IEEE SoutheastCon 2023 Hardware Competition

Hurricane Alley

"CAT5 Robots Rebuild the Magic at Duck Gardens"

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Preface - Concept Release

Welcome to the first release of the SoutheastCon 2023 Hardware Rules. This release is a concept release. The purpose of this release is to provide a textual and visual aid for the competition rules. Readers should consider the descriptions, visual components, and dimensions as rough concepts. The next phase of the competition rules development includes analysis and testing of the concept to determine the feasibility of the concept, fine-tune details, and determine which are the best design methods which will best help the robot accomplish this challenge. I will lead a design team to build the board, analyze the concept, fine-tune the details, and provide refined rules by August 2022 with the goal of a final release by November 2022. Since the requirements are being analyzed, you should not consider these rules to be final. You should not build competition boards or robots based on this release of the rules. I am looking forward to your input on this release. I encourage you to provide your questions and comments directly to me.

Welcome to Duck Gardens, the IEEE Orlando Theme Park!

Thank you,

Stephen Hopkins

SoutheastCon 2023 Student Programs Chair

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I. Introduction

Orlando has been hit by a hurricane. The hurricane has left some damage and stranded animals at the IEEE theme park Duck Gardens. IEEE Region 3 is working to fix the damage, save the animals, and re-open the magic of Orlando. There is a lot of work that is time-consuming and guests are waiting to drive and fly to Orlando. We need autonomous robots that can help animals, clean up debris, and rebuild Orlando. Luckily, IEEE is rolling into town for an annual conference. IEEE Student Teams are bringing their CAT5 Recovery Robots to recover Duck Gardens Orlando. Their robots will have several tasks to pick from to help rebuild the magic. The robots may do them all or as few as they would like to.

II. Playing Field

The main course is constructed of a 4' x 8' sheet of plywood with a boundary of 1' x 4' wooden beams on three sides and 2 – 2" x 4" x 4' wooden beams on one end. The entire course is painted black. Figure 1 includes the design of the board. Figure 5 includes a photo of the concept. The board should be sanded before being painted.
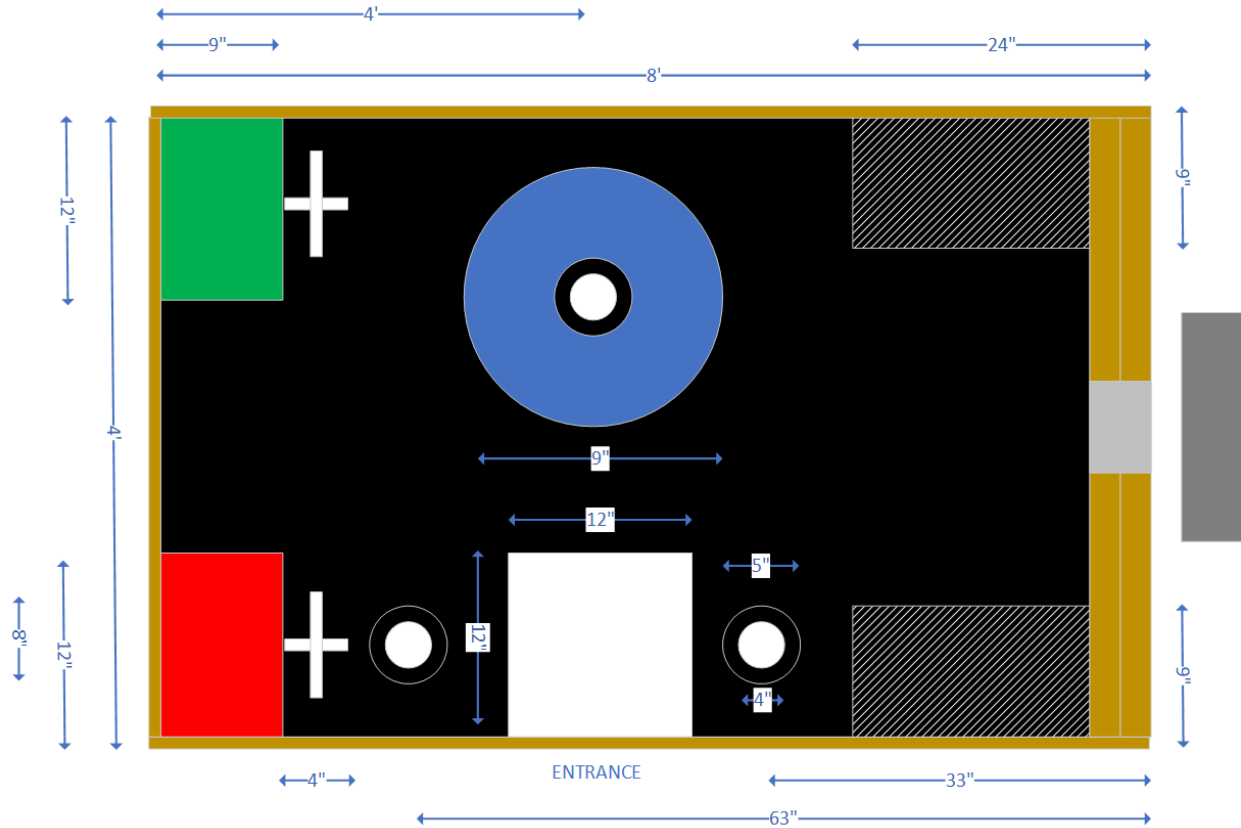
Figure 1 Board Design (Concept not final dimensions)

