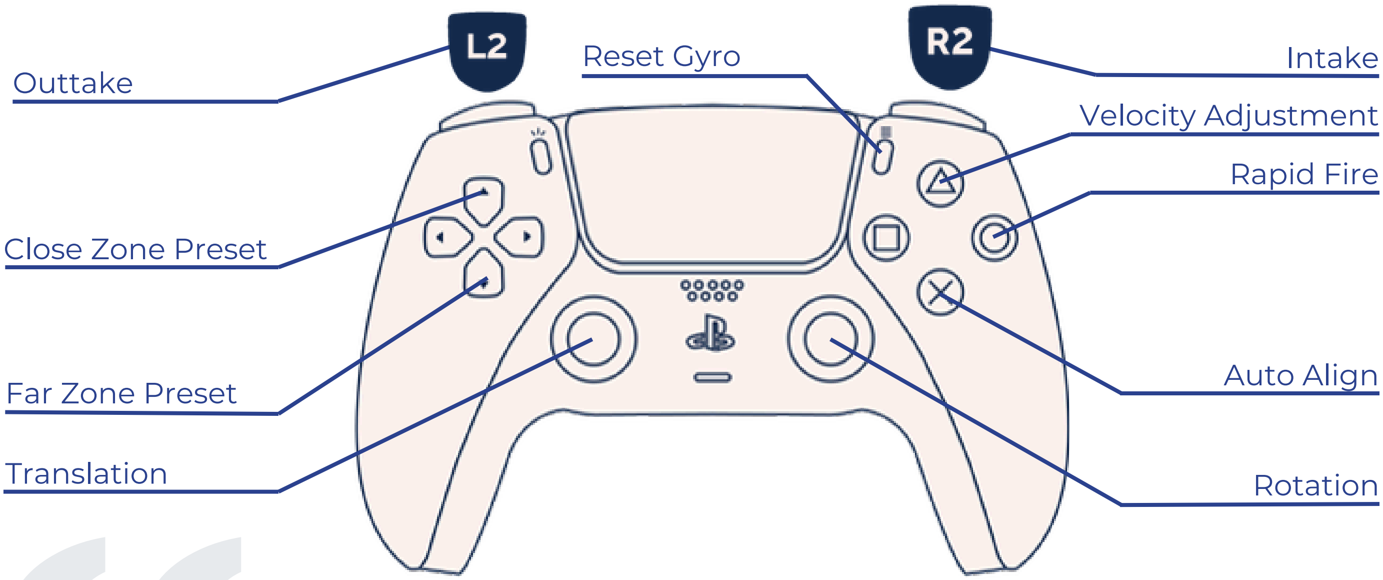
Variable Vision-Powered Auto Align

Using our **Limelight 3A,** we apply a **closed-loop controller** to the AprilTag's position to quickly and precisely align to the center of the goal.
However, we learned that we needed to offset our alignment based on our location, which we implemented using a **custom distance calculation algorithm:**

$$\vec{d} = \frac{\vec{h}_{goal} - \vec{h}_{ll}}{tan(\theta_{ll} + \theta_{ty})}$$

With these improvements, we saw an increase in accuracy of **48%** from 44% to 92%, with a **70% increase** in far zone accuracy!

DRIVER-OPTIMIZED TELEOP



> We chose to incorporate **one controller** due to the simplicity of the game. Additionally, we found that using one controller removed the need for **communication** between driver and operator, allowing us to **optimize our cycles** and **prevent confusion** during matches.

Robot-Centric Driving

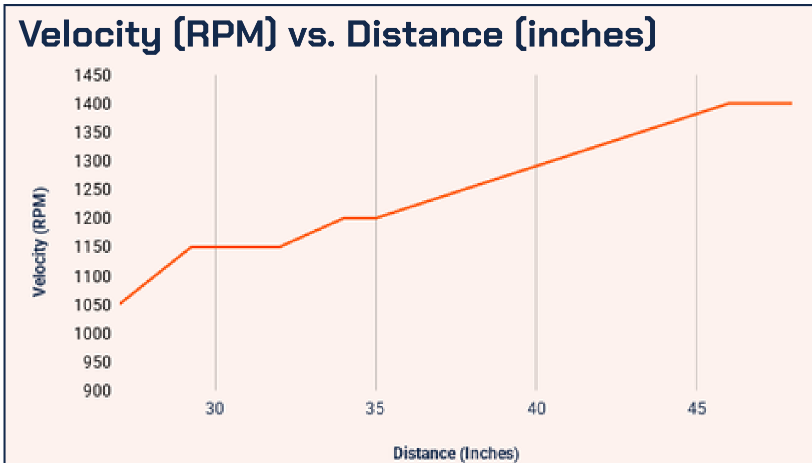
- **Easier** to code
- **Confusing** with field-centric **perspective**
- **Complex** movements nearly **impossible** (e.g. rotate + translate)

Field-Centric Driving

- More **difficult** to implement
- **Intuitive** driving experiences
- **Complex** movements simple to do
- Improved **maneuverability** in **defense-heavy** matches

For our first two meets, our robot used robot-centric driving. However, after **weighing the benefits and pitfalls** of robot- and field-centric drive modes, we **ultimately switched** due to the reasons above. Using our **goBILDA Pinpoint IMU**, which prevented **gyro drift** over time, our field-centric drive **never faltered** for the duration of our third league meet and was a **major contributing factor** to our success.

DRIVER-OPTIMIZED TELEOP: CTD.



Interpolation Formula

$$y = y_1 + (x - x_1)\frac{y_2 - y_1}{x_2 - x_1}$$

Velocity Interpolated Lookup Table

After our experience in **Meet 3** without hard-coded velocities, we realized the importance of being able to **shoot anywhere** on the field. So, we implemented an **interpolated lookup table.** Using our distance function, we tested optimal shooting velocities, reducing our cycle time from **6.5s** to **3.8s**, a **41.5% decrease**.

Status Indicators

After using LEDs on our first iteration, we understood that it **minimizes driver overhead.** So, we refined and adjusted our colors to optimize **information transmitted** with each status and removed **irrelevant** statuses.

Version 1

Disabled	1 Ball Detected	2 Balls Detected
3 Balls Detected	0 Balls Detected	At Shooting Position

Version 3

Disabled	Flywheel Disabled	No AprilTag Seen
Shooter At Velocity	Shooter Not At Velocity	