Collegiate Aerial Robotics
Game Manual (v1.1)

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The Field

Description

Towers will be played inside of a 27-foot wide by 54-foot long by 12-foot high net (may actually be as high as 16 feet depending on the venue).

On the field, each alliance will have a designated safe zone, marked by tape of the color of their alliance, of 10-feet by-27 feet from where all of their robots will start.

Each alliance will have two towers assigned to them, one short tower and one tall tower, the shorter tower being on the near side of the field, and the tall tower being on the far side of the field. There will be a third tall tower in the center of the field which can only be scored upon after the alliance gains control of their own towers.

The short towers are 4.5' tall, have an loose mesh top to prevent robots from falling inside of the towers, and a 12" diameter hole centered with the bottom of the opening at 3' from the ground on the two faces that are 90 degrees from the alliance stations. The tall towers are the same as the short towers with the addition of a second level, which makes these towers 7' tall with an additional set of 12" openings on the same faces with the bottom of the openings at 5.5' from the ground as the lower level.

The towers all have bases that are designed to distribute balls randomly back onto the field perpendicular to the 12" diameter holes on two faces of the tower. The 12" diameter holes will have a 2" ring of green around the opening to help vision systems on ground robots locate them.

The perimeter of the top tower openings will be surrounded by a 2" wide by 2" tall bar illuminated on the top and outside which will be green, red, or blue depending on the state of the tower.

Tower Vision Target Colors

Vision targets change color during the match to signify different states for different towers.

Before the start of the match, the four alliance towers will be lit red or blue based on who the base belongs to and the center tower levels will alternate between red and blue.

When the matches start, the lights will all change as defined in the sections below.

At the end of the match, all lights will turn off for a period of time and will eventually be set

to the pre-match lighting configuration in preparation for the next match.

Your Own Towers

The towers of an alliance will start the match green, change to the color of the alliance when "charged" and return back to green if they are "discharged" by the opposing alliance. The towers of an alliance will turn off while the center tower is activated for them and return to green after their time with the center tower activated is done.

The Center Tower

The center tower top vision target remains green for the entire match, the ring of vision target lights on the first level starts the match turned off.

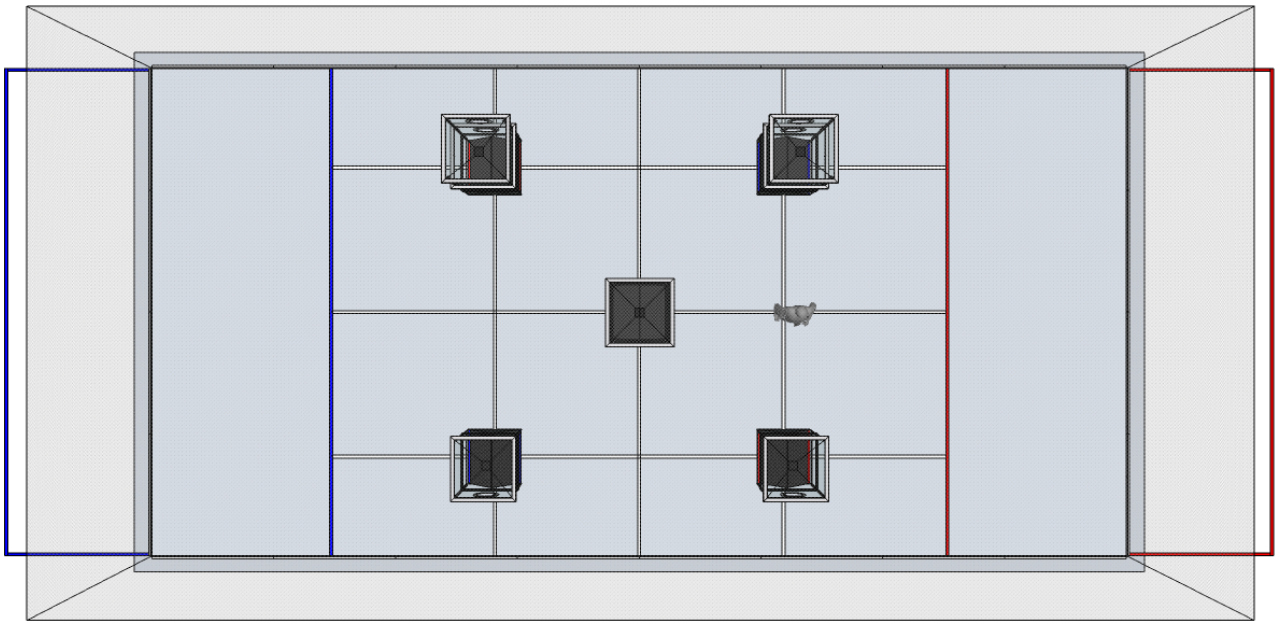
If an alliance "charges" both of their towers which activates the center tower, the lower ring will illuminate with the color of that alliance. When the time for a alliance's activation of the center tower shows 5 seconds remaining, the lower level of the tower will begin to alternate on and off for half second periods in each state. In the last second, the light will skip the off cycle, meaning at the end of the tower being active the light will be on for 1.5 seconds.