Table 1 Board Design Legend

Board Component	Description
Duck Gardens Theme Park	4' x 8' arena
Green Rectangle	Manatees Aquarium Attraction
Red Rectangle	Alligator Aquarium Attraction
Blue Circle	Duck Pond Attraction
Black and White Circle	Duck Statue Attraction
Rectangle with Diagonal White Lines	Recycling Attraction
Light Grey Rectangle	Switch Box for Fireworks
Dark Grey Rectangle	Fireworks Display Computer

Figure 2 Duck Gardens Concept Photo

III. Objective

Teams will build a robot that operates inside Duck Gardens. Unfortunately, the roads are damaged. Most of the lines on the road are washed away. A few broken lines remain. The hurricane forced the ducks out of the duck pond and knocked over the three duck statues. The ducks and statue pieces are scattered throughout the park. The park includes manatees and alligators. The manatees are safely in their pen but are hungry. The alligators are in their pen next to the manatee pen. The alligators are hungry as well. The robot will navigate the park feeding the manatees, feeding the alligators, moving the ducks back to the pond, rebuilding the statues, and placing the remaining pieces in the recycling bins. In customary theme park

tradition, the robot may end their cleanup by starting the daily fireworks! The robot may do any number of tasks in any order.

Hurricane Damage

The ducks, Figure 3, have been blown all over the theme park. None of the ducks are located inside any attraction. There is no rhyme or reason as to how they are laying on the ground. No ducks are within 2" of an outside wall. There are no ducks within 14" of the theme park entrance. This means the robot can move left towards one end or right towards the other end without running into a duck. There are 10 ducks in the theme park. One of the 10 ducks is a pink duck. To accomplish the placement of the ducks, the pit crew will randomly toss the ducks into the arena.

Figure 3 Duck Gardens Duck

Ducks measure 3-1/2"L x 3"W x 3"H, are weighted and balanced to float upright, and sealed to block out moisture. Table 2 includes a sample source list for ducks.

Table 2 Duck Source

Duck Source List
https://www.amazon.com/Classic-Yellow-Rubber-Ducky-Schylling/dp/B000K21D4K

