Contest Manual

2022 National Robotics Challenge

April 7-9, 2022

www.thenrc.org

(Updated 2/16/22)

1986 - 2022

36 years of open-robotics

The longest continually operating robotics competition in the world!

Contest Sponsors

We would like to thank our contest sponsors. Without their financial and in-kind contributions this event would not be possible.

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Table of Contents

Every attempt has been made to publish an accurate Contest Manual. However, updates and new information becomes available on a regular basis.

For the most current information and announcements, please refer to the contest web site:

www.thenrc.org

OFFICIAL RULES AND REGULATIONS

INTRODUCTION

The National Robotics Challenge began in 1986 as the Robotics International of the Society of Manufacturing Engineers (RI/SME) Robotic Technology and Engineering Challenge (RI/SME-RTEC). RI/SME-RTEC was developed under the guidance and inspiration of Tom Meravi, Associate Professor from Northern Michigan University and the late Dr. James Hannemann, co-chairman of the event. RI/SME-RTEC moved to Marion, Ohio in 2004 under the guidance of Ed Goodwin, Ritch Ramey and Tad Douce. In 2005 the contest was renamed the National Robotics Challenge. From this humble beginning, with two workcells and two pick and place competitions, the 2022 competition offers ten exciting contest categories.

The National Robotics Challenge is designed to provide students of all ages and levels of study the opportunity to demonstrate their knowledge and understanding of manufacturing processes, controls, robotics, and other technologies through competitive engineering contests. Students are judged on their application of technology principles, engineering concepts, and their ability to solve real-world problems through a team approach.

The National Robotics Challenge is designed to complement classroom instruction and provide students the opportunity to apply classroom knowledge in challenging and fun situations. Each contest is specifically designed to test the students' skills and knowledge in a particular area of manufacturing, technology, robotics, and automation. The event is open to any student in elementary, middle school, high school, or post-secondary school anywhere in the world.

Last year over 1200 participants from 13 states and 2 countries competed in the NRC event. Our vision is to become the premier robotics competition for elementary, middle, high and post-secondary school students around the globe.

MISSON

The mission of the National Robotics Challenge is to provide educational robotics competitions where students can develop the creativity, engineering, problem solving, and leadership skills they will need in the world of tomorrow.

GENERAL INFORMATION

The 2022 competition is Thursday, Friday and Saturday, April 7, 8 & 9, 2022.

Registration costs: $70 per team/school plus $10.00 per robot
Registration must be received no later than Friday, February 18th, 2022.

All registration will be completed online.
The registration link will be available on the National Robotics Challenge website (www.thenrc.org) by Monday, January 3rd, 2022.

STAYING IN TOUCH

The National Robotics Challenge committee has several online tools to facilitate communication between the NRC Committee, Advisors, Student and Parents.

Facebook:
Become a fan of the National Robotics Challenge on Facebook. Search for "The National Robotics Challenge" or go to: www.facebook.com/TheNRC

Twitter:
Follow us on Twitter - @followNRC

YouTube:
www.youtube.com/nrcrobotv

CONTEST MANUAL

An updated version of the Contest Manual can be found on-line at the National Robotics Challenge website (www.thenrc.org) under the "Contest Manual" link.

There are ***many*** changes from last year's contest manual. Every attempt has been made to highlight these changes with (**New for 2022**). However, in order to ensure your team's successful participation in this year's event, ***please*** **review the contents of this manual carefully.**

Check the website often; it is your source for current information, updates, and changes.

General Competition Information

Contest Categories

The National Robotics Challenge is composed of twelve exciting contest categories. These educational activities are designed to provide students with an opportunity to demonstrate their knowledge and understanding of technology through a variety of contests. Each contest challenges student knowledge in a particular area of manufacturing, technology, robotics, and automation. A robot may only be entered in one contest category per year, unless otherwise noted in a contest category section of this manual.

Advisor Expectations

Advisors may not handle the robot at any time at the competition area. Advisors may only serve as a coach and should not actively engage with repair, programming, and/or operation of the robot. Any operation that involves the robot must be completed by a student.

Levels

Individual students and teams are invited to participate in the following divisions, based on the current academic level of the most senior team member:

Elementary

- Students enrolled in a public, private, or home school offering instruction less than middle school.

Middle School

- Students enrolled in a public, private, or home-school offering instruction between and including grades six, seven and/or eight.

High School

- Students enrolled in a public, private, or home-school offering instruction between and including grades nine, ten, eleven and/or twelve.

Post-Secondary

- Students enrolled in a public, or private school offering instruction at less than the baccalaureate level or a public or private school offering programs at or beyond the baccalaureate level (included community college, technical institute and university undergraduate and graduate students.)