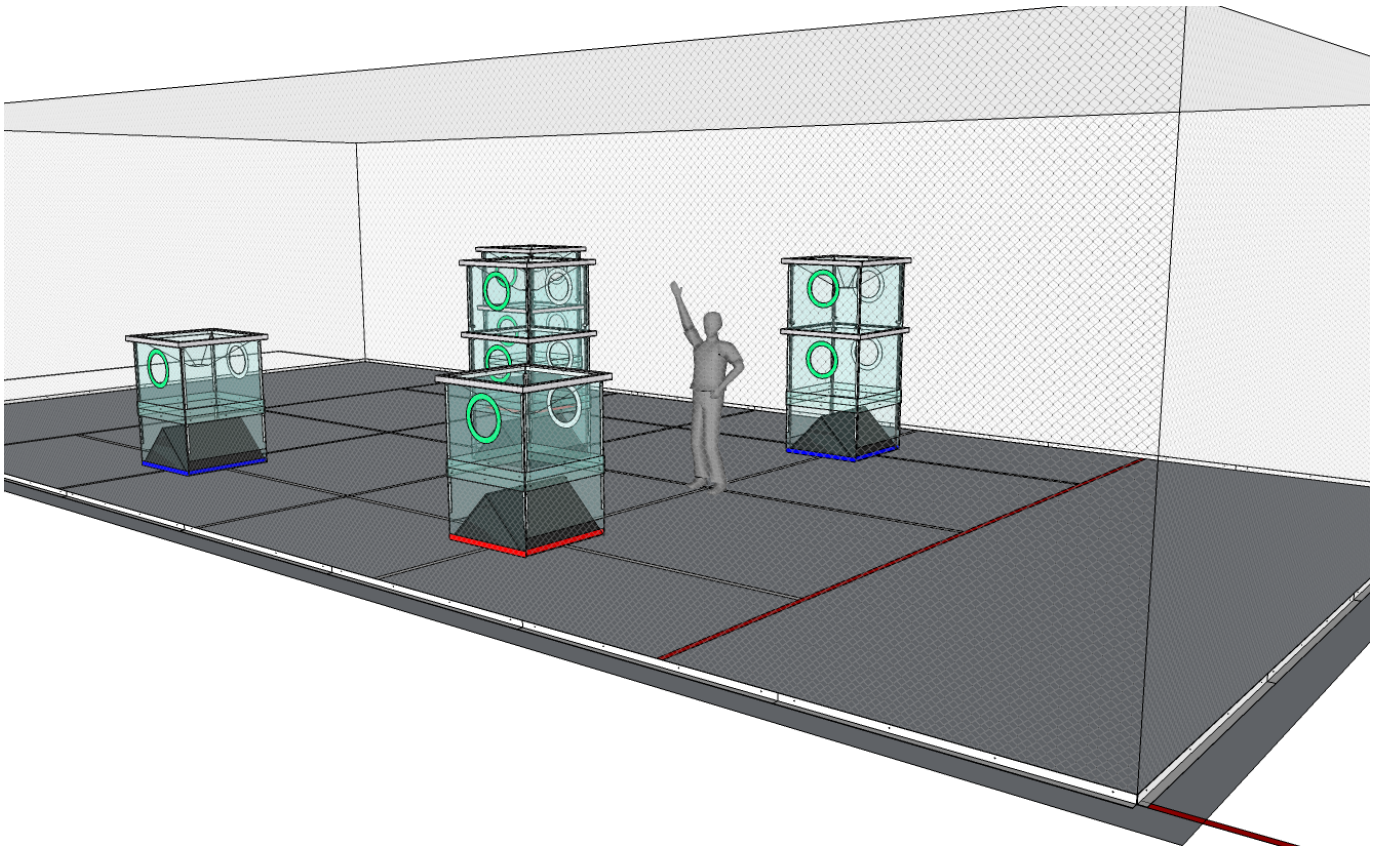
If the center tower is active for both alliances the lower ring will be purple. The warning sequence is the same as described above except it will alternate purple and the color of the alliance whose time is not expiring. If red's time is expiring that means it will alternate purple and blue until it stays blue following 1.5 seconds of purple at the end of the countdown.