The statue pedestals, Figure 4, are cylinders. There are seven statue pedestals. Three are white, two are green, and one is red. The three white statue bases are the bottom pedestals for each statue. The two green pedestals are the second level for two of the statues. Those two statues are the ones to the left and right of the robot's starting position. The red statue pedestal is the third level of the statue in the duck pond. There is no rhyme or reason as to how they are laying

on the ground. No pedestals are within 2" of an outside wall. There are no pedestals within 14" of the theme park entrance. This means the robot can move left towards one end or right towards the other end without running into a duck.
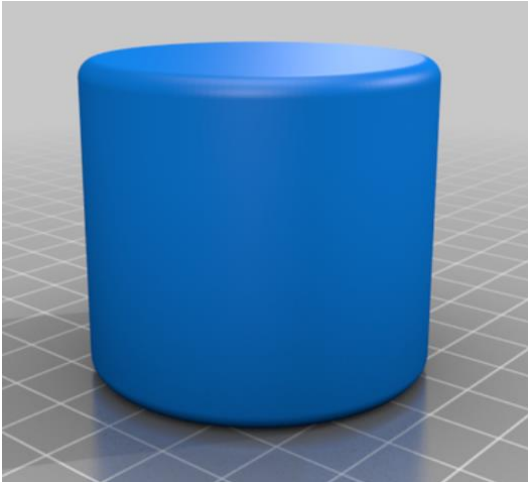

Figure 4 Duck Garden Statue Pedestal
source: https://www.thingiverse.com/thing:4869571

The statue pedestals are made with TPU 1.75 mm diameter filament. The 3D Print file is located at https://www.thingiverse.com/thing:4869571 (edited). The only change made was to change to use 10% infill. TPU is not the standard print material. So, some of you may not have that in your maker spaces. It is also a finicky material to print, so make sure to read up a little bit before you try it for the first time. Table 3 contains a TPU filament source list.

The following details the settings from a successful print with a Prusa MK3+ using the setting Saintsmart TPU material. ALL speeds set to 20mm/s. Retraction is set to 0. Load the filament with Flex setting of the Prusa. Finally, the gears pulling in the filament must be on the loosest setting you can have without the screw falling out. The main issue is to prevent the extruded from clogging. If your print has a bubbly texture on the top, add more top layers and cover the printer with a cardboard box during printing. Printing one pedestal takes a little over 4 hours.

Table 3 TPU Filament Source

TPU Filament Source List
https://smile.amazon.com/dp/B07VGVW546/ref=cm_sw_r_oth_api_glt_i_W6VNWB9A54MNY1XF7N4W?_encoding=UTF8&psc=1

Duck Garden Attractions

Duck Gardens is a 4' x 8' theme park. The entrance to Duck Gardens is on one 8' side of the park. The entrance is located halfway along the side. The gates are closed during hurricane recovery. The robot will start just inside the entrance on a 12" x 12" square white square painted on the black painted board. The robot must fit in this 12" x 12" square and be no taller than 12". The left end of the park includes the manatee and alligator aquarium attractions. The right end of the park includes the recycling and fireworks attractions. Directly in front of the robot's starting position is the duck pond attraction. There are three duck statue attractions, which are pedestals with a duck on top. One duck statue is located in the center of the pond. The other two duck statues are on the left and right sides of the robot's starting area.

Duck Statues

There are three duck statue locations at Duck Gardens. Two statue locations are on either side of the robot starting location. The third duck statue location is in the center of the duck pond. Each duck statue location is a circular area with two rings. The inner ring has a radius of 2" from the center and is painted black. The outer ring has a radius of 2.5" from the center and is painted white. The robot can choose to rebuild the statues. The duck pond has three pedestals. The other two statues have two pedestals. The three duck statues have a duck on top, leaving seven ducks for the duck pond. Each completed statue has a duck on the top of the highest pedestal. The duck pond statue is supposed to have a pink duck on top. Robots placing the pink duck on

top of the duck pond statue are awarded more points than placing a non-pink duck. Any duck placed on top of a statue is awarded points. Statues do not have more than one duck on top. The duck pond statue is centered in the duck pond 12" from the wall opposite of the park entrance and 28" from either outside end of the park. The statue placed to the right of the robot's starting area is centered 6" from the park entrance side of Duck Gardens and 33" from the far-right side of Duck Gardens. The statue placed to the left of the robot's starting area is centered 6" from the park entrance side of Duck Gardens and 33" from the far-left side of Duck Gardens. The robot may only stack one statue at a three-pedestal height.