Post-Secondary events:

- Autonomous Vehicle Challenge (AVC)
- Combat Robot (Beetleweight Only)
- Manufacturing Workcell
- Micromouse Contest
- Sumo Robot

Judging

All of the contests are ranked based on the criteria in this manual. Students are judged on their application of technological principles and concepts, and their ability to solve difficult problems through a team approach. During the judging for each contest, only the contest facilitator and judges/officials are permitted in the designated contest area. Instructors, team advisors, parents, and additional competition attendees are prohibited from entering into the designated contest area while judging is occurring. Concerns regarding, or objections to a judge's ruling must be brought to the attention of the Director of Contest Judging or Director of Events at the time of the contest judging. For all contests and special awards, the decisions of the judge(s) are final and binding.

Awards

Awards for each contest are presented on the following levels: Gold, Silver, and Bronze

Honda Innovation Award

This award will be presented to the team with the most creative/innovative design that exemplifies Honda values. The judging team will nominate one team from each category for this award. A panel of award judges will analyze each nominated team and then select a winner. Each team that was nominated will receive a plaque and the winning team will receive a trophy/plaque and a $500.00 check for their school.

Safety and Liability

The National Robotics Challenge organization, staff, committee, competition sponsors, competition facilitators and/or judges/officials may stop the operation of any contest or special award participant if it is determined that the operation of the entry is hazardous. Such stoppage may disqualify the participant from that portion of the competition. Each contestant is responsible for his/her own personal safety and safety equipment. EduEverything, Inc. assumes no financial or organizational liability through its role as a sponsor of the National Robotics Challenge. The National Robotics Challenge, EduEverything, Inc., and the Veterans Memorial Coliseum, Marion, Ohio, shall hold harmless the other party from and against all claims, suits or actions or injury or damage arising from any intentional or negligent act of the party's employees, agents, officers and/or authorized subcontractor(s) while performing duties needed for sponsoring this event.

Dress Code

The National Robotics Challenge showcases outstanding entries, students, instructors, programs, schools, and sponsors. Our judges and sponsors come from diverse professional organizations and they expect students to look and act like professionals. For this reason, we ask that you abide by the following dress code at this event:

A. All participants, advisors, and chaperones must wear a collared shirt and pants at <u>all</u> times on the competition floor.
B. A team or National Robotics Challenge t-shirt may be substituted for a collared shirt. (Teams are encouraged to develop a team shirt or uniform to wear during the event.)
C. The following attire is not permissible at the National Robotics Challenge:
    1. Shorts
    2. Cut-off pants
    3. Ripped, Distressed, or Destroyed Pants
    4. Torn clothing
    5. Overly baggy clothes
    6. Open toed shoes (safety concerns)
    7. Soiled clothes
    8. Hats (Official National Robotics Challenge hats may be worn during competition)
D. Any individual who does not adhere to the above dress code will be asked to comply or be disqualified from his/her event(s).

Accessibility

The National Robotics Challenge is committed to providing reasonable accommodation to persons with a disability to facilitate their full participation in the National Robotics Challenge events. Please contact Tad Douce at 740-361-6772 at least one month prior to the National Robotics Challenge should such accommodations be required.

Financial Assistance

You should begin planning now to finance the cost of your participation and trip. The following are recommendations to obtain financial assistance:

Institutional Support

Request support from your school or university. Your Faculty Advisor/Instructor can help determine if your institution can pay for a portion or all of your expenses. ASK YOUR FACULTY ADVISOR / INSTRUCTOR FOR HELP!

Fund Raisers

Fundraisers are a good way to obtain the funds required to finance your trip. Students and communities are willing to “pitch-in” for a good cause. What is your cause? A challenging, educational experience that helps prepare you for your manufacturing future, and a chance to represent your school. Some ideas include: donut, bagel, bake or candy sales, car washes, community yard service, snow shoveling, lawn raking, senior citizen services, selling popcorn/candy at school sporting events, etc.

Local Service Organizations and Government Agencies

Check with your Faculty Advisor / Instructor to determine whether any community organizations, state or Federal government agencies, such as NASA, a local foundation, or service organization would be willing to donate a portion of the needed funds.

Local Companies

Is there a local manufacturing company that may be interested in sponsoring your trip? Perhaps they are willing to donate some of the needed equipment. Check with your Faculty Advisor for contact names.

Manufacturers and other Industry Partners

Manufacturers and industry partners are excellent contacts, which are often more than willing to get involved in a project of this type. Your Faculty Advisor/Instructor can provide a list of contacts.

Dr. James Hannemann Leadership and Service Award

James W. Hannemann Ph.D. (1937 – 2001)

Working behind the scenes, Dr. Hannemann volunteered his time and talents tirelessly for fifteen years helping the Robotic Competition grow, expand and develop into the competition it is today. From its humble beginnings in 1986, with two workcells and two pick and place competitions, the current competition offers contests for elementary to post-secondary students in a wide range of categories.