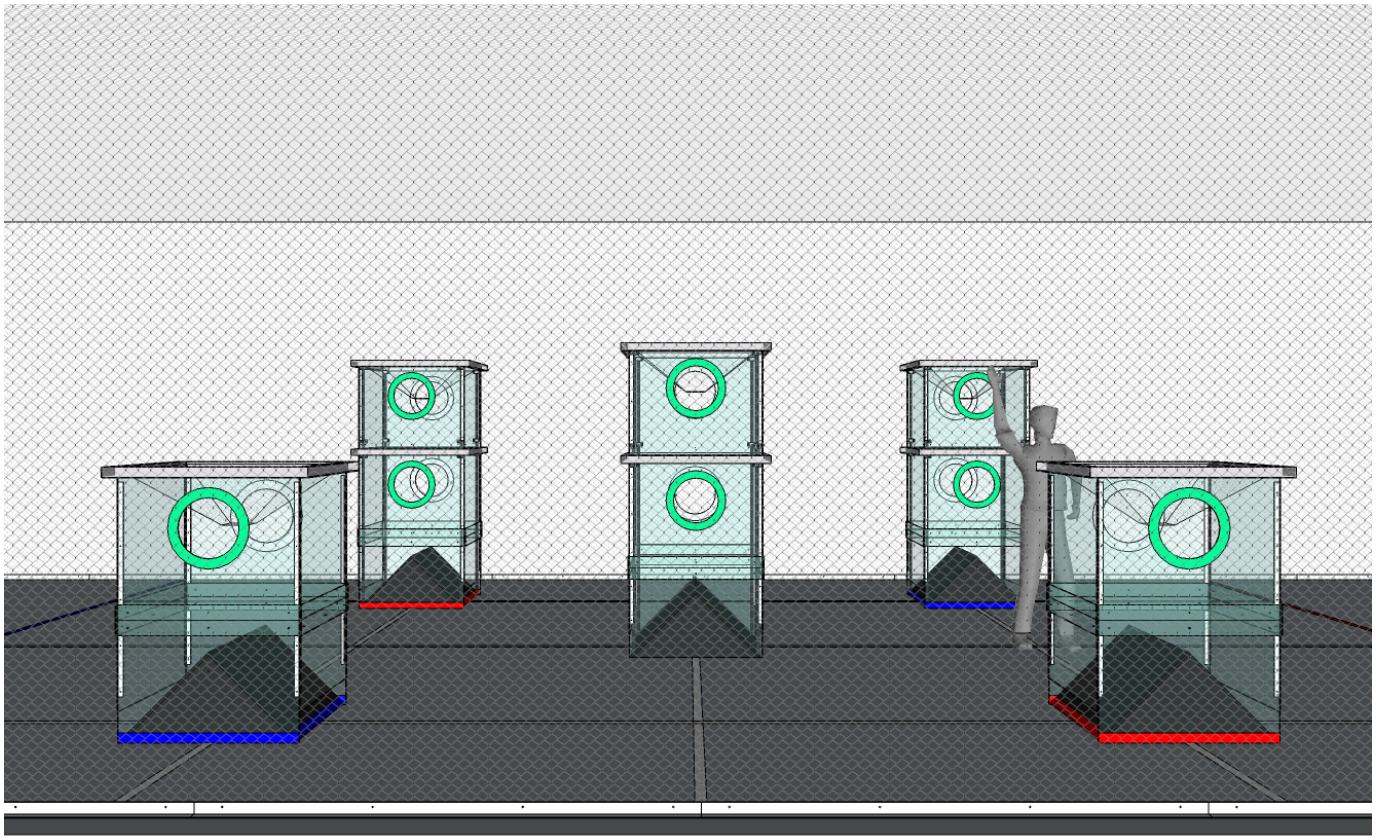
Renderings

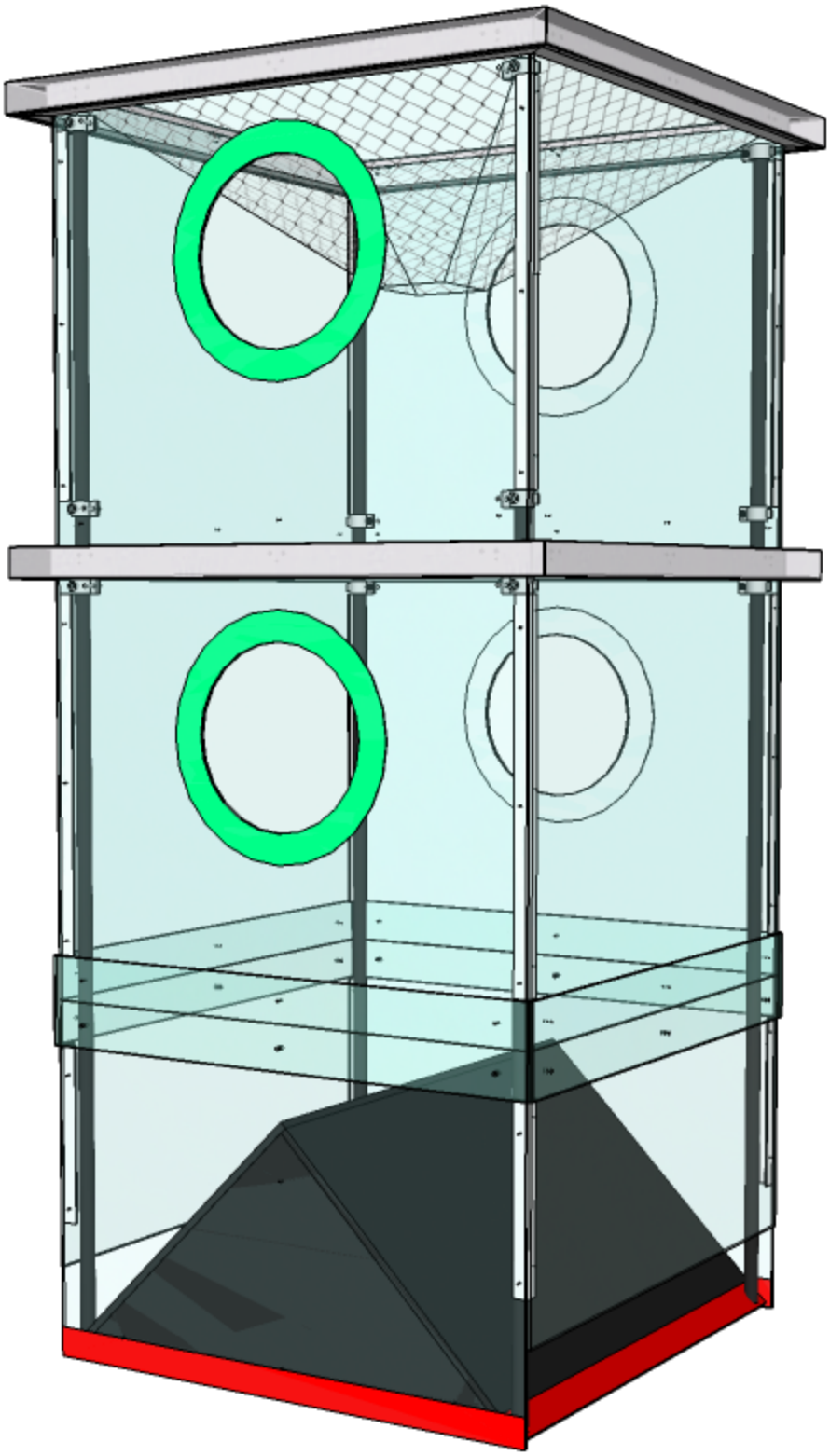
Additional videos, images and google sketchup files can be made available by request.

Video: Rendered fly by of field









Game

Overview

Two alliances consisting of two randomly paired teams, each provide a ground vehicle and an air vehicle for a match (meaning there will be up to 8 robots total on the field per match). Matches last 2 minutes and 30 seconds with the last 30 seconds being designated as the end game period.

During the match, both ground and air vehicles must obtain and manipulate tennis balls to score on their alliance towers, which concurrently "charges" the center tower. Robots may assist other robots on their alliance in obtaining game pieces during the match and there is no limit to the number of game pieces that can be possessed simultaneously after the start of the match.

Scoring

Points are scored by 1) ground vehicles shooting tennis balls into the holes in the sides of active towers and 2) air vehicles dropping tennis balls into the top of active towers.

For all towers when activated:

- 5 points for a ground vehicle shooting a tennis ball into a first level.
- 10 points for a ground vehicle shooting a tennis ball into a second level.
- 20 points for an air vehicle dropping a tennis ball into the top of a tower.

A tennis ball will only score if it was put into motion from deliberate possession of a robot prior to entering the tower. If a tennis ball is shot by a robot, bounces off of a robot from the opposing alliance and goes in the goal, the robot who had initially started the ball in motion from possession would score. If a tennis ball gets caught in a collision between two ground vehicles and pops up into a tower, neither alliance would score.

