TRITON ROBOTICS

Annual Season Schedule

2021-2022 | University of California, San Diego

Table of Contents

TRITON ROBOTICS

[1] Competition Culture

2020-2021 | University of California, San Diego

[1.1] Culture and Significance of the Robomaster Competition

RoboMaster University Championship is an annual robotics competition for universities worldwide. This is the first PVP live projectile robotics competition in the world which attracts many media companies and tens of thousands of technology zealots by its stunning audio-visual effects. The competition mainly focuses on the comprehensive application and participants' engineering practice abilities with respect to computer vision, embedded systems, and mechanical designs, which encourages students to put the theories they learned in class into real practices. This competition is designed to be comprehensive and challenging. New teams can easily get on the basic design and coding, while old teams can keep investigating on more in-depth topics such as autonomous driving. Our team values the sustainability of the competition and believes that this competition is worth our endeavors for years to come.

Every team as a part of RoboMaster is built up by college students who have deep affection for technology and are willing to devote themselves to this field. A team has to stand out among 200+ teams from all over the world in order to get a good ranking, which cannot be realized without devoting tons of time. When teams are developing robots, they need to consider various technical problems they could encounter on the competition field and find out those problems by consistently testing. Behind the scene, young engineers might be stuck in debugging or overthrowing their designs over and over again with countless overnight team meetings and discussions. This trains the patience and willpower of the participants, which are also the core quality for excellent engineers. The spirit of pursuing the ultimate perfect is the core of RobotMaster, which builds a solid foundation for future technology development.

The participant teams are not simply focusing on technological research, but also seeking various ways to solve funding problems. Higher budget brings more resources for the team, which provides more design possibilities and better chances for a team to win the competition. This encourages every project team to run like a small company: besides the necessary technology crews, a team also needs a business group, a promotion group, and an operation group to be fully functional. During the process of seeking potential sponsors, the team members will learn how to negotiate business collaboration through reaching out to various companies, which is a valuable experience to acquire before working in a real company. This also provides students a chance to learn how to run a business and foreshadows the emergence of new technology companies in the future.

A great number of young engineers are gathered by this competition, fighting for a common goal, which is beautiful scenery. During the process of preparing the competition, the technology communication between different schools also facilitates the equality of educational resources. Triton Robotics wants to be a part of it and help the robotics community thrive in our school, in North America, or even for every robotics enthusiast in the world. This competition truly fulfills the mission “glorify their youthfulness, empower their thinking, cultivate global engineers to be executors of their dreams”.

[1.2] Core Values of Triton Robotics

Mission Statement

Diligence and pride signify the core values and beliefs of Triton Robotics members. It is the understanding that the work you produce will be honored by senior members to help in your development as an engineer. We believe everybody has the potential to contribute significantly regardless of the major or background. We take a holistic approach of identifying talented members who have gone through hardships and overcome it to achieve a goal. RoboMaster is the extension of that vision of diligence and pride. Our work is prideful once we can compete on the stage, but that pride only comes when diligent people work together. The unique challenges require members to exercise their creativity and knowledge to accomplish tasks effectively. Robomaster is the personification of human emotions and the process of engineering. It teaches young engineers how to harness their emotions into the future development of technologies and innovation.

Perception of Robomaster and Lasting Impressions

During engineering showcases, some people gawk at the lights illuminating from the robot. Others are unimpressed by the concept. Throughout Triton Robotics' development, the leaders are tasked with reframing Robomaster into something more than "just a game." That phrase echoes in the ears of all the members who spent countless hours refining and developing their passion projects. In the most fundamental definition, a game is the completion of observable tasks with rules to maintain integrity. To the doubtful onlookers, Robomaster is a lesser competition compared to Formula SAE and Base 11 competitions due to the scope of the competition and scale of the design. The significance of Robomaster is the freedom of expression to build a complete engineer. All of our members chose to join an unestablished organization with little infrastructure and stability because you do not learn the managerial aspect of engineering. It is easy to gain experience doing CAD design and analysis, but established organizations never learn the hardships of developing a stable system the first time. What sets us apart from the competing project teams is the ability to introduce new programs and systems that help the team succeed in the long term, such as product design sketching for decreased concept generation turnout and behavioral interviews to assess diligence. There are many branches of engineering glanced over in our curriculum. It is the members' drive and passion to discover them and introduce ways to integrate it into our club. Our loose style of management allows for a stream of innovation from members both in engineering and leadership. The removal of a hierarchy is imperative for team bonding and growth of management.

Team Identity

The team's identity is described by strength in numbers. Each member exhibits the diligence and pride necessary to accomplish fantastic achievements. The team retooled and rebuilt from the ground up after the founding class graduated. During the rebuilding year from 2019-2020, the team has undergone rebranding, restructuring of finances and operations, and retooling of fresh engineers. After participating in the majestic Robomaster competition, the 6 returning members managed to grow the team to over 40 members within one year. Due to this experience, the team officers believe that the future of Triton Robotics is predicated on the ideology of strength in numbers. It symbolizes the belief that each person can accomplish great things if given the chance. Our perception in university has transformed from the "hermit" organization into the gateway organization for engineering organizations. We are the most reliable team for engineers with little to no experience, and we develop them into competent members. They can either move onto new project teams or continue supporting the very team that gave them a chance. Our numbers have fluctuated as a result, but we have a strong following that is committed to making Triton Robotics a competitive organization at UCSD.

Mentorship

Mentorship is not limited to the leaders within the club. As stated earlier, the team operates with a superficial hierarchy system that only exists for University relations. In actuality, all members of every background/class standing are allowed to mentor another. Triton Robotics understands that experience and confidence comes at a relative pace. It is expected for everyone to understand a facet of engineering, but it is a different issue if they are able to apply those concepts. Mentorship builds faith in the trainees to commit their time to Triton Robotics. It is an important distinction to classify "leaders" and "those who lead" as completely separate terms. Leaders are merely figureheads. Those who lead are the teachers that one can look up to. We train our members to approach challenges openly and develop them into role models that will lead the next generation. This system was inspired by the commitments of the founding class who believed in the leadership and engineering capabilities of the underclassmen.

Aspirations

Despite our rankings in Robomaster, there is much we can improve upon. Our lofty goal is to become the best team in North America first. Once we achieve that, we will strive to be the best international team. During the previous school year, we were able to grow the team size from 6 to 30 and establish relationships with the different organizations and programs at UCSD. There is further focus on reorganizing all our files and formalizing meeting minutes for officer meetings. This school year, we are focused on developing our committed members in preparation for Robomaster 2021. We created articles, videos, and demonstrations pertaining to leadership, engineering, and personal development. The different forms of media helps accommodate all types of learners, which helped spike our retention rate of new trainees from 34% to 62%. At the start of 2021, the team will have a new cast of officers-in-training to learn how to lead the team next school year. We have introduced technical manuals that share the thought process and design decisions from last year. New members are required to read it to prevent repeating the same mistakes as the previous members. In total, we have completed 15 technical manuals describing an assortment of sub-assemblies, such as turret, suspension, and image processing. Our goal is to make a condensed version of the manuals for competition use. This allows participants in China to understand how to repair, replace, and operate the robots without ever building it. By the end of the school year, we are aiming to have all robots except the drone completed and competition ready. Due to budget constraints, the drone may not be feasible. However, we have opened a crowdfunding campaign to offset the costs. We hope it will be enough, but we recognize that our attention must be focused on the smaller projects first.

[1.3] Common Goals of the Team

We envisioned our common goals of the team in two parts: one part for the competition and the other part for operation.

Goals for the Competition

In the middle of the COVID-19 Pandemic, the primary objective is to compete in RoboMaster 2022 at any cost by attending the RoboMaster North America Competition and the RMUC in China if possible. With this goal in mind, we will actively communicate with the tournament organizers about any limitations that we foresee and be prepared at any time. That means, we will turn-in the relevant documentation and assessment on-time to present ourselves in a positive light.

Different than last year, this year we have returned to in-person learning and the team meeting became much more convenient and accessible. With the previous benefits, we are determined to become the RoboMaster North American Top Three and up. And this will lead to our next goal of qualifying for the RoboMaster Final Tournament and winning a few rounds if the competition is in person. Ultimately, we want to be the International first place for RMUC.

Goals for Operation

In regards to the goal for operation, we plan to host the RoboMaster North America Competition in San Diego, California and in UC San Diego in particular if possible. Not only will it allow our team to have more exposure within the university clubs and the North American RoboMaster community, it also provides us a great opportunity to advertise the RoboMaster competition in the West Coast of the US, where the game is not yet widely known.

To achieve this, we will have to build up an operation team that will be in charge of advertisement, marketing, and various important logistics. Secondly, we plan to have funding beyond $10,000. Thirdly, we have plans and are actively searching for a lab space to hold our weekly meetings and working sessions and expect everyone to work 15 hours per week. Additionally, we will like to keep around 50 active members in the club.

[1.4] Goals for Team-Building

According to UCSD News, UC San Diego is ranked the No.6 Best Public University in the U.S. In particular with the U.S. Top 1 ranking in the Computer Vision area. To best utilize our university's rich resources and open up the potential of our club members, we aim to specialize in ROS2 SLAM (Simultaneous Localization and Mapping) and Navigation. Though we started our research last year on this challenging task, we have reached some outstanding progress such as producing a ROS simulation for the RoboMaster AI Challenge. This year we have started fresh and use ROS2 for the autonomous infantry for SLAM and Navigation. Moreover, with the possible help from the professors (Helps from: Contextual Robotics Institute, Bioinspired Robotics and Design Lab, Safe Autonomous System Lab) and graduate students for our club, we are confident about achieving our goal.

TRITON ROBOTICS

[2] Project Analysis

2020-2021 | University of California, San Diego

[2.1] Rules Interpretation

The RoboMaster Competition 2022 starts stressing the importance of design integrity. This protects the teams making technological breakthroughs from being directly copied from other teams and encourages a healthy research environment. The Midterm Assessment could now affect the initial coins of each team at the beginning of the game, which encourages participants to well document their work. This ensures a rigorous design process and also helps build the team legacy.

Although the Arena of 2022 is similar to the version of 2021 with minor changes, these changes facilitate the participant teams to further refine their current design with the same functionality. The participant teams need to retrospect the advantages and disadvantages of their design in the past year, improving or redesigning the robot to achieve a better performance.

Arena

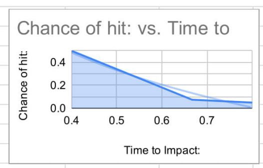
- The area of the bumpy road is increased at the center of the competition field, which is also the most spatial area in the area where most of the confrontations happen. This implies that all ground robots need to apply a better chassis design for a stable driving. Especially for robots applying beyblade mode in shooting, a stable chassis could largely decrease the difficulties for operators to execute precise shooting, and decrease the deviation for the computer vision calculation.
- A rotating lift platform is added to the Power Rune Activation Point, which increases the difficulty for activating the Power Rune. Thus, a good calculation from the computer vision is required,
- The Outpost now contains a rotating armor module. As a result, either a good dart design or Hero lob shot could be decisive to take over the Outpost due to the tremendous damage they can exert on buildings.

Game Mechanics

- The Hero Sniper Point is changed, and the buff enables the hero to knock down the Outpost with 5 ammos at the least. This adds more expectation for the Hero to shoot accurately from a long distance away.
- There is a new Resource Island Buff added, which protects the Engineer from interference for a better game flow.
- In the second round of releasing minerals from the Resource Island, there will be two minerals dropping at the same time. This prevents the team with better engineers taking over all the economic advantage and the other team having no ammos to shoot. This guarantees a better game flow and adds more possibility to the outcome of the match.
- When activating the big Power Rune, there is a chance that both of the teams can get the buff, which decreases the chance that one team will be ruled over by the other. This guarantees a better game flow and adds more possibility to the outcome of the match.