Dr. Hannemann obtained his BS degree in Agricultural Education from South Dakota State University, an MS in Agriculture from Cornell University and a Ph.D. in Secondary Curriculum from Michigan State University. He worked as a Vocational Education Consultant for Oakland Intermediate School District (Michigan) from 1968 to 2000 when he retired. Dr. Hannemann served many schools, teachers and students and he loved his work. He took joy in experience and discovery – of places, foods, music, ideas and most importantly, people. He was an active member of the FFA, the Society of Manufacturing Engineers, the Automotive Industry Planning Council, VPAC, and ACTE. In 1999 he received the Presidents Award for outstanding service to ACTE.

In recognition of Dr. Hannemann's years of service to the RI/SME Student Robotic Competition, now the National Robotics Challenge, and to the thousands of students he touched, the National Robotics Challenge has established the Dr. James Hannemann Leadership and Service Award. This award is given annually at the National Robotics Challenge awards ceremony.

2019 Dr. James Hannemann Leadership and Service Award Recipient

The directors of the National Robotics Challenge are pleased to announce that the 14th annual Dr. James Hannemann Leadership and Service Award was awarded to Ritch Ramey from Tri-Rivers Career Center. This award honors and recognizes individuals and organizations who have shown outstanding support for engineering and technology programs at the middle school, secondary, and post-secondary level and who have supported the continued growth of the National Robotics Challenge.

The NRC wouldn't exist if it weren't for Ritch Ramey. Ritch was one of three Marion, Ohio area teachers who were at the SME Robotics Challenge when they announced they could no longer host this great event. On the bus ride from Rochester, NY to Marion, Ritch proposed that Marion, Ohio host the event moving forward. He cited our excellent network of educators, business and industry support, and public sector efforts to support robotics initiatives. From that moment, the NRC was born. From that day, Ritch has worked tirelessly to grow and improve the NRC. Ritch has coordinated judging teams, wrote grants to get more schools the equipment they need to participate, developed industry partnerships, and still coached his own students as they competed each year. Ritch's experience with the NRC and his prowess as a pre-engineering educator helped launch the Robotics & Advanced Manufacturing Technology Education Collaborative (RAMTEC) on the Tri-Rivers Career Center Campus. RAMTEC is the first training facility of its kind in the State of Ohio, partnering directly with business and industry to provide industrial robotics and advanced manufacturing skills and industrial certifications to high school and adult students. We are looking forward to his continued involvement in the NRC and robotics education.

Parent/Student Authorization Form

National Robotics Challenge Authorization Form – 2022

CONSENT, RELEASE, HOLD HARMLESS AND AUTHORIZATION TO REPRODUCE PHYSICAL LIKENESS

This form is required of all minors and adults who attend the National Robotics Challenge (NRC). Copies of this completed form are to be retained and kept on file by minor's parents, advisors and/or school administration. It is the responsibility of the advisor to make sure there is a completed form for each participant and to give a copy to the school administrator if necessary. The National Robotics Challenge reserves the right to request a completed copy of this form at any time from the chapter advisor or state advisor. Do not send this form to the National Robotics Challenge office.

As used below, NRC shall mean the National Robotics Challenge and its officers, directors, employees, assigns, and agents (including any third party designated and approved by the NRC) at any time, including, without limitation, individuals or entities involved in print, publication, television, broadcast, or video media. As used below, "Participant" shall mean any individual, student, advisor, teacher, or volunteer involved in an NRC activity. The participation in any NRC contest, program, meeting or conference (collectively, the "Event"), agrees to the following:

I hereby grant to the NRC the right to photograph and/or videotape me (my child) during my participation in an Event. I further grant to the NRC, forever and throughout the world, the right to use these photographs and videotapes of my likeness, voice and sounds during my participation, and to reuse or license the right to such photographs and videotapes of my participation, and my name, likeness and biography, as the NRC may desire, in all media and in all forms and for all purposes, including without limitation, advertising and other promotions for the NRC, without further compensation to me or any limitation whatsoever. In granting this license, I understand that the NRC is not under any obligation to exercise any of their rights, licenses and privileges herein granted. Each such photograph and videotape shall be a work for hire and the NRC shall be deemed the owner of any copyright and/or trademark rights therein (and all applications, registrations and renewals resulting there from). If, however, the work is deemed not to be a work made for hire by a court of competent jurisdiction, then this Consent and Release to Produce Physical Likeness ("Release") shall constitute an irrevocable assignment by the Participant of the worldwide copyright in the work to the NRC. It is an NRC policy not to print a minor's picture accompanied by his/her name unless the NRC has obtained specific permission from his/her parent or guardian.

The undersigned being fully cognizant of the risks in participating in an Event, hereby assumes the risks of bodily injury (including, without limitation, death) and property damage, inherent in such participation. Exception to the extent due to the gross negligence or willful misconduct of the NRC, to the fullest extent permitted by applicable laws, I hereby waive any claims or causes of action which I may now or forever have against the NRC arising out of my participation, and I will indemnify and hold harmless the NRC against any and all claims resulting from such participation.