Bonus points can be scored at the end of the match by landing an air vehicle on top of a ground vehicle inside of their safe zone. If an air vehicle is 1) touching nothing but robots, 2) the lowest point of the air vehicle is at least 1-foot off the ground, 3) the air vehicle is not hovering, and 4) the air vehicle is fully inside of the safe zone, then the alliance is awarded 50 bonus points. The landing action has to start during the 30 second end game period. If an air vehicle is in a "bonus points position" when the timer shows 30 seconds, the air vehicle must take off and leave the safe zone before attempting to land again for the end game bonus. Failure to do so will result in no bonus points awarded to the alliance.

Charging and Activating Towers

At the start of the match your own towers are active for scoring. Each time you score in one of your towers it "charges" the lowest "uncharged" level, which then deactivates that level from scoring for a period of time. This means any score on the short tower means the tower is then "charged" which deactivates that tower. After two scores on the tall towers, the tower is "charged" and deactivated, with the second score needing to be through the second-level hole by a ground vehicle or dropped in from above by an aerial vehicle.

The opposing alliance can score into a "charged" level to "discharge" that level, but no points are awarded for this action. Scoring into the lower level of an apposing alliance's fully "charged" tall tower will not "discharge" any levels, the upper level would have to be "discharged" first.

When both of an alliance's towers are "charged" simultaneously, the center tower becomes active for that alliance for 30 seconds and does not deactivate after any scores. Alliances can gain points quickly by scoring many times on the center tower while it is activated for their alliance. There is no de-scoring or de-activating of the center tower. Once the center tower is "charged" for an alliance, the alliance's towers will "discharge" and remain deactivated until the time period for access to the center tower expires.

The center tower may be active for both alliances at the same time. If the second alliance activates the center tower within five seconds of the first alliance their timer for control of the center tower will be set to the amount of time left on the first alliance's center tower timer plus five seconds so that the warning sequence for the end of the activation time will not overlap.

Match Start

Before the start of the match, roughly 50 game pieces will be scattered on each half of the field for a total of 100 game pieces in each match.

Alliances will be allowed to load up to three (3) of the tennis balls from their safe zone into each of their air vehicles (up to six [6] total for an alliance). Aside from the aforementioned allowances on tennis balls per air vehicle, no tennis balls may be in contact with the robots.

G-1.1 Repositioning Game Pieces

Alliances may not move game pieces around to give themselves an advantage before the match starts. If a referee believes that an alliance has intentionally moved a game piece to gain an advantage, the referee will reposition any game

pieces they see fit to eliminate the perceived advantage.

G-1.2 Robot Starting Position

Robots must start completely inside of their safe zone (which includes the width of the tape). If they are deemed to be over the far end of the tape by a referee, the referee will reposition the robot so that it is roughly in the same orientation, but within the safe zone.

Rules

Failure to comply with any of the rules outlined in this document will result in repercussions ranging from a warning or 10-point penalty for incidental, inconsequential and quickly remedied violations, to 50-point penalty, disqualifications from a match for a team and/or disqualification from the competition for a team.

Referees are the sole judges on what is "incidental, inconsequential and quickly remedied" and their word is final. Repeat violations (even if you state that they are incidental) will likely result in disqualifications.

G-2.1 No landing on towers

Air vehicles may not land on top of any towers' protective netting at any point during the match.

G-2.2 No goal-tending

Air vehicles may not hover over or impede access to a tower when not currently in the process of scoring, particularly when the tower is not active for your alliance.

G-2.3 No shooting at air vehicles

Intentionally shooting tennis balls at an opposing alliance's air vehicles is strictly forbidden. While incidental hits may occur and should be planned for, intentionally targeting opposing alliance air vehicles will not be allowed.

G-2.4 No entering into opposing safe zone

Air vehicles and ground vehicles may not cross the outer edge of the tape that marks the border of the opposing alliance's safe zone at any point during the match.

G-2.5 No damage to the netting

Contrary to last year, there will likely be no hard barrier around the perimeter of the field. Therefore, it is important that ground vehicles especially avoid contact with the netting as much as possible.

G-2.6 No damage to the field

Robots are not allowed to attach or grapple or grab any field elements or carpeting and are to not damage the field or its elements.

G-2.7 Expanding past the allowable dimensions

Robots are not allowed to expand past the dimensions specified in the “Robots” section of this manual.

G-2.8 No air vehicle to air vehicle contact

Air vehicle to air vehicle contact is prohibited. Teams should have enough control over their air vehicles to prevent most collisions.