Robots building statues inside the inner ring without the statue touching anything outside the inner ring will receive the most points. Lesser points will apply for statues built entirely within the outer ring. Lesser points will apply for statues built anywhere else.

Manatee and Alligator Aquariums

The manatee aquarium is a 9" x 12" rectangular area in one corner on the left side of the park. The manatee area is painted green. The alligator aquarium is a 9" x 12" rectangular area in one corner on the left side of the park. The alligator area is painted red. The 12" side of the aquariums runs along the left side of the park. One aquarium is nearest one corner and the other aquarium is nearest the other corner. Some boards swap the location of the alligators and manatees. The robots must detect where each aquarium is located to correctly feed the manatees and alligators. Your robot will be randomly assigned a particular board configuration for each match. On the interior 12" side of each aquarium is a white cross painted on the arena floor. The white cross is composed of an 8 line and a 4" line. The 8" long line runs parallel along the 12" side of the aquarium and is centered 2" from the edge of the 12" side towards the center of the board. The 4" line is perpendicular to the 8" line and centered a 6" along the 12" side of the aquarium. There will be three green food chips and three red food chips on the board next to the robots' starting space. The three green food chips are for the manatees. The three red chips are for the alligators. The teams will be allowed to pre-load the food chips in the robot before the match start. The robots will put the food chips in the aquarium(s). Robots will be awarded more points for putting the correct food chips in an aquarium. Any food chip in any aquarium will be awarded points. The robot does not have to feed either aquarium. The robot may feed one aquarium and not the other.

Figure 5 Food Chips

Table 4 Food Chip Source

Food Chip Source List
https://www.amazon.com/Fun-Express-59-3086-Stackable/dp/B005HPXAFA/ref=sr_1_7?keywords=counting+chips+1%2F2+inch&qid=1648758996&sprefix=counting+chips%2Caps%2C98&sr=8-7

Duck Pond

We need to clear the park so everyone can get back to the magic at Duck Gardens. Robots will relocate the ducks back to the duck pond. Robots will pick up ducks and place them in the pond. Robots may place 0 to 10 ducks in the pond. If the robot is placing ducks on tops of statues, then a maximum of 7 ducks will be available for the duck pond.

Recycling Attraction

There are two recycling areas in Duck Gardens. Each recycling area is a 18" x 12" rectangular area in each corner on the right side of the park. The recycling area is painted with diagonal white lines. Points will be given for moving the unused or never used items into either recycle bin. The robot may place any or all food chips, pedestals, and ducks in the recycling area.

Fireworks Attraction

The right end of the park is where the fireworks is located. A light switch is mounted horizontally on the 2 – 2" x 4" x 4' wooden beams in a metal electrical box. The electrical box is a 1-gang gray metal new work/old work standard electrical box. The box is a 4" x 2" x 1.875" deep and the capacity is 13.0 cubic inches. The switch is connected to a small projects board which is designed to activate a video of fireworks on a computer. When finished with all chosen

tasks, the robot may, but is not required to, flip the switch and activate the fireworks attraction. Fireworks will display on the attached computer screen. The fireworks video will run for 5 seconds. The video is in mp4 format. Duck Gardens includes a complimentary fireworks video which any robot can use. Table 5 contains an electrical box and switch source list.

The design of the projects board, which is likely to use an Arduino or Raspberry Pi, will be provided at a later release by August, 2022. Duck Gardens will provide the project board(s) at the competition. You may not use your practice project board during matches.

Teams are encouraged to make your own fireworks video to play during your matches. The video must be in mp4 format and 5 seconds long. All submitted fireworks videos will be judged and the top three selected for awards. This is a separate award than the hardware judging. Teams are encouraged to demonstrate your school spirit in your videos. You will be required to submit your fireworks video at least 30 days prior to the competition. Judges will review and approve your video for use in the competition. You will be able to redesign and resubmit videos until the deadline for videos passes.