I hereby release the NRC and its respective successors, affiliates, licensees and assigns from all claims, demands, liabilities, damages, costs and expenses (including, without limitation, attorney's and other professional fees and expenses) that I may now or ever have against the NRC arising in connection with my participation in the Event and the NRC's exercise of rights hereby granted, including, without limitation, claims for compensation, defamation, or invasion of privacy, or other infringements or violations of personal or property rights of any sort. In the event I should sustain injuries or illness while involved in an Event, I hereby authorize the NRC to administer, or cause to be administered, such first aid or other treatment and medications I may bring as may be necessary under the circumstances, to include treatment by a physician or hospital of the NRC's choice.

This Release shall be binding upon my heirs, personal representatives and assigns, and me and shall be governed by and construed under the laws of the State of Ohio without regard to conflicts of laws principles. Venue for any legal action arising out of or in connection with this Release shall be in Marion County, Ohio. This release constitutes the entire agreement among the parties hereto with respect to the subject matter of this Release and supersedes any and all previous agreements among the parties, whether written or oral, with respect to such subject matter**.** I understand that this form involves a release of legal rights. A parent or guardian agrees to all of these terms on behalf of a minor.

Participant's Name _____

Participant's Signature _____

School _____

Home address_____ City_____ State _____ Zip _____

Allergies_____

Current Medication_____

History of heart condition, diabetes, asthma, etc. _____

Physician's name and telephone_____

Insurance company and policy number_____

_____

Parent/Guardian's Name _____

Signature of Parent/Guardian of Minor Participant _____

Minor's Age _____

Parent's Phone _____(h)_____ (c) Email_____

Contest Complexity Guide

Event	Mechanical Complexity	Electrical Complexity	Programming Complexity
Autonomous Vehicle Challenge (AVC)	⚙⚙⚙⚙	⚙⚙⚙	⚙⚙⚙⚙⚙
Bot Ball	⚙⚙	⚙⚙	⚙⚙⚙
Combat Robot	⚙⚙⚙⚙⚙	⚙⚙⚙	⚙⚙
Manufacturing Workcell	⚙⚙⚙⚙⚙	⚙⚙⚙⚙⚙	⚙⚙⚙
Micromouse	⚙⚙	⚙⚙⚙	⚙⚙⚙⚙⚙
Pick and Place Programming	⚙	⚙	⚙⚙⚙⚙
Rescue Robot	⚙⚙⚙⚙	⚙⚙⚙	⚙
Robo Hockey	⚙⚙⚙⚙	⚙⚙	⚙
Robot Maze	⚙⚙	⚙⚙	⚙⚙⚙
Sumo Robot	⚙⚙⚙	⚙⚙⚙	⚙

Autonomous Vehicle Challenge (AVC)

Middle School, High School, Post-Secondary

(Updated for 2022)

Contest Description

For the Autonomous Vehicle Challenge each team will design and build a vehicle to navigate an obstacle course. A successful run is one where the vehicle navigates around the 4 waypoints (blue stanchions) and crosses the finish line in under 5 minutes. Additionally, bonus points are given for completing special tasks during a run. Once earned, bonus points cannot be taken away. Teams can score bonus points even if they do not complete a successful run.

Rules and Course Layout

1. The course will be located on the parking lot of the Marion Veterans Memorial Coliseum, Marion, Ohio

2. Each vehicle must pass on the outside of stanchions in the course shown in Figure 1: AVC Course Layout. Blue stanchions will be placed on top of the blue corner dots shown and yellow stanchions on the yellow dot. Final placements of stanchions and obstacles will be at the discretion of the judges.

3. The autonomous vehicle must fit inside a 24” x 24” x 24” space. Any robot entered that does not meet the size requirement by the end of the device evaluation or expands beyond that size during competition will be disqualified.

4. The vehicle must be fully autonomous and self-contained. No transmitters or communication beacons (other than GPS) of any kind are allowed. You may NOT tether to a laptop or other device. Everything necessary for the vehicle’s navigation/processing/sensing must be attached and part of the vehicle itself.

5. The AVC event will take place outside in the parking lot west of Veterans Memorial Coliseum. The event will run regardless of weather conditions. (with the exception of lightning)

6. Allowances for unforeseen delays will be taken into account, but will be up to the contest judges. Please notify the contest judges immediately if you have an issue that prevents you from competing on schedule. (Repairs, bad code, gremlins, or dead batteries do not count. Be prepared for anything and everything.)

7. Each team is given 3 attempts throughout the day to earn points.

8. Teams will be called when it is time to bring your vehicle to the starting line and if you are not ready, you will forfeit that run and receive no points.