G-2.9 No causing damage to ground vehicles

Air and ground vehicles may not contact ground vehicles in a manner that is likely to damage the opposing alliance's ground vehicle or force the opposing alliance's ground vehicle to cause damage to the field (example: pinning into the net). It is legal to push ground vehicles and to obstruct ground vehicles, but ramming and pinning ground vehicles is prohibited as it runs afoul of the first part of this rule.

G-2.10 Drawing penalties

A robot may not cause the opposing alliance to commit a penalty. For example, flying over an air vehicle of the opposing alliance that is in the process of scoring in an attempt to try to get the opposing alliance's air vehicle to get a G2.1 penalty.

Robots

Starting Size

R-1.1 Ground Vehicles

At the start of the match, each GV must fit, unrestrained, into a box no larger than 3ft x 3ft x 3ft. Nothing may exceed this box at the start of the match (no bolt heads, nuts, rivets, etc).

R-1.2 Aerial Vehicles

At the start of the match, each heavier-than-air AV must fit, unrestrained, into a box no larger than 3ft x 3ft x 3ft. As with the GV nothing may exceed this box. Lighter than air AVs must fit, unrestrained, within a box that is 3ft x 3ft x 6ft; as before nothing may exceed this box.

Playing Size

R-2.1 Ground Vehicles

During the match, while a GV is fully within it's safe zone it can expand past the starting size restriction in all dimensions. On the rest of the field the GVs may expand in width and length but must be no taller than 3ft.

R-2.2 Aerial Vehicles

AVs can expand in all dimensions regardless of their position on the field.

Weight

R-3.1 Ground Vehicles

GVs are limited to 60lbs maximum weight, which includes everything on the robot as it plays in a given match. The parts that you have on your robot can change from match to match as long as the GV weighs less than or equal to 60lbs each time it enters the field. For major robot modifications, the robot may have to pass a re-inspection to ensure safety and rule compliance.

R-3.2 Aerial Vehicles

AVs have no weight restriction.

Team Numbers and Alliance Colors

R-4.1 Ground Vehicle

Your team number must be displayed in enough places to make it easily viewable from any standing position around the robot. The number should be clearly legible from 100ft away. It is recommended to use numbers no less than 4" tall with a ¾" pen stroke located on all sides of your robot. Ground vehicles will also be required to display their alliance color (red or blue) for each match. The method by which you display these alliance colors is up to you, but it must be clear from all sides from no less than 100ft away.

R-4.2 Aerial Vehicles

AVs will need to clearly display their alliance colors and team number such that it is easy for the audience and announcers to tell which AV represents which alliance and team. AVs will also have to clearly display their alliance color (red or blue) for each match. The method is left to the team's discretion such that the alliance color is clearly visible from all sides and from no less that 100ft away.

Budget

R-5.1 Each Robot Separately

For each match, each robot on the field must cost no more than $2,000.00. A detailed budget with a parts list and associated costs is required for each robot. For the purposes of this budget, the fair market price of all items must be listed, regardless of the price that your team paid (if you get something sponsored you still have to record and account for its full price).

Safety

R-6.1 Robots must not be unsafe to operate

Safety is of the utmost concern. If at any point your team or your robots are viewed to be unsafe by the Head Referee, Lead Inspector and/or the Planning Committee Chairs, sanctions will be imposed. Sanctions can range from not being allowed to play in a match to removal from the event. All AV propellers must have safety fences so that the AV could potentially fly into a wall and not break a prop or fly into a person and not cause injury. You may be asked to demonstrate your safety systems during the inspection process. All pinch points, chains, flywheels and other hazards must be covered and protected. No exposed flames are allowed.

R-6.2 Lasers

No visible or harmful lasers will be allowed. If you want to use a laser of any sort, be ready to prove that it is safe for people to be interacting with that laser. Safety data sheets are a great way to prove this. In general, Class I lasers are the limit of acceptable use in this competition.

Batteries

R-7.1 Lead Acid batteries

Lead acid batteries must be factory sealed and non-spillable, having no visible defects.

R-7.2 Lithium-Polymer

Please be safe! These batteries are very dangerous if mishandled. Battery status devices are highly recommended to track the voltage in each cell of the battery, and to warn you if the voltage in the battery drops below the critical level. It is also highly recommended that you follow all other best practices such as storing and charging in proper Li-Po charging bags designed to reduce the damage caused by a battery should a battery fail.