Table 5 Electrical Box and Switch Source

Electrical Box and Switch Source List
https://www.lowes.com/pd/RACO-1-Gang-Gray-Metal-New-Work-Old-Work-Standard-Handy-Ceiling-Wall-Electrical-Box/1098497?cm_mmc=shp-_-c-_-prd-_-elc-_-ggl-_-LIA_ELC_206_Conduit-Fittings-Boxes-_-1098497-_-local-_-0-_-0&ds_rl=1286981&gclid=CjwKCAjwopWSBhB6EiwAjxmqDZo3tUCFv32moaWrwiZIKtTeCjnKC8yC8-G0qYuJKIG0bU88ovlWzRoClD4QAvD_BwE&gclsrc=aw.ds
https://www.lowes.com/pd/Eaton-1-Gang-Light-Almond-Single-Toggle-Standard-Wall-Plate/1001456722
https://www.lowes.com/pd/Eaton-Single-Pole-White-Compatible-with-LED-Toggle-Light-Switch/1001438312

IV. Vehicle

The robot must be completely autonomous and must fit completely within the 12"x12"x12" starting area at the start of each match. The robot body (or bodies) must at all times be wholly

contained within the playing surface, but may reach a maximum of 1" beyond the outside edge of any arena walls, and a maximum of 1/2" down the backside of the arena walls. There is no weight restriction on the robot. Aerial or flying robots are not allowed.

The robot may expand beyond the initial size to any size. It may split into multiple independent robots during the competition. It does not need to be tethered. If multiple independent robots are used, they must all start within the same starting space and split after the competition begins.

Emergency Cut-Off Switch

The robot must have an easily reachable emergency cutoff switch to allow the robot team to disable the robot if necessary (this is to avoid damage to both the robot and the arena in case a sudden stop is required). It is advisable that if the robot splits into multiple independent robots, the single emergency cutoff switch should stop the motion of all the robots, but this is not a requirement. It is recommended that robots automatically stop at the three-minute mark to avoid teams having to manually reach over to stop the robots and accidentally interfering with the stack.

Start Switch

While multiple switches can exist on the robot for powering up and controlling the various subsystems on the robot, there must be a single, clearly visible, labeled start switch. The start switch can be either a pushbutton or a toggle switch. The start switch will activate the robot and prepare it for a competition run. The robot will not start a competition run. The robot may position or center itself in the start box at this time. The robot will start the run upon reading a rd LED light located in the center of the start area. The LED light is recessed below the board top level. A judge will activate the LED light, which the robot will sense and begin the competition.

Sonar and LIDAR

Sonar and LIDAR sensors are allowed on the robot. Teams should be aware that other teams may be using similar sensors, so teams are required to handle any accidental interference from other robots or other noise sources with either shielding or software filtering of false data. However, while it is the team's responsibility to handle accidental interference, any intentional interference by another robot or team will not be tolerated and can result in sanctions.

Dangerous Chemicals and Gasses

The robot cannot contain any explosive, pyrotechnic, toxic or corrosive materials. Flammable liquids or gases are also prohibited.

Compressed gas is allowed on the robot as long as the pressure is limited to no more than 30 pounds per square inch at any time. Gases other than air are permitted as long as they do not pose a safety threat if accidentally released.

General Safety

The robot shall not present any danger to the judges, spectators, playing arena, or area surrounding the arena. If at any time the judges deem the robot is causing or is likely to cause harm, the judge may terminate the match immediately. The judge will have the discretion of whether any points are awarded for that match and if the robot is allowed to complete in any remaining matches.

Spirit Flag

It is encouraged that the robot display a flag on the robot representing the school flag or logo, state, territory, or national flag, but the flag must fit within the initial size constraints of the robot. The flag can be static, or can be raised automatically at any time once the match begins. The flag size can be no bigger than 2" x 4" and must fit within the 12" x 12" x 12" size of the robot.

V. Rules of Play

Sequestered Area

At the start of each round of matches, the judges will require that all robots be sequestered in a special staging area. Once in the staging area, the robots must remain turned off and cannot be touched by students until they are called for their match to begin. The robots cannot be charging during the sequestration period.

Match Pre-staging

For each match, the judges will call the names of the teams to run in that match. Once called, teams will have two minutes to retrieve their robot from the sequestration area and move it to a pre-match staging area near the arenas. In this area, teams can perform final checks to the robot,

make any last-minute adjustments, swap in a new set of batteries, and power it on. This time will overlap with the time another set of teams is competing. Once the current set of teams has completed their matches and cleanup, the judge will call the teams from the pre-match staging area to the arena to begin their setup.