9. During the competition the course will be closed to both spectators and participants. Participants with vehicles currently running may follow within the inner perimeter of the course (Yellow lines in figure 1), but may not be on the course with the vehicles when they are running.

10. Teams are expected to make all necessary measurements, adjustments, and sensor readings before the event starts. Once the first heat is started, only competing vehicles and their team may be in the course, and to start their vehicle for the run.

11. We will be running 1 vehicle at a time. You will place your robot anywhere behind the start/finish line, wait for a signal, and press a button to start your robot. Time will begin when the robot first crosses the Start line. It must be in a ready position, and be started with a physical input (button, switch, etc). It may not be started wirelessly.

12. If you need to wait for GPS lock or a setup routine, you will need to do this before your run starts.

13. Time-based points start at 300 and are deducted (1 per second) until the run is completed. You cannot get negative points for time. Time points only count if your run is successful. Each successful run will be given points based on the time it took them to finish the course and whatever bonuses were achieved.

14. All teams are scored and ranked by the total number of points accrued in all three runs. The team with the highest points wins. Each run will add more points to the team's overall score.

    Bonus Points
    - 50 - passing through the arch
    - 50 - clearing the ramp
    - 25 - each successful corner cleared (vehicle must completely clear corner, not just reach it)

Scoring Examples:
- Teams complete a run in 2.5 minutes and passes under hoop. this team would score 150 points for their time, 20 points for each completed corner (100 points), and 50 points for the hoop bonus. Their total score would be 150+100+50 = 300
- Team does not complete course, but goes around 3 corners and clears the hoop and ramp. they would score no points for time (did not complete course), but would receive 60 points for 3 successful corners, 50 points for the hoop, and 50 points for the ramp. they would end up with a total of 160 points for the run.
- Team completes course in 1 minute, but does not clear the ramp or the hoop. They would get 240 points for time and 100 points for successfully clearing all 5 corners. Their total score would be 340.