Standard Drivetrain					
	Performance Lv	Max HP	Max Power (W)		
Initial Setting	0	100	40		
Power-Focus	1	150	60		
	2	200	80		
	3	300	100		
HP-Focus	1	200	45		
	2	300	50		
	3	400	55		
17mm Launch					
Launching Type	Performance Lv	Heat Limit	Cool/sec	Initals Speed lim	ATI (seconds)
Initial	0	50	10	15	0.3333333333
	1	150	15	15	0.3333333333
Burst	2	280	25	15	0.3333333333
	3	400	35	15	0.3333333333
	1	50	40	15	0.3333333333
Cooling	2	100	60	18	0.2777777778
	3	150	80	18	0.2777777778
	1	50	10	30	0.1666666667
Projectile Speed	2	100	20	30	0.1666666667
	3	150	30	30	0.1666666667
Armor	Dmg Per Shot		Distance for shots(m):		CONSTANT:
Robot Armor	10		5		0.049
Base Armor	5				
Collision	2				

Accuracy Claculation:	
Time to Impact:	Chance of hit:
0.8	0.05
0.6666666667	0.075
0.4	0.5
0.2	0.55
0.1	0.9
0.01	1



		Shot Efficency:			Dmg Efficency:
Accuracy	Return to 0 heat	Shots per sec	Shots per 5 sec	Shots per X sec	Dmg per sec:
0.4940062709	5	5	10	6	20
0.4940062709	10	15	22.5	16.5	70
0.4940062709	11.2	28	40.5	30.5	130
0.4940062709	11.42857143	40	57.5	43.5	190
0.4940062709	1.25	5	25	9	20
0.5841163279	1.666666667	10	40	16	50
0.5841163279	1.875	15	55	23	80
0.8166446385	5	5	10	6	40
0.8166446385	5	10	20	12	80
0.8166446385	5	15	30	18	120
				Time (X)	
				1	
					ADPC*dmg/sec

[2.2] Infantry Design

[2.2.1] Understanding of the Role

Infantry is a ground robot that can be operator controlled or fully autonomous, and it is expected to maneuver around the playing field agilely due to its lightweight and smaller size compared to other ground robots. Its mobility allows it to quickly kill robots using guerilla tactics. Due to the low ammo cost, low revival time, and low amount of experience points needed to level up, it is common for the Infantry to have a major influence during competition. However, this mobility comes at a cost; the Infantry has the lowest level 0 health and the damage it can inflict is 20 times less than the other ground robot, Hero. Nevertheless, the Infantry robot played a major role in the RMUL 2021 competition. The reliability of its burst mode outclassed that of the Hero robot and some matches were won due to a dominant Infantry.

[2.2.2] Analysis on Current Design

[2.2.2.1] Basic Information

- Dimension (mm): 450mm x 580mm x 400mm (WLH).
- Weight (kg): 15 and 15.772 (after full loading)
- Maximum ammo capacity: 241 projectiles

[2.2.2.2] General Performance

- Maximum moving speed(m/s): 2.8 m/s
- Maximum acceleration(m/s^2): 4.2 m/s^2
- Maximum shooting rate(per sec): 12
- Maximum shooting speed(m/s): 28 m/s
- Maximum Turret Angle of Elevation: 35 Degrees
- Maximum Turret Angle of Depression: 30 Degrees
- Maximum Turret Yaw Degree of Freedom: No limits

[2.2.2.3] Advantages

- Suspension: The suspension system was changed to make the shock absorbers parallel to the front and back direction instead of using a double wishbone suspension system. On flat ground, it performs well, but it has not been tested on a bumpy road. Based on the final design of the suspension, the springs can be changed for higher or lower stiffness as needed.
- Chassis: the outer casing is secured with 4 thumb screws, 2 at the front and 2 at the back, which allows for quick access to the electronics inside. The plates that make up the outer casing have pre-cut holes that allow wires to go through.
- Turret Base: the turret base is designed so that the Pitch motor can fit inside the base so that there is less rotational moment of inertia, releasing some burden from the Yaw motor. The pitch motion is then controlled by a virtual four-bar linkage.

[2.2.2.4] Disadvantages

- Size: without an outer protector, this current Infantry is very close to the 600x600mm size limit, which leaves little room for the protector, and this can be changed by shortening the length of the chassis and suspension arms.
- Mounting: the mounting methods for the electronics need to be modified. Since we are introducing more components, such as the supercapacitor and the Nvidia Jetson, we will need to take them into account in the next design.
- Higher Precision Manufacturing: The current prototype consists of parts that are 3D-printed, laser cut, and hand drilled. For further iterations, all carbon fiber parts and metal parts need to be made using either manual machining or CNC machining.

[2.2.3] Mechanical Expectation

[2.2.3.1] Overall

- **Lighter robot:** Use carbon fiber plates to reduce the weight
- **Center of gravity:** The shooter should be on the same vertical line with the center of gravity to reduce the work of controller
- **Dimensions:** Fix dimensions of first prototype (e.g. some parts were too short)

[2.2.3.2] Gimbal

- **Flywheel vibration:** Introduce a bottom plate to reduce vibration
- **Flywheel placement:** Use trial and error to determine velocity of rounds based on flywheel placement (allows for optimization of speed)
- **Development board placement**: Extend the top plate to allow mounting of the dev. board

[2.2.3.3] Chassis

- **Wire management:** Use cable sleeves and cable clips to better organize wires
- **Compactness:** Move square tubing under base plates to allow for more space
- **Outer Shell**: Add a secondary plate under standoffs to improve strength in order to survive a 42mm round from Hero
- **Protective frame placement**: Make new holes that allow the frame to mount and be modular
- **Battery mount**: Introduce a better location to mount the battery (work in progress)

[2.2.3.4] Suspension

- **Suspension brackets:** Decrease length of moment arm to reduce tilting and fill the space between outer brackets to even out the load
- **Modularity**: Use a mechanism similar to how Sentry mounts to rail to easily mount suspension system (work in progress)

[2.2.4] Software Expectation for Regular Infantry

[2.2.4.1] Hardware/Electronic Components Upgrades

- *Supercapacitor Management Module*
- *Nvidia Jetson TX2*
- *CV High Speed Camera*

[2.2.4.2] Embedded

- **Strafe-Capable:** The chassis should be able to move in any direction regardless of orientation without experiencing instability in the chassis or turret.
- **Stationary Pivoting Firing Mode:** The Infantry should be able to rotate in place while maintaining accurate fire on a fixed point.
- **Supercapacitor:** Should work in accordance to the referee system and give chassis a burst of energy when discharged

[2.2.4.3] Computer Vision

- **Auto-Aiming:** Turret should be able to automatically aim at an opposing armor module. The Nvidia Jetson TX2 should be able to run the CV code required for auto-aiming

---

[2.2.5] Software Expectation for Autonomous Infantry

- **Localization**: The autonomous infantry will make use of various sensors located on the robot to find its location on the battlefield.
    - Wheel encoders: Can be read to find how far the infantry has traveled, and can be used to find a position
    - RPLidar: Can be used to map the surrounding battlefield, and find the robot's position in relation to the rest of the field
    - Kalman Filter: Can be used to fuse these two sources of input and create a final, more precise location of the infantry
- **Path Planning:** The infantry will be able to travel to and from various locations in the battlefield. These locations will be determined by the human operators throughout the game with the use of a map.
    - Obstacle Avoidance: The infantry robot will make use of the RPLidar to detect possible collisions with obstacles or other robots and plan accordingly.
- **Controlling:** Given a planned path, the infantry will attempt to follow the path by using localization and error correction between its current location and desired location.
- **Rebounding:** If the autonomous infantry falls off the path due to third party interference (i.e. bumped by another robot), it will attempt to go back onto the path by traveling to its last known location.
- **Object and Enemy Detection**: The autonomous infantry will utilize a depth camera as well as computer vision to locate targets (such as armor plates) around the field as well as scan for enemy robots using the depth camera.

[2.3] Hero Design

[2.3.1] Understanding of the Role

Hero is a user-operated robot that is designed to sustain damage, deal significant burst damage, and inflict moderate building damage. The primary focus of the Hero is the 42mm launcher that fulfills the damage roles of the robot which can fire a maximum of 12 rounds per minute. The Hero is 33% larger than the infantry robot and contains significantly more Health Points than the infantry, so the Hero needs to be able to sustain more damage. These abilities are capable of significantly shifting the momentum of a match through burst damage, “tanking”, and long range building damage. These strengths are complemented with significant downsides with decreased mobility, increased weight, low firing rate, and accuracy-dependency. The low firing rate and accuracy dependency can be alleviated with the optional 17mm projectile launcher, but if the 42mm is not reliable, then the Hero is effectively a tankier Infantry.

[2.3.2] Analysis on Current Design

[2.3.2.1] Basic Information

- Dimension (mm): 800x800x800
- Weight (kg): 29 (Empty) / 32 (after full loading)
- Maximum ammo capacity: 300x17mm, 45x42mm

[2.3.2.2] General Performance

- Maximum moving speed(m/s): 2
- Maximum acceleration(m/s^2): 1
- Maximum shooting rate(per minute): 10
- Maximum shooting speed(m/s): 9
- Maximum Turret Angle of Elevation: 45 Degrees
- Maximum Turret Angle of Depression: 30 Degrees
- Maximum Turret Yaw Degree of Freedom: 720 Degrees

[2.3.2.3] Advantages

- Bottom Feed Mechanism that allows full Turret yaw rotation
  - 42mm Ammunition Pathing permits a moderate degree of freedom in turret pitch without restricting yaw rotation.
  - 42mm Ammunition storage allows Engineer Robot to resupply, permits full yaw rotation, and can function as a structural component of the chassis.
- Modular Design for Maintenance: Design partially successful in permitting maintenance, but design needs to be expanded to more segments of the robot. This design should also permit ease of electronic maintenance.
- 17mm Launching capable: Capable of mounting an infantry turret on top of the Turret
- Chassis design allows strafing and movement in any direction regardless of orientation.

[2.3.2.4] Disadvantages

- The Chassis is not stable as forward and reverse acceleration results in the Hero lunging.
- Hero contains excess material, resulting in decreased mobility and difficulty transporting.
- The Hero chassis is larger than necessary and caused decreased mobility, logistic difficulties, and suboptimal space utilization.
- Supercaps are more vulnerable to projectiles relative to chassis-mounted electronics.
- Turret has a maximum degree of rotation when turning in one direction continuously.

[2.3.3] Mechanical Expectation

[2.3.3.1] Overall

- **Lighter robot:** The chassis should decrease material used and use alternative materials to minimize the weight of the Hero while maintaining structural and functional integrity.
- **Center of gravity:** The shooter should be on the same vertical line with the center of gravity to reduce the work of controller
- **Modularity:** Should be easy to disassemble and reassemble for transportation.
- **Consistency:** Reduce the frequency of jamming in Bottom Feed Mechanism

[2.3.3.2] Gimbal

- **Slip ring:** This enables the hero to rotate continuously to reduce the probability of the armor plates from receiving hits from hostile robots.

[2.3.3.3] Chassis

- **Easy to disassemble for Maintenance:** Chassis should have a modular design to make certain portions of the interior more accessible.
- **Strafe-Capable:** The chassis should be able to move in any direction regardless of orientation without experiencing instability in the chassis or turret.