Setting up for a Match

Once teams have been called from the pre-match staging area to the match, they will have an additional two minutes to get their robots and their arenas ready for the match. There is no limit on the number of students allowed in the arena area during setup as long as they can do so without disturbing other nearby arenas.

Conducting the Match

Once the team is ready, all team members but the one designated to initiate the robot start must step away from the arena. That team member then indicates the readiness of the robot to the judge, backs away from the arena, and the judge begins the match countdown. Once the countdown is complete, the judge will activate the LED light underneath the robot. The robot will start its run based on the activation of the LED light. Any interaction with the robot (remote control, additional buttons, touching or adjusting of the robot, etc.) during this time could lead to disqualification.

Switches

The start switch will be actuated by the robot team once the judge indicates the start of the match. All other switches must be configured prior to the start of the match, and only the single start switch is allowed to be activated .once the judge indicates the match is ready to begin. Any interaction with the robot after the start button has been activated could result in disqualification. The start switch must be a physical switch located on the robot.

The robot may complete the challenges in any order. The robot may complete any of the challenges and may skip any of the challenges.

VI. Competition Format

Each match will last for a maximum of three minutes. The robot team can stop their robot at any time before the three-minute period and signal to the judge that they are finished with their

match. The judge may stop the match at any time if the robot is acting in a manner that may cause injury to anyone nearby or damage to the arena or itself. If the judge does force a stop in a match, it is the judge's discretion whether the points in that match are counted and if the robot is allowed to run in the next match. Each team will be allowed three matches. After the preliminary rounds, the top eight teams will advance to a single-elimination bracket. The teams will be seeded based on their placing in the preliminary rounds. The top two teams will advance to the final round. The final round will be held at the awards banquet.

VII. Scoring

Points will be awarded for performing certain tasks during the competition.

Points	Task
36	Three pedestals stacked on the duck pond statue location inside the inner circle and in the correct order (base level – white, second level – green, third level – red) with a pink duck on top
33	Three pedestals stacked on the duck pond statue location inside the inner circle and in the correct order (base level – white, second level – green, third level – red) with a yellow duck on top
30	Three pedestals stacked on the duck pond statue location inside the inner circle and in any order with a pink duck on top
27	Three pedestals stacked on the duck pond statue location inside the inner circle and in any order with a yellow duck on top
27	Three pedestals stacked on the duck pond statue location inside the inner circle and in the correct order (base level – white, second level – green, third level – red)
24	Three pedestals stacked on the duck pond statue location inside the inner circle and in any order
24	Three pedestals stacked on the duck pond statue location inside the outer circle and in the correct order (base level – white, second level – green, third level – red) with a pink duck on top

21	Three pedestals stacked on the duck pond statue location inside the outer circle and in the correct order (base level – white, second level – green, third level – red) with a yellow duck on top
18	Three pedestals stacked on the duck pond statue location inside the outer circle and in any order
18	Three pedestals stacked on the duck pond statue location anywhere in the park and in the correct order (base level – white, second level – green, third level – red) with a pink duck on top
15	Three pedestals stacked on the duck pond statue location anywhere in the park and in the correct order (base level – white, second level – green, third level – red) with a yellow duck on top
12	Three pedestals stacked on the duck pond statue location anywhere in the park and in any order
30	Two pedestals stacked on a non-pond statue location inside the inner circle and in the correct order (base level – white, second level – green) with a pink duck on top
27	Two pedestals stacked on a non-pond statue location inside the inner circle and in the correct order (base level – white, second level – green) with a yellow duck on top
24	Two pedestals stacked on a non-pond statue location inside the inner circle and in any order with a pink duck on top
21	Two pedestals stacked on a non-pond statue location inside the inner circle and in any order with a yellow duck on top
21	Two pedestals stacked on a non-pond statue location inside the inner circle and in the correct order (base level – white, second level – green)
18	Two pedestals stacked on a non-pond statue location inside the inner circle and in any order
18	Two pedestals stacked on a non-pond statue location inside the outer circle and in the correct order (base level – white, second level – green) with a pink duck on top
15	Two pedestals stacked on a non-pond statue location inside the outer circle and in the correct order (base level – white, second level – green,) with a yellow duck on top