AVC Course Details

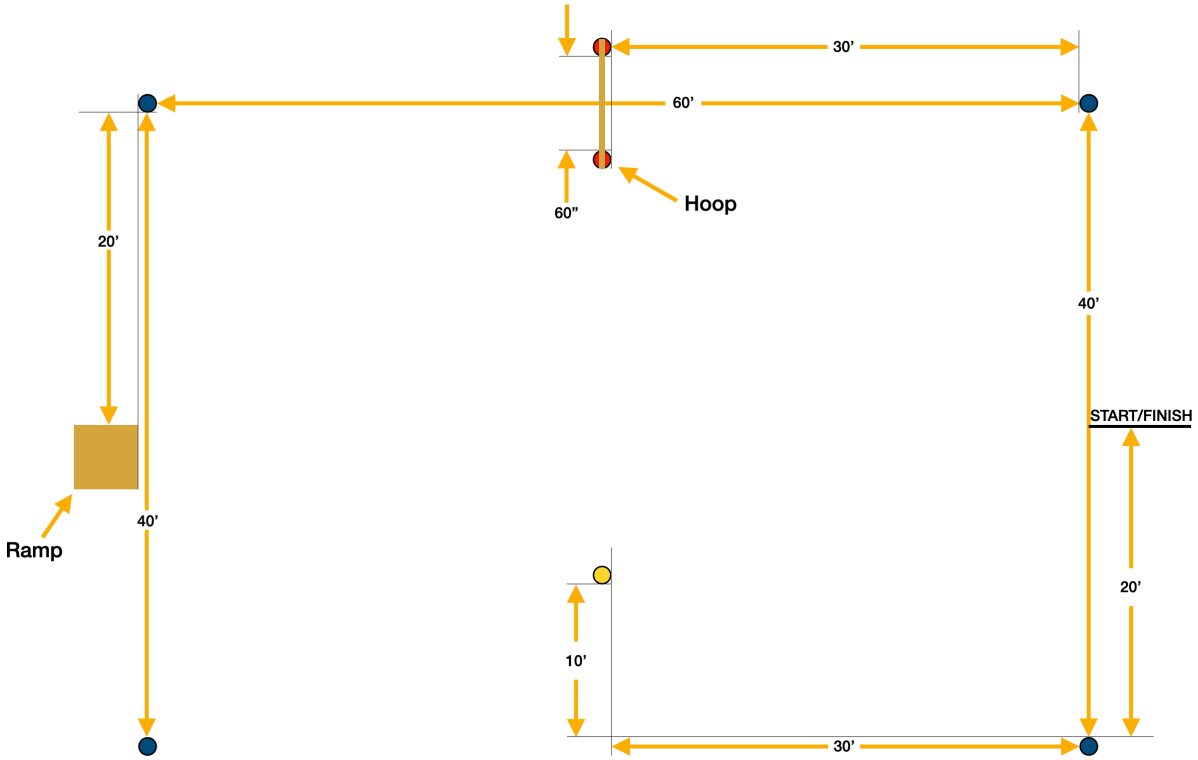


Figure 1: AVC Course Layout

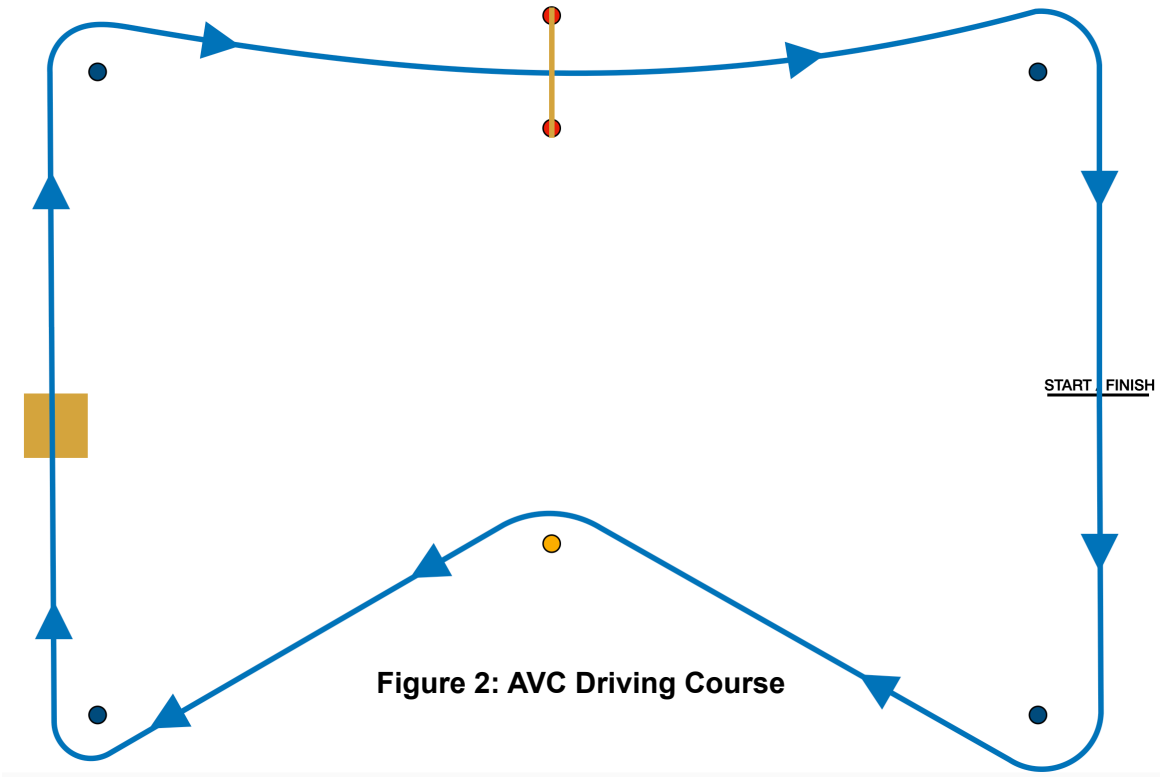
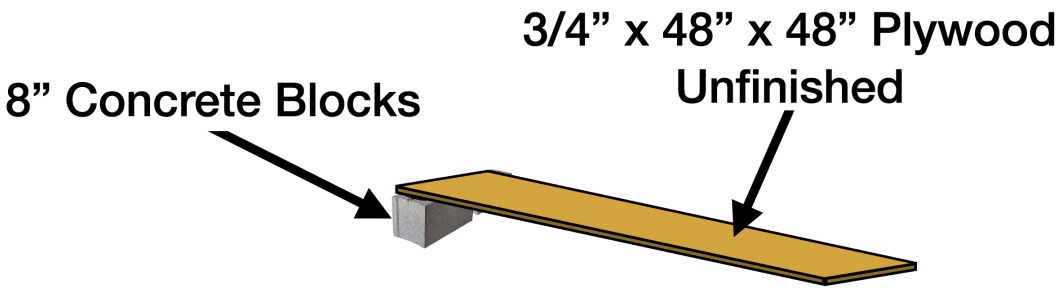