[2.3.4] Software Expectation

[2.3.4.1] Hardware/Electronic Components Upgrades

- *Robomaster GM6020 Brushless DC Motor*
- *Robomaster M2006 Brushless DC Motor*
- *Robomaster M3508 Brushless DC Motor*
- *Flywheel Friction Motor*
- *MCV-CA013-20UC High-Speed Camera*

[2.3.4.2] Embedded

- **Strafing:** The Hero should be able to strafe in any direction regardless of orientation.
- **Stationary Pivoting Firing Mode:** The Hero should be able to rotate in place while maintaining accurate fire on a fixed point.
- **Siege Mode:** The Hero should be able to enter the Elevated Sniper Point and hit a hostile structure while remaining stationary.

[2.3.4.3] Computer Vision

- **Auto-Aiming:** Take the trajectory of ammos into account (need trajectory analysis from mechanical members)

[2.4] Engineer Design

[2.4.1] Understanding of the Role

The Engineer plays a role of securing resources and rescuing other ground robots in the competition. A good Engineer robot ensures that the team has sufficient supply and executes fast rescue, which guarantees that other ground robots make consistent damage to the enemy robots or buildings. This is the most complicated ground robot with multiple functions in a compact design.

[2.4.2] Analysis on Current Design

[2.4.2.1] Advantages

- The 2D maneuver gear is able to elevate the claw at different heights from 500mm to 700mm to adjust the different height of small and big resource islands and exchange zones.
- The mineral store box is able to rotate the mineral around the yaw axis.
- The electronics are mounted on drawable plates which makes electronics easy for access.
- Pneumatics is used on the claw for fast catching, which is confirmed to be especially useful in the 2021 final tournament.

[2.4.2.2] Disadvantages

- The mineral box is not able to rotate mineral around the pitch axis
- Only one mineral can be stored in the rear at a time
- Space inside the robot is not efficiently used. There is a lot of empty space in the middle of the robot.
- The chassis is weakly designed without much support on the bottom plate.

[2.4.3] Mechanical Expectation

[2.4.3.1] Overall

- **Center of gravity:** Lower center of gravity to make sure the robot will not flip over when catching a mineral or going down a ramp
- **Disassemble:** Should be easy to disassemble into different groups of parts and easy for transportation

[2.4.3.2] Mineral Acquisition and Robotation

- **Deformation Flexibility of Claw:** the claw should be able to pick up minerals in various situations with the minerals at different positions and angles, including ground, small and big resource islands.
- **Capacity:** the robot should be able to store 2 minerals in the rear, and easy access for the claw to redeem coins at the exchange zone.
- **Rotation:** the rotation mechanism should at least be able to rotate the mineral in 2 axes. Consider applying flywheels or belt friction to realize the function.

[2.4.3.2] Rescue Mechanism

- **Strength:** be able to two hero with maximum 35kg mass without breaking
- **Connection:** when driving on the bumpy road, the rescue mechanism will not be detached from the dead robot. Potential design for rescuing two ground robots at a time due to the increased maximum expansion size
- **RFID Rescue:** easy recognition for RFID rescue mechanism.

[2.4.3.3] Chassis

- **Strength:** Sufficient support on bottom plate, working for a long time without apparent deformation.
- **Stability:** be able to buffer the shaking by driving on the bumpy road to reduce fatigue on the rescue mechanism.

[2.4.4] Software Expectation

[2.4.4.1] Hardware/Electronic Components Upgrades

- *Raspberry pi*
- *Raspberry pi 5 inch screen*
- *Raspberry pi Noir Camera Module V2 8MP 1080P*
- *Flywheel Friction Motor*

[2.3.4.2] Embedded

- **Multi-Camera:** be able to switch between different cameras on the 5 inch screen to provide a better view to exert different tasks.

[2.3.4.3] Computer Vision

- **Resource Island Flash Light Recognition:** This helps the claw to locate precisely where the mineral will drop within a few seconds

[2.5] Sentry Design

[2.5.1] Understanding of the Role

Sentry is a fully autonomous robot which is restricted to running on a rail. It targets all the enemy robots running close and plays as the last defense of the base. It also provides a virtual shield with 500HP to the base while it is still alive, and can only shoot 500 ammos at maximum in one round. Thus, we need to keep it alive as long as possible and also shoot accurately and wisely.

To decrease the damage that sentry might undertake, we need to improve its moving speed. One way to do this is to make the mechanical design as light as possible in order to decrease the friction between the chassis and the rail. To improve its shooting performance, we also need to make sure the turret is smooth enough to shoot the ammos on a stable trajectory without jamming so that it can hit the enemy robots precisely in a short time. Efforts also need to be made on differentiating different robots so that to make appropriate decisions.

[2.5.2] Analysis on Current Design

[2.5.2.1] Basic Information

- Dimension (mm): 450x490x542
- Weight (kg): 13 kg
- Maximum ammo capacity: 500

[2.5.2.2] General Performance

- Maximum moving speed(m/s): 2
- Maximum acceleration(m/s^2): 1.5
- Maximum shooting rate(per minute): 120
- Maximum shooting speed(m/s): 28
- Maximum Turret Angle of Elevation: 30
- Maximum Turret Angle of Depression: 45
- Maximum Turret Yaw Degree of Freedom: 720

[2.5.2.3] Advantages

- Current design is very easy to take on and off the rail quickly due to the chassis design
- Turret agitator operates smoothly with little to no jamming and a high feed rate
- Chassis is extremely stable and prohibits nearly all turret sway while moving on the rail

[2.5.2.4] Disadvantages

- Current design is unnecessarily heavy and utilizes too many metal plates and extrusions
- Turret design is significantly height constrained and needs to be more compact
- Flywheels have too high of a speed dropoff between shots, limiting shooting speed

---

[2.5.3] Mechanical Expectation

[2.5.3.1] Overall

- **Lighter robot:** Replace the aluminum plates with carbon fiber plates to reduce the weight
- **Center of gravity:** The shooter should be on the same vertical line with the center of gravity to reduce the work of controller
- **Disassemble:** Should be easy to disassemble into different groups of parts and easy for transportation

[2.5.3.2] Gimbal

- **Dual Turret / Double Barrel:**
    - **Plan I:** Add a turret above the chassis in order to defend robots from the elevated ground.
    - **Plan II:** Modify existing turret to shoot out of two seperate barrels
- **Slip ring:** This will enable the turret to rotate 360 degrees unlimited time and will improve the shooting efficiency. (imagine one infantry is running around the sentry but the sentry is not able to keep tracking the infantry due to the rotation limit)

[2.5.4] Software Expectation

[2.5.4.1] Hardware/Electronic Components Upgrade

- *RM 17 mm Speed Monitor Module*
- *Robomaster GM6020 Brushless DC Motor*
- *Robomaster M2006 Brushless DC Motor*
- *RoboMaster Snail 2305 Brushless DC Motor*
- *HuaRay A3138CU000E Camera*

[2.5.4.2] Embedded

- **Detection mode:** The two turrets should be always pointing to opposite directions. Both of the turrets should be constantly rotating and nodding. The sentry should constantly move back and forth on the sentry rail.
- **Attacking mode:** If the robot is farther than 5m, use the turret above; if the robot is located within 5m, use the turret. When one turret is attacking, the other should keep itself in detection mode until it detects one enemy robot. After the turret ends its shooting, it should wait for the other turret to rotate in the opposite direction in order to restart the detection mode.

[2.5.4.3] Computer Vision

- **Nvidia Jetson TX2:** Troubleshoot the Jetson and make it able to run the cv code
- **Ground robots differentiation:** use svm deep learning algorithms to differentiate different robots according to different numbers on their armor plates.
- **Camera Upgrade:** Our current camera can only detect armor plates within 2 meters. An upgrade on the camera is necessary.
- **Auto-Aiming:** Take the trajectory of ammos into account (need trajectory analysis from mechanical members)

[2.6] Aerial Design

[2.6.1] Understanding of the Role

Aerial is a remote control operated robot that is restricted to flying in the Flight Zone of the competition field. It is controlled by two operators, one pilot and one gimbal operator. The gimbal operator also controls the dart and radar. The Aerial only becomes active in the match when air support is called, at which point the aerial has 30 seconds of flight time. During this flight time the aerial cannot be targeted by other robots, but has the capacity to shoot 500 17mm projectiles with no barrel heat limit.

In order to maximize the potential damage of the aerial, the drone must be fast and stable with high accuracy and a quick fire rate. The stability of the drone is key for accuracy as the drone will be likely shooting enemy robots and the base from a significant distance. Computer Vision auto aim is also extremely important in order to quickly lock onto targets and not waste the limited 30 second window of aerial support

[2.6.2] Mechanical Expectation

[2.6.2.1] Overall

- **Minimize weight:** We are aiming for 10kg weight. A lighter drone allows us to make a quadcopter instead of hexacopter, which reduces overall cost
- **Thrust:** Thrust potential of drone is enough to carry turret and 500 projectiles
- **Center of gravity:** The turret should be on the same vertical line with the center of gravity to reduce the work of controller and improve accuracy

[2.6.2.2] Gimbal

- **Minimize weight:** Fabricate turret from carbon fiber, PLA, and acrylic
- **Projectiles:** 500 projectile capacity
- **Fire rate:** Produce a fire rate of at least 10 projectiles per second.

- **Accuracy:** Projectile launcher can reliable hit target from 5 meters

---

[2.6.3] Software Expectation

[2.6.4.1] Hardware/Electronic Components

- *RM 17 mm Speed Monitor Module*
- *Robomaster GM6020 Brushless DC Motor*
- *T-Motor Brushless Gimbal Motor GB36-2*
- *RoboMaster Snail 2305 Brushless DC Motor*
- *Robomaster M2006 Brushless DC Motor*
- *E2000 Pro Tuned Propulsion System*
- *Pixhawk 4 Flight Controller*
- *ZED 2i Stereo Camera*
- *Nvidia Jetson TX2*

[2.6.4.2] Embedded

- **Flight control:** we will modify the firmware of the Pixhawk 4 flight controller to be able to communicate with depth sensors and enable autonomous motion planning. This will allow the aerial to correct itself if it recoils when the turret shoots.

[2.6.4.3] Computer Vision

- **Location Assistance:** we will use ZED 2i Stereo Camera and Jetson TX2 to help the drone map in real time, find the best path to follow to reach the desired location, and maintain position to prevent drift due to recoil
- **Auto-Aiming:** we will use the Jetson TX2 to run the computer vision code for turret auto-aim

[2.7] Dart Design

[2.7.1] Understanding of the Role

The Dart System is made up of the Dart Launcher and Darts. For each round of a match, the Dart Launcher may be loaded with 4 Darts. The Dart System is allowed to launch twice in a match, each with a 15 second window. The Dart can use visionary intelligence to locate objects and use flight controls to guide and attack an object. The Darts can attack either the base or outpost, doing 1000 damage to the former and 750 to the later.