Radio Communications

R-8.1 5GHz

We will be providing a 802.11n at 5GHz network which will be the suggested network for teams to use and we will do what is necessary to make it so that people who want to use the 802.11n at 5GHz network can do so (including requesting that teams who bring devices that interfere with the provided 5GHz network figure out a way to replace the devices).

R-8.2 2.4GHz (WiFi)

We will be allowing and providing 2.4GHz at the event, though using it and any devices that operate at 2.4GHz will be at your own risk with regard to interference.

R-8.3 Implementation

As with last year, the networks will be wired to Ethernet switches at each alliance station. There may be measures in place to prevent teams from staying connected to the wireless networks when they are not on the playing field, but even if there are not measures in place, it should be expected that teams will not be connected to the network except from several minutes before their match until the end of their match, so it is suggested that teams figure out a way to tether their robots or use an alternate frequency for practice. We may sanction the creation of an alternate 802.11n network for use while not on the playing field.

R-8.4 Other Frequencies

Teams may also use other frequencies or other connections to communicate with your robots. It is highly recommended that you use the provided hardware if you are going to be operating over a WiFi network. However, we do realize that various 2.4GHz and other non-licenced frequency hardware cannot be run through a standard router (Spectrum R/C transmitters/receivers, etc.) and for these, it is perfectly acceptable to use the devices in their stock conditions at your own risk provided they do not interfere with any other robots or devices present at the event.

Inspection Process

R-9.1 Practice Inspection

Before a team may operate their robot in either the practice area or on the competition field, they must pass a safety inspection. This will holistically look at the robot for safety concerns including but not limited to:

- Pinch points
- Safety guards
- Prop fences
- Sharp points/corners/edges
- Safe and reliable communications

R-9.2 Full Inspection

Before a team can score any match points during the qualification rounds, they will need to pass a full inspection where they will be checked for compliance with all the rules, including starting size, weight, budget, and safety.

Tournament

The competition will consist of two portions; the qualification rounds and the tournament bracket. The qualification rounds will be a rotating match schedule in which teams will be paired with and against as many different teams as possible. The goal in qualification is to gather Match Points by consistently having robots on the field participating in, and winning matches. The tournament bracket will consist of matches with fixed alliances playing in rounds that are a best of three matches.

Qualification Rounds

During the qualification rounds teams will be participating in scheduled matches with a variety of other teams (as listed in the schedule provided in teams registration packets). These matches are pseudo-randomly generated to diversify alliance pairings and prevent back-to-back matches.

Match Points

In each qualification match, the teams that are competing on the field have the opportunity to score match points. These will be the basis for how teams are ranked for their performance in qualification matches. In the event of disqualification from a match, the penalized team will receive zero match points for that match. Match points will be awarded to teams for each robot the team (not the alliance) has on the field as follows:

- 4 pts/robot for a win
- 2 pts/robot for a tie
- 1 pt/robot for a loss (but showed up to the scheduled match)

Rankings

Throughout the qualification rounds, teams will try to gain as many match points as possible, after each match a new set of rankings will be posted, ranking teams by the following criteria:

a. Sum total of accumulated match points
b. Highest match score

Ranking Tiebreaker

If at the end of the qualification rounds, any teams are tied in both match points and highest match score and are in one of the alliance captain positions, a diplomatic method for breaking the tie will be decided by the planning committee before the start of the tournament rounds.

Alliance Selection

Based on the number of teams attending the event, the number of alliances for the tournament rounds will be selected so that the greatest number of teams can participate in tournament matches. At the end of the qualification matches, the top ranked teams will select their alliance partners for the tournament matches. The selection process will begin with the top ranked team followed by the 2nd place team and so on. Teams that are designated as alliance captains cannot select other teams that hold alliances captain positions. Selections will continue until the last alliance captain has selected their first alliance partner and at that point selection will continue in reverse order from the lowest ranked alliance captain to the top ranked alliance captain. In the event that an alliance has more than two teams, it will be up to the alliance captain to select which robots will participate in any given match (any four robots from the alliance teams could be used so long as there are two GVs and two AVs).

Tournament Bracket

Based on the number of teams attending the event and the number of alliances formed from alliance selection, an appropriate bracket will be created for the tournament rounds. Each match-up in the bracket will be a best of three series. If the number of alliances is not an exponent of two (i.e. 2, 4, 8) the lowest seeded alliances will face off in a sub-bracket to find the top 2, 4 or 8 alliances.

Tournament Alliances

Similar to last year there will be an opportunity for teams/robots from the losing alliances to join forces with the winning alliances to take on their next opponent.