Figure 2: AVC Driving Course

AVC Obstacle Details

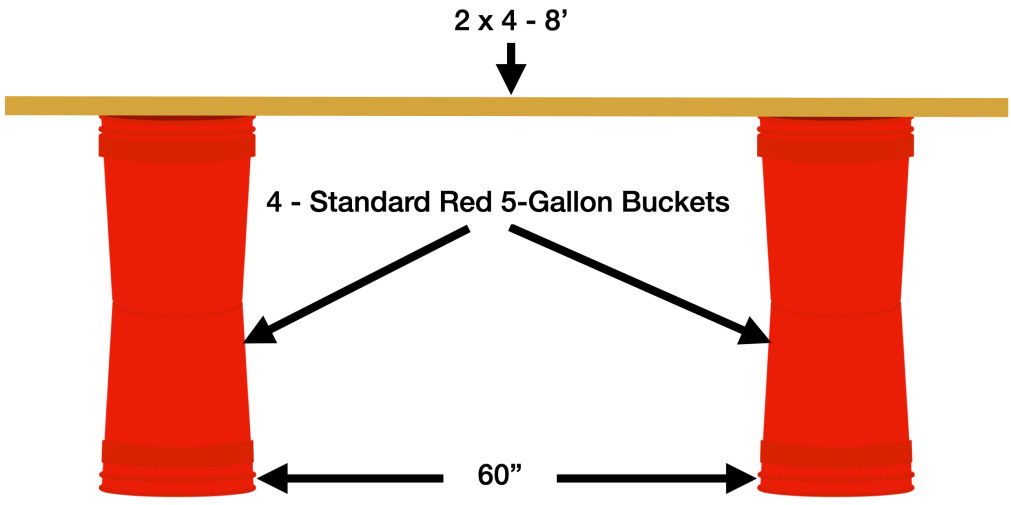
On the course, you will encounter several obstacles. The dimensions and details for the obstacles can be found below.

Ramp



Stanchions

Arch



FINAL EVENT –
Autonomous Vehicle Challenge (AVC)

LEVEL: **_____ Middle School** **_____ High School** **_____ Post-Secondary**

SCHOOL: _____

CAPTAIN: _____

Size Requirement Passed: _____ Robot Size Requirement: 24” x 24” x 24”

	Points Each	Round 1	Points Awarded Round 1	Round 2	Points Awarded Round 2	Round 3	Points Awarded Round 3
Corner 1 Cleared	**+20**						
Corner 2 Cleared	**+20**						
Corner 3 Cleared	**+20**						
Corner 4 Cleared	**+20**						
Corner 5 Cleared	**+20**						
Ramp Cleared	**+50**						
Passed Through Arch	**+50**						
Course Complete<5 min.	**+300**						
Total Points ***(Max. 500)***							
Time Based Scoring Subtract one point for each second of the timed run. (if < 5 minutes)		Time in Seconds _____	-	Time in Seconds _____	-	Time in Seconds _____	-
Run Total (Total Points minus Time Based Scoring)							

Accrued Run Total: _____

Judge’s Comments:_____

_____

Judge’s Signature: _____

Bot Ball

Elementary, Middle School, High School

Contest Description
The Bot Ball contest challenges student teams to design, construct, program and operate a battery-powered robot for use in ball collection game.

Rules

1. Only two team members at a time are allowed at the playing field while the Robot is on a task attempt. To share in participation, members may switch out with each other between attempts.

2. There will be a random selection prior to the competition to determine which team is the white team and which team is the orange team.

3. Once the team color is determined, the team steps up to the playing field and has 30 seconds to perform any needed setup routines and download the applicable program to their robot.

4. The Judge starts the match, and the team performs task attempts for 90 seconds. The first 70 seconds are autonomous (no remote control) and the final 20 seconds can be operator controlled via a wireless remote. More matches run until every team has competed once, this process is known as a “round”. There are 3 rounds in the contest. After each match, teams may go to the pit and fix or adjust the robot.

5. The judges will signal when operator control is available. Teams may choose to continue with their robot in autonomous mode if desired.

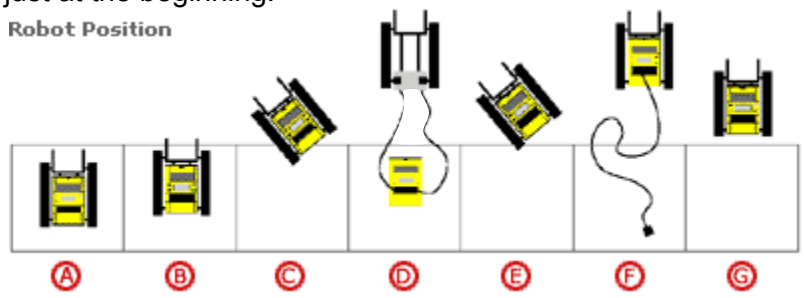
6. The robot is defined as the micro-controller, (NXT, EV3, VEX-IQ, Parallax, Arduino, etc.) and anything connected to it in any way, including any loose objects being held, manipulated, or moved.

7. The robot must be programmed using programming software. (i.e. LEGO MINDSTORMS, RoboLab, Pbasic, C, etc.)

8. The “end zone” is the volume behind the black base line and inside border walls.

9. Before the match, between task attempts, and only while the Robot is completely inside the square “base” area, the team may aim the Robot, repair it, load or unload it, add or remove parts, switch programs, and reset mechanisms.