[2.7.2] Analysis on Current Design

[2.7.2.1] Basic Information

- Dimension (mm): Dart-250*150*150, Dart Launcher-1000*600*1000
- Weight (kg): Dart-0.22, Dart Launcher-25
- 4 Darts

[2.7.2.2] General Performance

- Maximum Dart speed(m/s): 15.76
- Maximum Launch Angle: 45 Degrees
- Minimum Launch Angle: 25 Degrees
- Maximum Yaw Degree of Freedom: 13.8 Degrees

[2.7.2.3] Advantages

- Cost efficient
- Simple and low weight
- Easy fabrication

[2.7.2.4] Disadvantages

- Lots of testing required for Dart
- Not self guided
    - No other propulsion in air
    - Needs high accuracy Dart Launcher
- Launcher is slow to move
- More research and development from embedded and software on the future Dart designs

[2.7.3] Mechanical Expectation

[2.7.3.1] Overall

- **Consistency:** Have consistent dart shots on outpost and base
- **Speed:** Reduce the time it takes to position, fire, and hit target

[2.7.3.2] Dart Launcher

- **Flywheels:** Use two sets of flywheels to allow consistent and fast shots
- **Belt Fed:** Belt feed on a long track to push darts into flywheels consistently and timely
- **Yaw:** Motor and gear system to allow easy and accurate yaw motion
- **Pitch:** Linear actuators that move the platform to launch darts controlling the pitch angle accurately

[2.7.3.2] Dart

- **Aerodynamics:** Maximize aerodynamics of the Dart
- **Simplify:** Eliminate unnecessary mechanical components effectively making the Darts a good projectile

[2.7.4] Software Expectation

[2.7.4.1] Embedded

- **Control Dart Launcher:** Have two set positions, one for outpost and one for base, that the launcher can move to before launching darts. Make the controls as simple as possible for the Aerial Gimbal Operator so that no time is lost and not much thought is required.
- **Future Research**: Research what would be required to have an effective self guided dart including testing of different controls and electronic components.

[2.7.4.2] Computer Vision

- **Self-Guidance:** Research and development into a dart that can lock onto a target, calculate the trajectory needed, and adjust position accordingly. Look into hardware such as cameras and microcontrollers that would be needed to fit in

[2.8] Technical Middle Platform Building Plan

[2.8.1] Software

1. **Capable of:**
   a. Detecting Small Armor Modules for auto-aiming
   b. Working Detection Code on one of the Power Rune video
   c. Simultaneous translation and rotation of all equipped robots (With slip ring)
      i. Robots equipped with slip rings have the ability to spin while shooting or moving, which allows robots to evade bullets.
   d. PID enhanced turret stabilization and aiming
      i. All robots with turrets are equipped with position-based PID control for human operators to correctly and precisely aim turrets through the use of their operator interface. Turrets are aimed using the x and y position of the operator's mouse.
2. **Desired Breakthrough:**
   a. More efficient and robust auto-aiming algorithm for both small and large Armor Modules, introducing a configuration reader
   b. More Robust Power Rune Detector after the completion of a sample Power Rune by the Mechanical team
   c. Even Better Collaboration with other divisions, especially with embedded and AI in discussing the use of ROS2
   d. Simultaneous location and mapping coupled with autonomous traversal throughout the field
      i. Incorporating the Nav2 library into all capable robots (Robots equipped with a Jetson TX2 or similar)
      ii. Creating a map of the surrounding environment using onboard sensors such as the RPLidar
      iii. Using the created map to navigate around the arena while avoiding obstacles

[2.8.2] Hardware

1. **Capable of:**
   a. Providing drive motors excess power through a supercapacitor power system
      i. Motor power draw is limited by competition and by physical limitations
      ii. Extra unused motor power is diverted into a super capacitor bank

   iii. Operator can temporarily obtain extra power flow (>80W) that the battery could not provide under normal circumstances
b. Power monitoring and display
   i. Battery power usage is displayed to the operator HUD
   ii. Supercapacitor energy levels should be displayed to the operator HUD as well as the state of the supercapacitor power system (charging vs discharging)
c. Operator and Competition power management
   i. Operators may manually direct power from the supercapacitor bank to the drive motors as need arises

2. Desired Breakthrough:

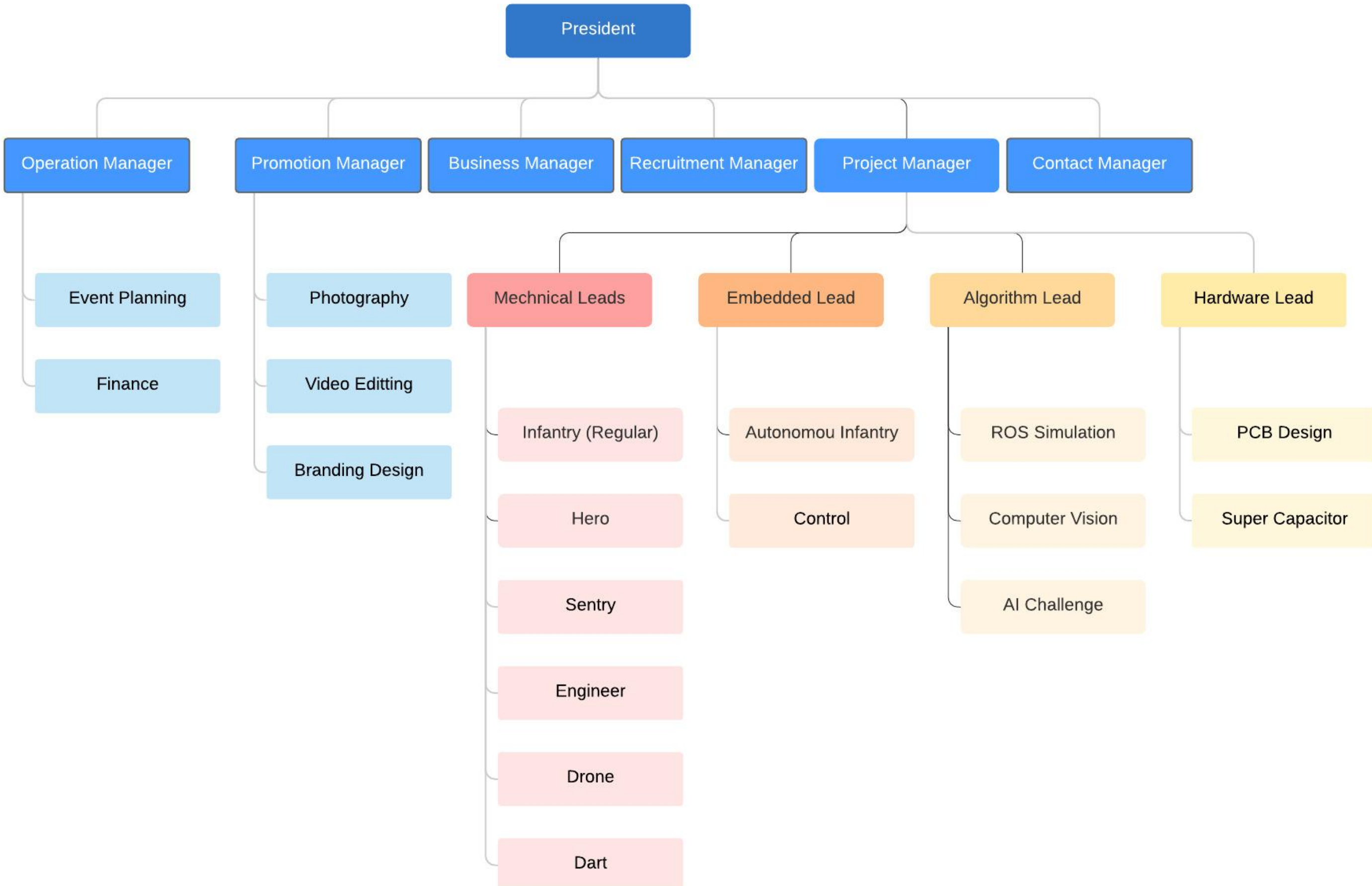
a. More efficient power utilization
b. Power monitoring displays should increase operator awareness of movement limitations
   i. Allows operators to actively compensate power limitations through modifying their driving or using the supercapacitor system
   ii. Allows mechanical teams to have a direct measurement of design efficiency
c. Satisfy operator power demands during operations that require high amounts of power

TRITON ROBOTICS

[3] Organizational Structure

2020-2021 | University of California, San Diego

[3.1] Internal Structure



[3.2] Role Expectations & Duties

President/Co-President - Presides overall administration and functions the club. Bears the responsibility of final approval over major club decisions and design changes. Ensures that the organization meets all University & RoboMaster operational requirements.

Project Manager - keep recording of everything happened in the team

- Collecting weekly reports and checking attendance
- Keep record and manage inventory and monetary calculation

Promotion Manager - media regulation and branding design

- Constantly updating TR's social media including news, weekly updates, etc.
- Design postcard, posters, merch, and anything related to TR branding

Business Manager - any contact for funding

- Contact companies / school / professors for potential sponsorship
- Prepare documentation for funding application related stuff

Operation Manager - team building

- Find vendors, place orders, and track packages
- Giving team building suggestions, coordinate internal team relation
- Event planning (eg. workshops, team building)

Recruitment Manager - recruitment related tasks

- Review applications and communicate with recruits
- Tracking the progress of trainee program

Contact Manager - anything related to communication

- Point of contact in university meetings and rmna
- Regulate the team server
- Contact for team events

Mechanical Lead(s) - Bears the duty to uphold the core values of the club and ensure that each member has the opportunity to grow both as a student and an engineer. He or she will be working to impart knowledge and experience among the members of the club in mechanical design.

Embedded Lead(s) - Bears the duty to uphold the core values of the club and ensure that each member has the opportunity to grow both as a student and an engineer. He or she will be working to impart knowledge and experience among the members of the club in embedded programming, power management, and autonomous driving.

Algorithm Lead(s) - Bears the duty to uphold the core values of the club and ensure that each member has the opportunity to grow both as a student and an engineer. He or she will be working to impart knowledge and experience among the members of the club in computer vision, AI algorithms, and ROS Simulation.

Members - Expected to attend most build day meetings and actively work on tasks and finish within the given time frame, give constructive feedback to leads, captains, etc.