12	Two pedestals stacked on a non-pond statue location inside the outer circle and in any order
12	Two pedestals stacked on a non-pond statue location anywhere in the park and in the correct order (base level – white, second level – green) with a pink duck on top
9	Two pedestals stacked on a non-pond statue location anywhere in the park and in the correct order (base level – white, second level – green) with a yellow duck on top
6	Two pedestals stacked on a non-pond statue location anywhere in the park and in any order
2	Placing a duck, food chip, or pedestal in the recycling attraction
7	Each correct food chip fed to the manatees
7	Each correct food chip fed to the alligators
3	Each incorrect food chip fed to the manatees
3	Each incorrect food chip fed to the alligators
5	Each duck in the pond
3	Each duck, chip, or pedestal in a recycling area
10	Start the fireworks

VIII. Tiebreakers

In the event of a tie, the team with the lowest total time will advance.

IX. Team Participants

There is no limit on team size for the participating team, but each team member should be a member of the same local student branch, and they must all be IEEE Region 3 student members. Only one team per student branch is allowed in the main competition. Teams that do not fit this qualification (additional teams in the student branch beyond the one allowed in Main, teams including students from other regions, hobby groups, or non-students, or the robots are not associated with the local student branch) may compete in the Open category, but all team members must be IEEE members.

XI. Design, Analysis, and Testing of the Competition Rules

The SoutheastCon 2023 Chair is the lead for the design, development, testing, and analysis of the arena, robot requirements, and the competition rules. The Valencia College hardware team is the local branch for the Orlando hardware competition The local branch is part of the team for building, testing, the arena prior to the competition. The local branch will support operations of the competition during the competition.

XI. Clarification and Design Questions

Competition teams may contact the SoutheastCon 2023 Chair through direct email and the competition Discord site. The SoutheastCon 2023 Chair will post responses to questions and comments in the SoutheastCon 2023 Google Docs site. Answers will be in the form of two categories, clarification and contest design. Clarifications relating to contest design will be posted to the Google Docs site. Questions relating to contest design will be submitted to the design review, testing, and analysis. Contest design changes will be communicated via official rules updates.

XII. Communications

Hardware competition communications will be through the SoutheastCon 2023 website, the SoutheastCon 2023 Discord site, and the SoutheastCon 2023 Google Docs site. The website includes official releases and notifications and links to the Discord and Google Docs sites. The Discord site provides an open channel for questions, comments, and discussion. The Google Docs site provides a repository of rules, design, and development information. Information on the website and Google Docs is authoritative. The website is authoritative if the information between the website and Google Docs differs.

XIII. Schedule

The dates below are the best estimates of the milestones leading up to the competition. The plan is to meet or exceed those dates, but if any delay occurs, it will be reported through the communication channels discussed above.

Date	Milestone

March 30, 2022	Presentation / Draft to R3 SAC
April 3, 2022	Presentation / Draft to SEC Community, Discord opens for teams to join
April 17, 2022	Google Docs opens for teams to access
June 15, 2022	Competition team initial rules input deadline
June 1, 2022	Updated release of rules and software
August 1, 2022	First official release of arena and arena electronics
October 1, 2022	Frozen rules released for review Post lessons learned to Google Docs site
October 15, 2022	Competition team deadline for frozen rules review inputs
November 1, 2022	Rules frozen FAQ started
March 11, 2023	Deadline to submit fireworks videos
April 8, 2023	Deadline for teams to register

Revisions

Revision	Date	Notes
1.1	3/31/22	Refinement based on simulated board design
1.2	4/2/22	Refinement based on SEC 22 Hardware Competition Lessons Learned
1.3	4/2/22	Refinement based on SEC 23 Conference Team review

FAQ

FAQs posted here will start November 1st, 2022.