Awards

CAR Values

The CAR Values Award is presented to the team who in the judges best estimation has truly achieved the goals of CAR. This team has been out in their community, and actively worked to bring today's culture to a greater appreciation of STEM. This team's influence is very very clear on their community, and perhaps the communities of others as well.

CAR exists to bring college students together, to learn about working together, and accomplishing goals. The robot is what brings us together, but the ultimate goal is to build teamwork skills, and change the culture to be one more appreciative of engineers, scientists, technologists, and the like. Part of any major project is recording the process so it may be repeated, and re-told. This holds true for CAR, as such you are expected to document your process and progress thoroughly.

The CAR Core Values Award is a multi-faceted and complex award covering many areas of expertise. The following are some of the things that judges will be evaluating to determine the winner:

- How strongly does the submission document the impact CAR has on the learning experience of the students, school curriculum, engineers, and/or community during the 2013 team year as well as in prior years?
- How has CAR effected the students involved? Has it aided them in their studies, been a motivating factor? Is there any integration with the home university (classes added, etc)? Has outreach to the community aided said community in any significant way?
- Has the team explained/demonstrated why/how it should be a role model for other CAR teams to emulate?
- How well has the team communicated its excitement and impact within the entire school, community, and beyond (state/nation) through participation in CAR during the 2013 team year as well as in prior years?
- Has the passion of the team become apparent in the community (Immediate, or distant)?
- Has the team documented an innovative way to spread the influence of STEM?
- How strong of a year-round team partnership effort is reflected during the 2013 team year as well as in prior years? (You can define partnership in many ways, including: the partnership among the team's students/corporate sponsor/engineers; school/university sponsor/engineers; students/adults; community/team)

- Does your team remain strong all year long? How is the team's relation to interested parties? (Mentors, Sponsors, University, etc)
- What did the team do to grow CAR In the past year (through starting/supporting newer teams, fundraising, etc)

As a whole, does the content of the documentation exemplify the true meaning of CAR?

The CAR Core Values Award submission should include documentation for all the above factors.

Submissions must carry the following information:

Brief Summaries:

- Team name
- School/City
- Sponsors
- Briefly describe the impact of the CAR program on team participants with special emphasis on the 2013 year (200 words allowed)
- Explain why your team is the team that every other should strive to be more like (200 words allowed)
- Describe the impact of the CAR program on your team and community with special emphasis on the 2013 year (200 words allowed)
- Team's innovative methods to spread the influence of STEM (200 words allowed)
- Describe your team's year-long efforts and relations to interested parties (200 words allowed)
- Other matters of interest to the CAR judges, if any (100 words allowed)
- Upload pictures (maximum of 5 allowed)

Essay:

- Essay (2000 words allowed)

Best Design Report

The purpose of this report is to outline the team's work over the season in the development of their robots and creation of interesting and novel engineering solutions.

Maximum number of pages in Report: 10

Recommended Headings:

- Abstract - 1 page max
- Design Description - present various design alternatives, include drawings, photographs and other visuals
- Performance analysis, solutions to problems encountered
- Innovative features
- Robot cost
- Safety features
- Team members, mentors, and sponsors: roles and contributions

Deadline: Teams should turn in the Design Report 1-2 days before competition. Teams may also create a paper, poster, or electronic poster based on the Design Report to present it during the competition.

Most Innovative Aerial Vehicle

Awarded to the team which demonstrates creativity, ingenuity and novel engineering approaches in the implementation of their aerial robot.

Most Innovative Ground Robot

Awarded to the team which demonstrates creativity, ingenuity and novel engineering approaches in the implementation of their ground robot.

Love of the Game Award

The Love of the Game award is given to a team that shows exemplary passion in supporting their peers and supporting each other. They are often the loudest, most visible team at the competitions, cheering for themselves, and when appropriate, their peers. The team is constantly seen actively cooperating in the pits by offering their assistance to whoever needs it.

GV/AV Cooperation

Awarded to the team which implements a successful, innovative, or effective collaboration between ground and aerial vehicles.

Team Marketing

This team is shown to have the greatest presence at the event. They show this through coordinated dress, loud cheering, banners, pit decorations, and always being noticed. Their enthusiasm for the competition is extraordinary and their spirit excels through exceptional partnership and teamwork.

Committee Support Award

This is the team who, in the committee's best estimation, has provided the most

support in planning and executing the event. Teams who had members assist the CAR planning committee are eligible to win this award.

Tournament Winner (1st Place)

These are the teams in the original alliance that wins the tournament rounds.

Tournament Runner Up (2nd Place)

These are the teams in the original alliance that places 2nd during the tournament rounds.

Safety Award

This award goes to the team that best demonstrates safety practices throughout the competition.