[3.3] Current Team Roster

OFFICAL ROSTER

Academic Year: 2020-2021

First Name	Last Name	Major	Year	Status	Primary Role	Secondary Role	Operations Role
Zoey	**Huang**	Aerospace Engineering	Senior	MEMBER	OPERATIONS	ENGINEER	PRESIDENT
Saman	**Naseri**	Mechanical Engineering	Junior	MEMBER	OPERATIONS	HERO	VP Internal
Calvin	**Joyce**	Mechanical Engineering	Sophomore	MEMBER	OPERATIONS	HERO	Mechanical Captain
Russel	Chough	Business-Econ	Sophomore	MEMBER	OPERATIONS		
Areen	Lu	Computer Science	Sophomore	MEMBER	OPERATIONS		
Kenny	**Wang**	Mechanical Engineering	Senior	MEMBER	INFANTRY		LEAD
Roger	Nguyen	Mechanical Engineering	Sophomore	MEMBER	INFANTRY		
Ho	Jin Kim	Mechanical Engineering	Freshman	TRAINEE	INFANTRY		
Ally	Baker	Mechanical Engineering	Freshman	TRAINEE	INFANTRY		
Brian	Kong	Mechanical Engineering	Freshman	TRAINEE	INFANTRY		
Transon	**Pho**	Structural Engineering	Senior	MEMBER	HERO		LEAD
Akash	Premkumar	Aerospace Engineering	Freshman	TRAINEE	HERO		
Anika	Chaukkar	Mechanical Engineering	First-Year Transfer	TRAINEE	HERO		
Dehao	Lin	Mechanical Engineering	First-Year Transfer	TRAINEE	HERO		
Giovanni	Ramirez	Mechanical Engineering	Freshman	TRAINEE	HERO		
William	Harris	Mechanical Engineering	Freshman	TRAINEE	HERO		
Parker	**Knopf**	Mechanical Engineering	Junior	MEMBER	ENGINEER		LEAD
Brian	Fader	Mechanical Engineering	Senior	MEMBER	ENGINEER		
Trianna	Rivera	Aerospace Engineering	Senior	MEMBER	ENGINEER	OPERATIONS	
Joshua	Estrada	Mechanical Engineering	Third-Year Transfer	MEMBER	ENGINEER		
Nicholas	Sudi	Mechanical Engineering	Sophomore	TRAINEE	ENGINEER		
Ethan	Carlson	Mechanical Engineering	Freshman	TRAINEE	ENGINEER		
Aidan	**Reedy-Schneider**	Mechanical Engineering	Sophomore	MEMBER	SENTRY	DRONE	LEAD
Andy	Rabanal	Aerospace Engineering	Freshman	MEMBER	SENTRY		
Ryu	Ozaki	Mechanical Engineering	Junior	TRAINEE	SENTRY		
Theo	Emery	Mechanical Engineering	Sophomore	TRAINEE	SENTRY		
Ethan	Quan	Mechanical Engineering	Freshman	TRAINEE	SENTRY		
Cynthia	Do	Mechanical Engineering	Freshman	TRAINEE	SENTRY		
Judy	**Mohamed**	Mechanical Engineering	Sophomore	MEMBER	DRONE		LEAD
John	Liu	Computer Engineering	Sophomore	MEMBER	DRONE	EMBEDDED	
Dan	Zubovic	Mechanical Engineering	Senior	TRAINEE	DRONE		
Nick	Azpeitia	Mechanical Engineering	Freshman	TRAINEE	DRONE		
Armond	**Greenberg**	Mechanical Engineering	Sophomore	MEMBER	DART		LEAD
Jeffrey	Denenberg	Aerospace Engineering	Freshman	TRAINEE	DART		
Seth	Durbin	Mechanical Engineering	Freshman	TRAINEE	DART		
Ankit	**Bhatia**	Computer Engineering	Sophomore	MEMBER	EMBEDDED		LEAD
Yitian	Wang	Computer Engineering	Senior	MEMBER	EMBEDDED		
Warren	Xia	Computer Science	Junior	MEMBER	EMBEDDED		Advisor
Ariel	Young	Computer Engineering	First-Year Transfer	MEMBER	EMBEDDED		
Ben	Stirling	Computer Engineering	Sophomore	MEMBER	EMBEDDED		
Dexin	Zhou	Math & Computer Science	Junior	MEMBER	EMBEDDED		
Edward	Burns	Computer Engineering	Sophomore	TRAINEE	EMBEDDED		
Anshal	Jain	Computer Engineering	Freshman	TRAINEE	EMBEDDED		
Laiwei	Wei	Electrical Engineering	Sophomore	TRAINEE	EMBEDDED		

Max	Gibson	Electrical Engineering	Sophomore	**TRAINEE**	**EMBEDDED**		
Ming	Yeoh	Electrical Engineering	Freshman	**TRAINEE**	**EMBEDDED**		
Sureel	Shah	Electrical Engineering	Graduate Student	**TRAINEE**	**EMBEDDED**		
Hongbin	**Miao**	Math & Computer Science	Sophomore	**MEMBER**	**CV**		**LEAD**
Kanishk	Gupta	Math & Computer Science	Sophomore	**MEMBER**	**CV**		
Nolan	Chai	Cognitive Science	Sophomore	**MEMBER**	**CV**		
Eugene	Kim	Computer Science	Second-Year Transfe	**MEMBER**	**CV**		
Aammya	Sapra	Computer Science	Freshman	**TRAINEE**	**CV**		
Aaryan	Agrawal	Data Science	Freshman	**TRAINEE**	**CV**		
Armaan	Banwait	Computer Science	Sophomore	**TRAINEE**	**CV**		
Daphne	Wu	Cognitive Science	Freshman	**TRAINEE**	**CV**		
Devin	Chen	Apllied Mathematics	Sophomore	**TRAINEE**	**CV**		
Junyi	Xu	Electrical Engineering	Sophomore	**TRAINEE**	**CV**		
Bryan	Nguyen	Cognitive Science	Sophomore	**TRAINEE**	**CV**		
Sandesh	Shrestha	Computer Science	Sophomore	**TRAINEE**	**CV**		
Yishai	Silver	Computer Science	Senior	**MEMBER**	**AI**		**LEAD**
Vicente	Montoya	Computer Science	Junior	**MEMBER**	**AI**		
Alex	Toofanian	Mechanical Engineering	Graduate Student	**TRAINEE**	**AI**		
Brooks	Niu	Computer Science	Junior	**TRAINEE**	**AI**		
Michael	Ingerman	Mechanical Engineering	Graduate Student	**TRAINEE**	**AI**		
Nate	Cusson-Nadeau	Mechanical Engineering	Graduate Student	**TRAINEE**	**AI**		
Rahul	Sahjwani	Electrical Engineering	Sophomore	**MEMBER**	**Hardware**		
Michael	Shao	Computer Engineering	Junior	**MEMBER**	**Hardware**		
Guang	Liu	Electrical Engineering	Sophomore	**TRAINEE**	**Hardware**		

[3.4] Recruitment

Recruitment Goals

● Executive Board: 6	● Embedded Team: 5-10
● Executive Team: 5~10	● Algorithm Team: 8~15
● Per Mechanical Team: 5-7	● Hardware Team: 3~5

Software Total = 25 | Mechanical Total = 30 | Operations Team = 10 | Total = 50+

Recruitment Periods

Triton Robotics conducts the primary recruitment period within the first two weeks of the Fall Quarter. During the rest of the year we conduct information sessions to keep interest growing about our club. However, in periods outside our primary rush phase we are more selective.

Application Method

- In-person table session → contacted for full interview

- Online application via our website → Google Form + Resume + Elevator Pitch Video

Trainee Program

We employ a trainee program used to test the abilities and dedication of potential members. Applications are filtered for individuals that either show potential with a needed skill set or demonstrated history of exceptional achievement, leadership, commitment and dedication. Triton Robotics is committed to maintaining a bias free recruitment process, prioritizing skills and potential contribution. In this respect, our recruitment team selects a distribution of applicants from a wide range of experience levels to ensure club longevity.

Each potential member is then invited to take part in our trainee program. The trainee program is a comprehensive curriculum that tasks trainees with learning material as well as weekly assignments to prove their proficiency. A program for both mechanical and embedded divisions has been developed.

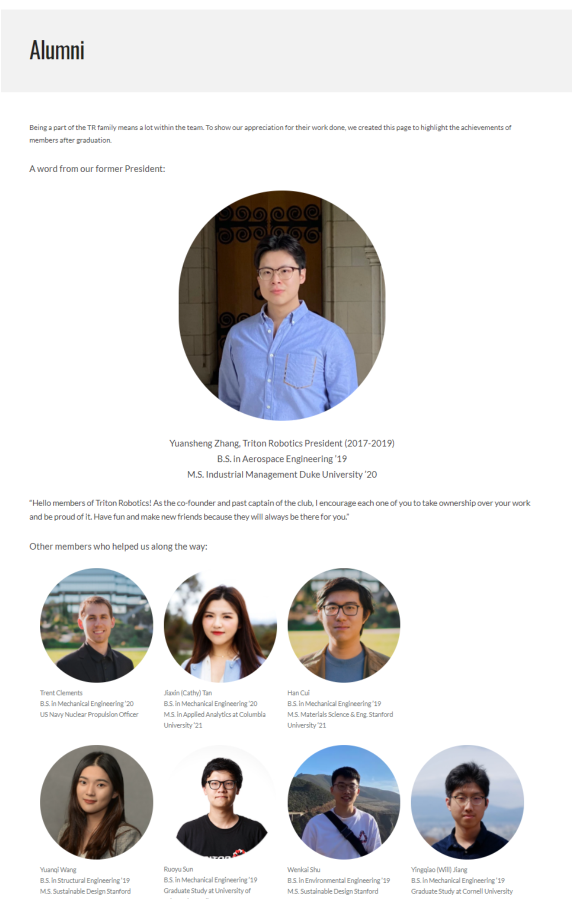
1. 3 Week Guided Orientation Period + Mandatory Educational Curriculum
2. 1 Week Sub-Team Shadowing Period
3. Mini-Capstone Project ~ used to evaluate trainee skills and self-management
4. Full Member Induction ~ granted full responsibility of a members
5. 3 Week Probationary Period ~ assessment of regular team performance

Rolling Recruitment Policy

Currently, the organization hosts two major recruitment periods; Fall & Winter Recruitment, usually taking place during weeks 1-3 in their respective quarters. The team will defer most interested applicants to apply within our recruiting periods however applicants with significant experience or expertise may be exempt by review of one of the current captains who can then initiate our rolling recruitment interview process which is similar to our standard recruitment process.

[3.5] Team Culture

In Triton Robotics we value the diversity of opinions within our workplace. The officers and leaders in Triton Robotics work to serve the members ultimately. We repeatedly instill the idea that no social hierarchy exists in our club, only those that can do the job . Role assignments are mostly for necessity and task assignments. In practice, sub-teams pursue whichever idea is the best, regardless of origin. The leaders encourage each member to speak out and challenge their decisions in an effort to truly achieve what is best for the team. As a team we hold our members to the highest standard and expect each one to treat their work in Triton Robotics with polished professionalism . A similar ethos is also visible in our executive leadership board where we practice a "check and balance" with each executive officer. This level of trust and mutual respect through all levels of Triton Robotics is a critical reason that we were able to adapt and transition to dealing with the restrictions of the pandemic caused by Covid-19. Even with little direct oversight and lack of physical work, members still reported diligently to meetings and even became more proactive in difficult times.



Our alumni are also very active in supporting our fledgling organization as most members have developed a long standing commitment to Triton Robotics beyond competition. Many of the past members, especially the founders, developed deep bonds and friendships.

Frequently, alumni offer advice in club operations as well as career choices. Some alumni visit and speak about their past experiences and talk about their current undertakings whether it be graduate studies or industry.

[4] Team Infrastructure

2020-2021 | University of California, San Diego

[4.1] Available Resources

Manufacturing Resources

- On-Campus Facilities
    - MAE Undergraduate Machineshop EBU II - *machining tools, drill press, etc.*
    - Envision MakerSpace SME - *small workshop, laser cutting, soldering, 3D Printer*
    - ECE Maker Space EBU I - *electronic prototyping lab, 3D printing*
- Off Campus Facilities
    - Miramar Water Jet Services
    - Maketory
- Raw Materials
    - Industrial Metal Supply ~ sheet metal and stock
    - EPlastics ~ acrylics
    - Matterhackers ~ 3D printing filament
- Online Component Sourcing
    - McMaster Carr https://www.mcmaster.com/
    - Misumi Industrial Sourcing https://us.misumi-ec.com/
    - Robotshop https://www.robotshop.com/
    - Miscellaneous: Amazon, Taobao, Ali Express
    - We maintain an inventory list of all purchased and retained materials in which members get to search for existing parts in order to prevent doubling up on purchases.

UCSD Funding Resources

- TESC Funding - ($800)
- JSOE Matching Funds - ($4000)
- ASEDI Funds- ($1500)
- AS Triton Competition & Community Fund - ($1300)

[4.2] Team Management Tools

Internal Documentation

Triton Robotics uses **Google Team Drive** to manage all of our internal documents. All relevant files are backed up onto the cloud platform for easy access.

- We provide official templates for all public material such as presentation slides, sponsorship letters, email- templates and more.
- Each sub-project is documented through an **Assembly Documentation** which outlines key elements of each mechanical sub-system including but not limited to project goals, relevant RM rules, design specification, engineering drawings, related analysis and a BOMs. These documents are meant to safeguard learned knowledge for future members.

Code Management

Triton Robotics uses **GitHub** to maintain and store our code base for our robots and other projects.
https://github.com/Triton-Robotics

CAD Management

Triton Robotics uses **GradCab** to maintain and store our CAD files for our robots and other projects. https://github.com/Triton-Robotics

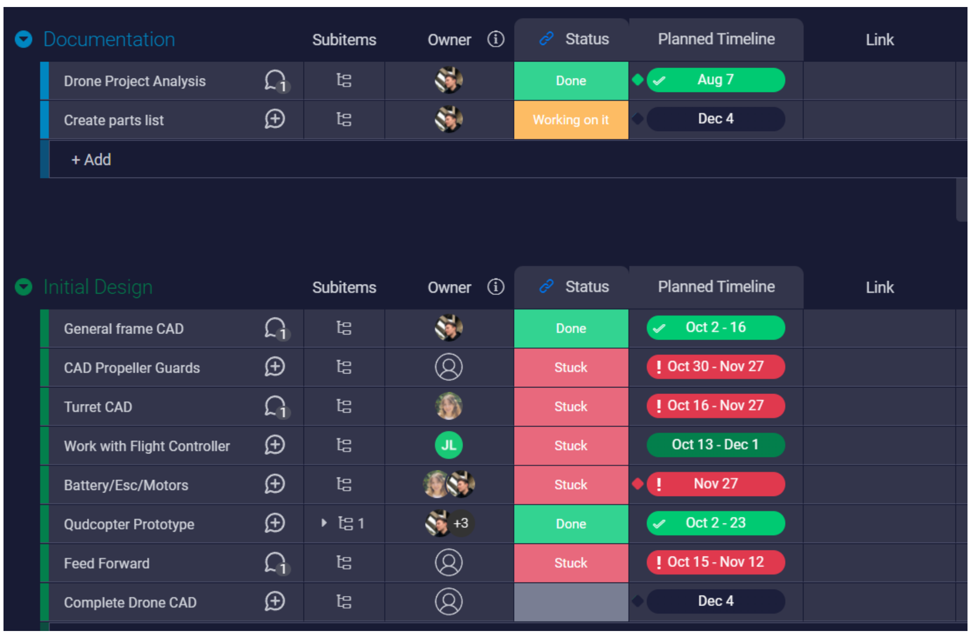
Communication

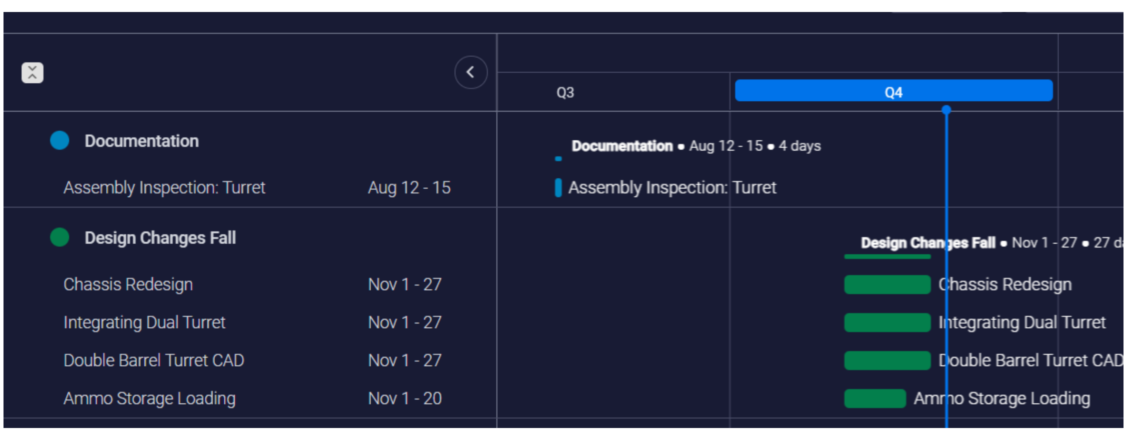
Triton Robotics uses **SLACK** as our main form of formal communication for technical and club related matters. Each relevant team or sub-group has a dedicated channel for information exchange. Additionally, adapting to the pandemic we utilize **Discord, Zoom or Airmeet.**

[4.3] R&D Management Tools

Project Management

Triton Robotics uses **Monday.com** to track the progress of subteams. Each Subteam has their own board to plan for their projects. Subteam Leads can assign tasks through Monday.com and members can check the deadlines and weekly update on the project boards.

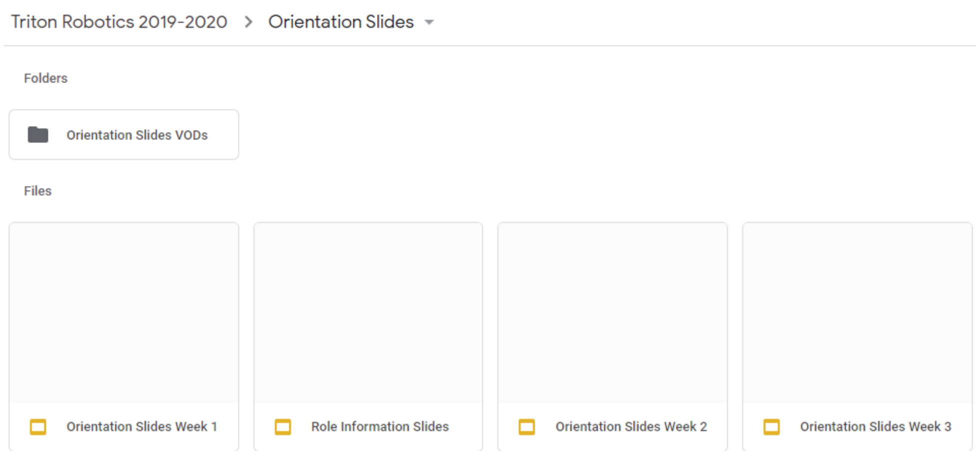


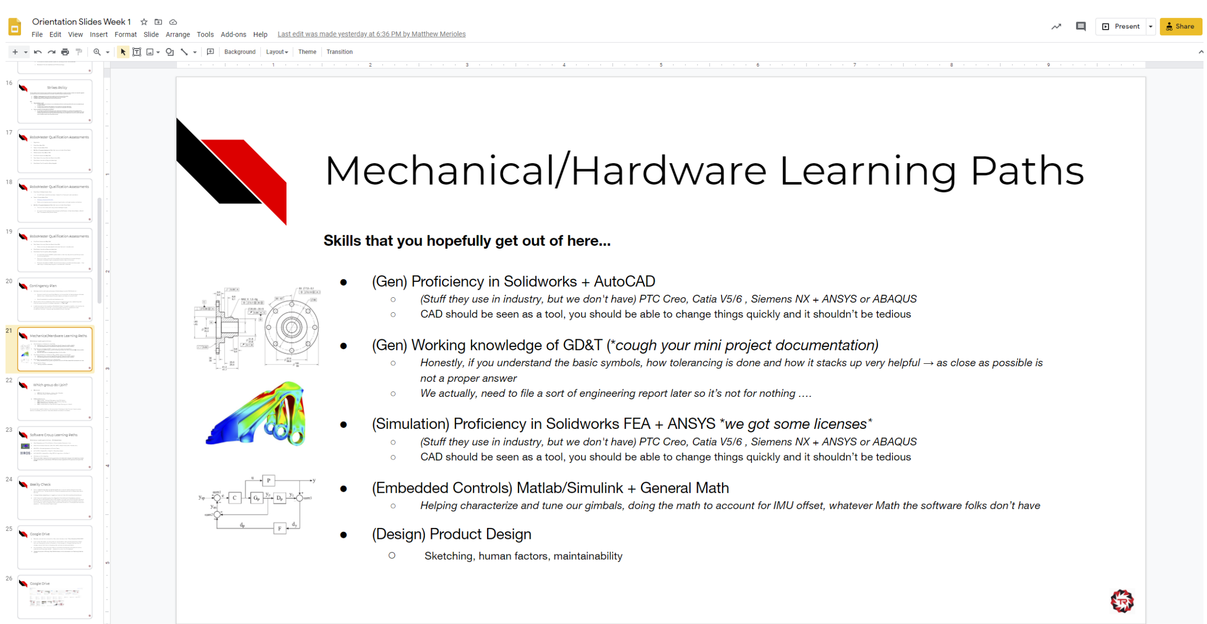


[4.4] Resource Management

Trainee Orientation Slides

All basic information and matters related to the introduction of the club have been compiled into a presentation for new members. In these slides are links to internal club resources as well as external informational links. Accompanying video presentations going over presentation materials were also recorded.

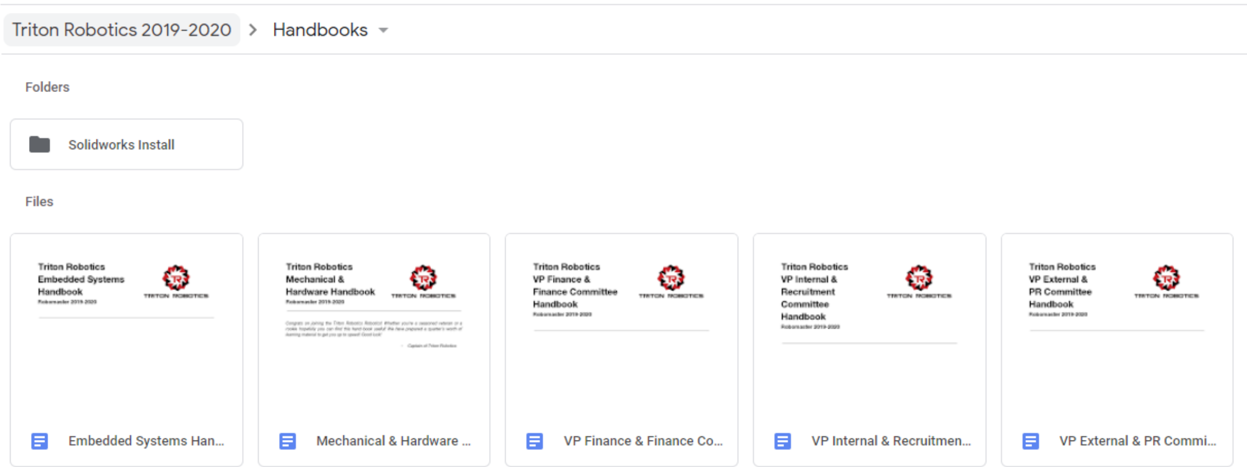




Internal Handbooks

To address the need for member learning materials Triton Robotics has developed “handbooks” which give tutorials basic informations for operation

- Embedded Systems Handbook
- Mechanical & Hardware Member Handbool
- VP Finance & Finance Committee Handboc
- VP Internal & Recruitment Committee Handbook
- VP External & PR Committee Handbook



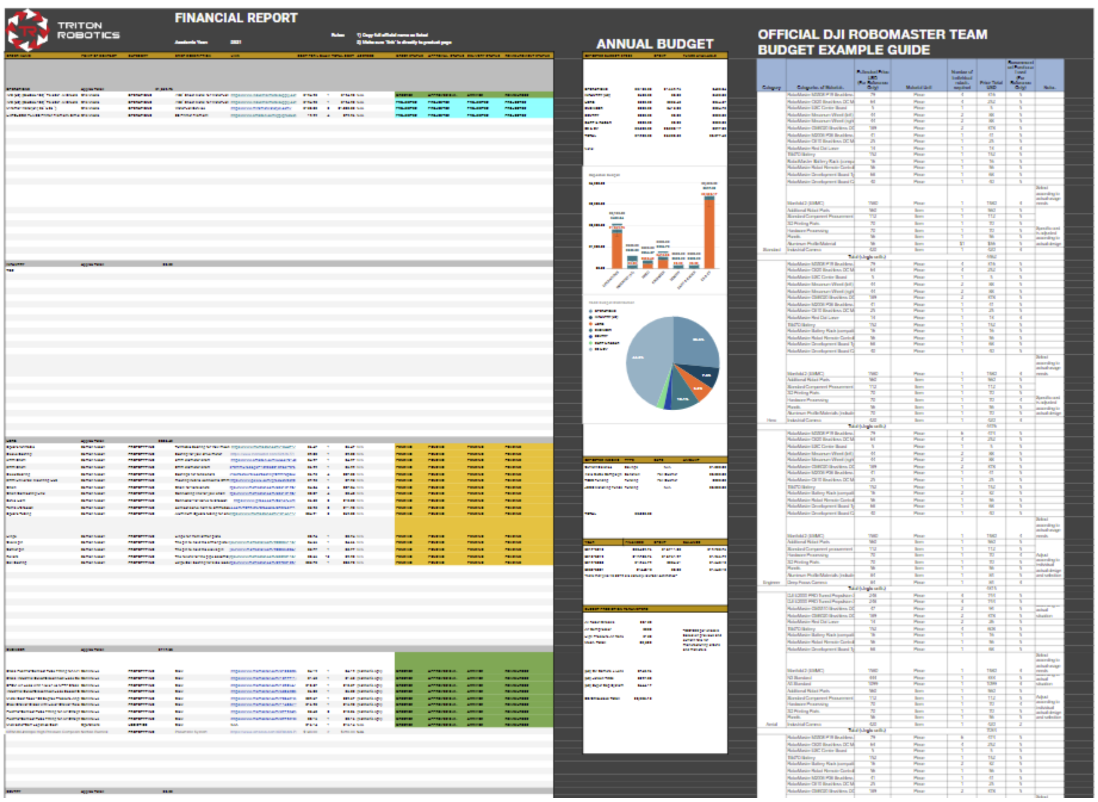
Research

The development and advancement of systems in Robomaster brings exciting flavor to the game. Triton Robotics endorses research and development into new features that can be integrated into our competing robots. The process usually occurs during the end of the school year after the completion of the competition robots, and the research period extends to the end of summer for members who do not travel to China. The proposal system begins at the beginning of an academic year, and it requires a presentation detailing the problem statement and design mock-up. A proposed budget is requested and the financial officer is responsible for allocating an amount for prototype development. The most recent innovation was the anti-slip mechanism that attaches to the ammo containers on robots which removes the need for springs and can be easily manufactured.

[4.5] Financial Management

All financial requests and purchases are publicly documented on our official **Purchase & Order Form.**

- This form is overseen by the financial committee as well the executive board who approve or reject purchase and rejection
- All purchases are made transparent to all member
- All spending records form **2020-2021** were also record in a similar fashion
- We also maintain and update an official **Inventory List** of all purchased materials in storage



Ex: Current Purchase & Order Form

TRITON ROBOTICS

[5] Business and Promotional Plan

2020-2021 | University of California, San Diego

[5.1] Promotion Campaign Plan

The Purpose

We are seizing every chance to increase our reputation, especially among all the engineering student organizations on campus. We are trying to host the 2022 RMUL competition on our campus to gain attention. This is helpful for either gaining human resources with higher quality or attracting fundraising from companies and our school.

Social Media

- **Facebook**

We post activities that are going on in our page and forward it to the UCSD community so that everyone could have a glance and join.

- **Instagram**

We are planning to do weekly updates on Instagram, as well as holiday posts. Our posts could be our progress on robots, updates on our daily activities, and our group photos.

- **YouTube**

Videos introducing the RoboMaster competition and our club are already put on our youtube channel Triton Robotics. In the future, we plan to do some workshops that are open to people who are not our members and put the recorded videos on the channel for non-profit education purposes.

- **Discord**

We created a public discord channel where whoever is interested in our club can join and learn our club through chat. They could be potential new members, members from other engineering clubs on campus, or captains from other teams.

Events

- **Triton Engineering Student Council**

We are a part of this council on campus. They hold an engineering club mixer every year, and we give out presentations on this mixer to show other engineering clubs what we are doing in the club and what's our plan for the next year. We talk to members in other clubs and look for potential corporations.

- **General Body Meeting**

This event is held every quarter. It is basically an info session where we will introduce our club to students on campus and answer any questions they may have.

- **Workshops**

Every quarter, we will hold workshops on mechanical design, and other robotics related topics open to all students. Through the workshop, we can attract more potential members and enlarge our community. The larger the group, the more influence we have, and thus more potential resources.

[5.2] Business Plan

Our Goal

We hope that we can cover most of our expenses for the team with the help from our sponsors. Our goal for fundraising this year is to reach $10,000 and above.

Business Plan Startup

Sponsorship letter

We have written a letter template ready to send out to companies.

Business Packet

There are several facets we need to include in the business brochure. This is going to be sent to companies when necessary.

- Briefly introduce the RoboMaster competition and technical skills we're going to apply in this competition. The focus is to show how much attention the competition is attracting and the influence of it among university students.
- Since we're a relatively new team, we would emphasize what potential level we can achieve in the future instead of our past achievements.
- Show our needs in expenses and what we can give back to our sponsors
- Our contact information

- **Business PPT**

This is a slideshow with similar content as the business brochure. This is used when we are attending technology exhibitions and networking events.

School Resources

- **Triton Robotics Alumni**

We accept donations from our alumni based on their free will.

- **UCSD Professors**

We accept donations from UCSD faculty who wish to support us.

- **UCSD Associated Students**

We receive funding for our new recruit training program from this department. They can also provide some funding for our travel expenses.

- **UCSD Engineering Department**

Jacob's School of Engineering has matching funds to support students in attending different competitions.

Social Resources

- **IndieGoGo**

We use IndieGoGo for crowdfunding as our first step. Our school would approve funds for us according to how much money we gain from the crowdfunding. We expect to gain $4000 from IndieGoGo.

Rewards for Fundraising on IndieGogo

>$5 digital thank you letter

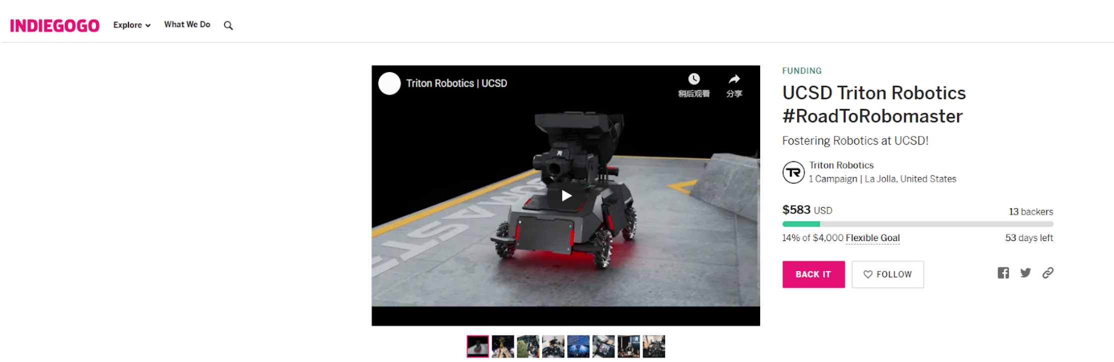
>$25 TR stickers + physical thank you letter

>$100 TR 2021 Shirt

>$250 advertising on social media

>$500 presentations, branding, website

>$1000 logo or name on robots



Future Target

- Startup companies looking for cheap advertisements.
- Companies related to robot manufacturing.
- Companies who may want to develop their business in China.

Branding Guideline

Color

Triton Red: #E22229

Triton Black: #231F20

University Navy: #182B49

University Gold: #C69214

University Yellow: #FFCD14

Typography

Logo Font: Bitsumishi

Text Font: Helvetica Neue

Logo

TRITON ROBOTICS

[6] Team Rules & Regulations

2020-2021 | University of California, San Diego

[6.1] Statement of Purpose

UCSD Triton Robotics is a 501(c)(3) non-profit student engineering organization founded through the CSI (Center for Student Involvement) in January of 2018 by several undergraduate students under the Jacobs School of Engineering. Currently, Triton Robotics is composed of 40+ members spanning a diverse range of disciplines. Our mission statement is to become an accessible platform that actively promotes the education and practice of robotics among college students across all proficiency levels. We pursue this goal by competing in robotics competitions, providing workshops, seminars and offering internal educational programs for new members. Currently, Triton Robotics actively competes in the *RoboMaster Competition* hosted by Da-Jiang Innovations (DJI) in Shenzhen, China. Triton Robotics has successfully qualified and competed in RoboMaster 2018 and 2019. We are also preparing to enter the RoboMaster AI Challenge variant hosted within ICRA. Additionally, our members engage other numerous projects exploring different aspects of robotics in search of potential organizational focuses or competitions.

Triton Robotics is overseen by a President, supported by a cohort executive office consisting of Vice Presidents overseeing Operations, Finance, Internal & External. To direct activities, Triton Robotics also has three captains leading the Mechanical, Embedded & CV divisions respectively. Students who join and partake in activities are exposed to the multidisciplinary nature of robotics allowing them to work or collaborate in small teams in projects that require knowledge in multiple fields of study . Triton Robotics provides practical experiences for members as we build our robots from the ground up allowing for hands-on mechanical design and manufacturing & embedded programming implementation all while working within a limited budget and fast-paced environment.

[6.2] Student Benefits

At Triton Robotics we strive to create an open and inclusive environment where each member has the opportunity to voice their input as well as meaningfully contribute to the organization. We actively try to recognize the hard work dedication our members contribute to the club. Members learn to work effectively in self-directed engineering teams learning to be both independent and collaborative. The members we accept into our organization all pose unique skill sets but display common traits of discipline and persistence as they tackle difficult engineering challenges.

Mechanical Division

Students in this role work on developing the mechanical hardware for different robotics platforms as required by the competition. This can range from suspension configurations, projectile launch systems, electrical power distribution and much more. Students learn to design and plan robust platforms that integrate numerous subsystems that meet performance requirements from all departments. Members gain experience in SOLIDWORKS from CAD skills, engineering drawings and integrated FEA analysis. Due to the logistical demands of deploying multiple platforms, a taxing multi-round format and overseas travel, our design philosophy is deeply motivated by maintenance and reliability factors, manufacturing cost and cross-platform design. We believe this is a unique aspect of our organization that is often overlooked. Heavy monetary investment is required for each platform so it is our main responsibility to design and build platforms with life cycles spanning multiple years into the future. As students learn more in their respective curriculum, many of our upper-class members begin to apply higher level knowledge on control system design, vibrational analysis and solid mechanics to optimize our designs.

Embedded Division

Students who design and create the control systems of robots are given an opportunity to develop skills in embedded programming directly working the STM32F427II; an Arm Cortex based microcontroller processor. This division gives “life” to our robotic platforms and works to add software based operational features or automate certain tasks and routines. Students learn and apply different topics such as linear controls control, sensor fusion, electrical power distribution and more. Additionally, members become familiar and work with numerous communication protocols such as CAN Bus, UART, PWM, radio communication, to name a few. Our work in embedded deals with creating a real time operating system to manage data flow from peripheral devices in conjunction with our CV system, which grows skills that are readily transferable to industry work. In addition, this year we have adopted the use of the ROS framework to begin working on creating simulations of our robots in virtual environments.

Computer Vision Division

After gaining experience with embedded programming, many of our software members transition to this division to pursue work in computer vision and machine learning. Currently RoboMaster advocates the use of automated aiming systems, and SLAM (simultaneous localization and mapping) in our platforms. Members in this division gain experience with modern image processing, filtering and machine learning and familiarity with frameworks such OpenCV, Tensor Flow (Keras) and the application of different machine learning models such as YoloV3, R-CNN Mobile Net and others. Our test bed platforms are equipped with Jetson TX2s with high-speed industrial cameras. Additionally we plan to purchase and implement LiDAR and RGBD Depth Cameras to supplement our current technology stack in order to stay competitive.

[6.3] Triton Robotics Official Constitution

ARTICLE I. NAME OF STUDENT ORGANIZATION

The organization shall be called Triton Robotics at UCSD. The name and branding of Triton Robotics shall not be used for business purposes in any kind without permission from executive boards at Triton Robotics.

ARTICLE II. STATEMENT OF PURPOSE

We strive to promote a comprehensive robotics community at UCSD for students from all majors, by providing students with actual hands-on experience of building robots in mechanical, embedded, and computer vision divisions. Accordingly, we have prepared corresponding tutorials to help new members get familiar with basic robotics knowledge. We actively engage in communication with professors from different departments to get technical help and provide the best experience for our club members. The environment of the club can help our members get prepared for their future careers.

All of our projects are designed around the RoboMaster competition organized by DJI (Da-Jiang Innovations) and hosted in Shenzhen, China. We participate in this annual international robotics competition. North American teams would have to take part in the North American regional competition, and the top teams would be invited to the final tournament in China. The competition logistics are subject to change depending on our situation.

ARTICLE III. NONPROFIT STATEMENT

Triton Robotics at UCSD is a non-profit student organization.

ARTICLE IV. REQUIREMENTS FOR MEMBERSHIP

1. Official Members:
    a. Members must be passionate about robotics, be respectful and supportive to everyone in this club.
    b. A minimum of 15 hours commitment is required for every member every week (except week 10 and final weeks). Members constantly failing to meet this requirement will face suspension of membership.
    c. A quarterly club due of $20 dollars would be charged for material purchasing, prototyping, and testing purposes. The fee can be waived or postponed by

condition according to the financial situation of the member. Failing to pay the dues without waiver for two quarters will disqualify the member from the club.

d. Active members who present outstanding ability in leadership and technical skills would be promoted to project leads.

e. Trainees who pass our trainee program and meet the standard of the club will be accepted as official members

2. Trainees:
    a. Students registered at UCSD from all majors and all years can join the club by submitting applications and taking an interview. We might send out acceptance letters in a lottery due to our limited capacitance.
    b. Trainees are supposed to do a 3-week training program to get familiar with robotics and submit a capstone project for review. The final decision of whether a trainee is accepted or not will be given at the beginning of the consecutive quarter.
    c. No dues are required for trainees.

3. The president of Triton Robotics reserves the right to change the requirements.

ARTICLE V. FREQUENCY OF ORGANIZATION MEETINGS

The general meeting would be held every Saturday, and an 8-hour working session is expected. Each member is allowed for two absences for the general meeting with reason in each quarter. Subteam meetings for each project team shall be organized by the project leads during the middle of the every week, the attendance criteria shall be set up by the team leads. Executive board meetings are required during the middle of every week unless there is an emergency.

ARTICLE VI. QUALIFICATIONS FOR HOLDING OFFICE AND METHODS OF SELECTING AND REPLACING OFFICERS

Only registered UCSD students may hold office in the organization. Only registered UCSD students may vote in elections for the selection of the organization's officers.

The president of Triton Robotics shall provide a master plan and direction for the club during their term and ensure the club meets the requirements of the university and RoboMaster. The new president shall be solely designated by the previous president.

The executive boards have many roles including recruitment, finance, public relation, and operation. The recruitment executive board is in charge of sending notification to our potential new recruits, reviewing the application, interview, trainee program designing and progress checking, and social events within the club. The finance executive board is in charge of controlling the budget, keeping an itemized record of the cost, and securing funds from the school. The public relation executive board is in charge of regulating social media and reaching out to companies for potential sponsorships. The operation board will be in charge of making arrangements to the internal affairs including checking up the attendance, reserving space for events, and mediating conflicts. The executive board shall be designated by the new president.

Division leads (mechanical, embedded, computer vision) oversee the work progress of the division and make plans and adjustments for the technical part. The division leads shall be elected by the members of the division based on their leadership and technical knowledge.

Sub-team leads are the people that members will look up to. The way they run sub-teams and the progress that they produce will set the tone for the rest of the club. Subteam leads shall be designated by the president to members who step up for projects.

ARTICLE VII. RISK MANAGEMENT

Triton Robotics at UCSD is a registered student organization at University of California, San Diego, but not part of the University itself.

Triton Robotics at UCSD understands that the University does not assume legal liability for the actions of the organization.

The org will most likely work with many advanced technical tools such as 3D printer, Lasercamm cutter, and some other machinery. Also, at least 12 members of the org must be able to travel internationally, specifically to China, over summer. Fortunately, the sponsor of the contest has promised to help with any VISA related issues as well as reimbursing 6 org members travel fees and providing local college dorms as places to stay during the contest period.

Triton Robotics will designate a Safety Officer for each project. Safety Officers are responsible for ensuring that all members are properly trained in UC San Diego policies and procedures, including lab policies, and that they have proper training in all machines being used during the project.

ARTICLE VII.

SECTION 1. IN CASE OF INTERACTION WITH MINORS AND/OR THE ELDERLY

Triton Robotics at UCSD is aware that all registered student organizations that serve minors or the elderly have access to training on child and elder abuse prevention for its members via the Center for Student Involvement, online or in person (in person by request only). Triton Robotics will develop plan(s) for activities and events where members will be interacting with minors or the elderly such that members will receive education and/or training on Child Abuse Neglect

Reporting Act (CANRA), common sense measures to both avoid child or elder abuse allegations (i.e. avoiding one-on-one situations; working with minors in plain view of others; limiting calls/texts/social media posts or other communications with minors), and how to properly report potential harm or neglect to minors or the elderly with whom they are working.

ARTICLE VII. SECTION 2. IN CASE OF THE PROVISION OF MEDICAL ASSISTANCE

In the event that Triton Robotics at UCSD provides medical assistance to a community, all volunteers will work under the direction of licensed professionals (doctors, nurses, counselors, etc.). The University does not recommend that students provide medical assistance.

ARTICLE VII. SECTION 3. IN CASE OF INTERNATIONAL TRAVEL

Triton Robotics at UCSD recognizes that the University generally recommends against all international travel by Student Organizations due to the myriad of risks travelers face in foreign countries. Student organizations are discouraged from traveling to foreign countries due to the wide variety of risks involved with foreign travel, and the extensive planning efforts required by the Student Organization's Members to manage those risks. Security risks and health care services vary widely from one country to another, so thorough research on those topics is especially important.

International travelers are advised to research US State Department Travel Advisories and the CDC Travel Health site and abide by all recommended alerts and warnings, and procure travel insurance with medical coverage that covers their chosen destination because most USA Health Plans are not valid in foreign countries.

ARTICLE VII. SECTION 4. IN CASE OF HANDLING OF HAZARDOUS CHEMICALS, MATERIAL, EQUIPMENT, AND/OR MACHINERY

Triton Robotics at UCSD recognizes that all student organization activities must be conducted safely, in accordance with all applicable federal, state and local laws. Additionally, Triton Robotics at UCSD will abide by UC San Diego requirements for students in labs, including policies for minors in UC laboratories, and ensure members receive safety training regarding the use of chemicals and/or machinery before entering the lab. Members must follow any best practices and lab safety protocols for the use of such chemicals, research equipment or machinery, including the appropriate use of Personal Protective Equipment, and should work under close supervision of those trained in the handling of chemicals/use of research equipment or machinery.

ARTICLE VIII. COMMUNITY ADVISOR

Triton Robotics at UCSD selects community advisors based on needs and schedule conflicts. We are students looking to apply our class theories into meaningful projects. Not every student will know the answer to everything so advisors are chosen based on their expertise in a respective field. They will serve annually, and can continue serving as an advisor if desired. Otherwise, the organization will search for another qualified advisor. The role of the advisor is to educate students on topics they are not familiar with and to assist with any conceptual questions.

ARTICLE IX. FINANCIAL MANAGEMENT

Sponsorships and TESC will assist with the funding for this organization. All finances will be relegated to the Finance Team which will be tracked on a document. All purchases will be initially purchased by the members, and reimbursed at a later date. Robomaster, the competition organizer, reimburses a portion for flight expenses, however, the rest of the cost will be covered by the members. If the organization earns any bonus from the competition, a portion of that will be given as a prize to recognized members who contributed significantly during the competition.

ARTICLE X. AFFILIATION WITH OTHER GROUPS

In the case that Triton Robotics at UCSD collaborates with other clubs or organizations, we will respect all persons from their respective organization. We represent a diverse group of engineers who strive to set an example for UCSD students. We have no political, business, or cultural affiliation other than UCSD. Our commitment to excellence is paramount.

[6.4] Mechanism For Team Management

Member Accountability: 3-Strikes Policy

This was created to have a formal due process to address any issues with negative effects on the team caused by members who have either neglected their duties and have not conducted any attempts at communication. We hold all members to abide by this policy.

➔ **1st Strike** - A verbal warning and an opportunity to explain or discuss the source of the problem

➔ **2nd Strike** - (ACTIONABLE) A meeting with administrative leads to work out the situation

➔ **3rd Strike** - Relieved of duties and leadership will assume the individual as missing in action.

FAQ

- **How are strikes incurred?**
  - A member neglects work and does not communicate leading to failure to uphold responsibility within and an incomplete task past an agreed timeframe.
  - A member does not respond to direct attempts of communication for more than a week period.
  - A member produces work that is unsatisfactory or inconsistent with claimed effort within reason.
- **Are you removed from the team after the 3rd Strike?**
  - No, members who violate the 3rd Strike are only first marked as MIA. We believe in our members and acknowledge that life happens. MIA members will not be assigned specific duties however, it is on the individual to look for impactful ways to contribute to the team again and clear their name. If the individual either formally informs of departure from the club or no action takes place within an academic quarter, they will be officially removed.

Member Expectations

- Members are expected to treat their project assignment as professional work and must adhere to the agreed time frame
- Members must turn quality work that meets the expectations of the time allotted and follows all internal documentation protocols
- Members are held accountable for design decisions are expected to address any issues related issues that arise during competition
- Members are expected to let their subteam lead know if they can not make it to a work session at least 48 hours in advance

Project Verification Procedure

1. **Initial Completion:** Sub-project group announces completion of task and submits an **Assembly Checklist** providing a comprehensive documentation of their project and presents to the sub-team lead
2. **Division Lead Review:** After presenting to the original sub-team lead a project proposal is discussed with other sub-team leads and relevant personal for purchasing approval
   a. If project proposal is not up to standard, the project team is sent back to re-work until requirements are satisfied
3. **Captain's Review:** After passing sub-team lead inspection, the captain of the team will review the work, and will give final approval for moving on to purchasing stage
4. **Prototyping Stage:** Initial prototypes are manufactured and tested on satisfying initial design requirements outlined in Assembly Checklist
   a. Sub-project members will spend their time addressing issues that arise until original specification are met
5. **Stress Testing:** Each component or robot is put through its paces in a simulated game time environment where performance metrics will be recorded. Further development is subject to the satisfaction of original design specifications.
6. **Design Finalization Stage:** Component or robot would have been approved for completion and small changes and fixes will then be conducted to finalize the design. The sub-project members will finalize their
7. **Assembly Checklist** adding testing results, documenting issues and such.
   a. All related analysis and documentation are compiled to single storage location
   b. All necessary component files are compiled such as DXFs, STLs, CAD files etc.