10. All task attempts must start with the robot completely inside the “base” area as shown in the robot position diagram in position A, with the robot turned on but all programs turned off. The robot must start from within the base lines. This starting technique applies during the whole match, not just at the beginning.



11. Jigs or other alignment devices may be used to help aim the robot in starting position and they must stay completely in the end zone.

12. While on a task attempt, the robot is to be controlled only by its program, its motors, and its interaction with the field, and not by interaction of any kind with the team. Remote control or signaling of sensors in any way is not allowed during the autonomous period.

13. A task attempt is started when the team starts a program. Delaying or causing the release of stored energy in any form by hand is not allowed. This starting technique applies during the whole match, not just at the beginning.

14. A scoring attempt is an effort by the robot to move one or more of the game objects into scoring position. Scoring attempts can be tried in any order, re-attempted whenever possible, or not attempted at all.

15. Touching the other team's robot will result in automatic disqualification for that round.

16. During the autonomous period the robot is understood to be on a scoring attempt starting from the instant a program is initiated. The next time the team controls or interacts with the robot in any way (touching/carrying is most common), it is a signal that the robot is failing or can no longer continue on its own, and the current scoring attempt is immediately terminated. The team must then bring the robot by hand to the starting position (base) for the next scoring attempt. Any changes to the playing field after the instant the team interacts with the robot are invalid, and are reversed by the referee.

17. Points for moving an object are awarded only if the object is ***completely*** in scoring position as specified in the game description, no matter where the robot is, and no matter whether the object is packaged, palletized, or bound/connected to other objects.

18. Objects in the way of future task attempts can be removed from the field by the referee upon request unless doing so would have a direct effect on scoring.

19. Refer to the robot position diagram after rule 10. If a scoring attempt is terminated while all functional parts of the Robot are completely out of the end zone as shown in positions D, F and G, the team must bring the Robot by hand to Starting Position for the next scoring attempt. Because of this action, one "*Robot Return Penalty"* is deducted from the score, but accomplishments made during the scoring attempt are retained. Scoring attempts terminated in positions A through E do not result in a "*Robot Return Penalty"*, and there is no loss if the robot happens to be out of Base when the match ends.

20. If an object being moved is NOT held by or linked to the robot when a task attempt is terminated, the object stays where it is on the field. If an object IS held by or linked to the robot when a task attempt is terminated AND the object is not completely in a scoring position, there are two possibilities: 1) Objects that began the Match in the End Zone are kept by the team for another task attempt. 2) Objects that did not begin the Match in the End Zone are taken off the playing field by the referee (and do not score). This rule applies to all objects, including scoring objects, projectiles, props, tools, and agents of any kind.

21. Once an object is completely inside the End Zone (completely past the black line), a team member can move the object by hand to any place within the End Zone.

22. At any time during the match, the team may recover robot parts that come off as an obvious result of damage or disintegration. The team may do this by hand or request help from the referee.

23. The team may not touch “Task Models” outside of the end zone. If they are damaged or otherwise disturbed between task attempts or by anything but valid robot action, the referee restores them as soon as possible. If it is obvious to the referee that task model damage is part of team strategy the team will be disqualified from the event.

24. To minimize controversy about what happened during a match, THE SCORE IS DETERMINED AT THE END OF THE MATCH, BY THE CONDITION OF THE FIELD AT THAT TIME ONLY. If the thickness of a line on the field comes into question, and for other situations that are “too close to call” the team is given the benefit of the doubt. Scores from each Round are independent, and only a team’s best score counts.

25. The “Terms & Rules” are superseded by the “Challenge Tasks” when the two conflict.

26. Decisions of the judges are final and binding.

Game Description

Points are awarded for moving ping-pong balls and tubes into a scoring area (end zone or gutter). Additional points are awarded for moving any “nest” or large foam ball into a scoring area. Points are also awarded for each ping-pong ball that is “free” (outside of the tubes, nests, gutters or end zones) and touching the playing surface outside a scoring area.

Challenge Task points are awarded as follows:

- 5 points for each ping-pong ball of your team’s color in either “gutter”.
- 5 points for each tube of your team’s color in either “gutter”.
- 5 points for each foam ball in your team's “gutter”
- 3 points for each ping-pong ball of your team’s color in your team’s “end zone”
- 3 points for each tube of your team’s color in your team’s “end zone”
- 3 points for each foam ball in your team’s “end zone”
- 3 points for each nest in your team’s “end zone”
- 1 point for each “free” ping-pong ball of your team’s color touching the playing surface
- 10 points for each BONUS ball in your team's “gutter”
- -30 points for the BONUS tube in your team's “gutter”
- -20 points for the BONUS tube in your team's “end zone”

1. “Starting Position” is with the entire robot completely within the base. The base is defined as the square center section on each end of the board.

2. On the judges signal the robot is to leave the base, attempt to earn challenge points through a scoring attempt and return to base with only its program to control it. If the team touches the robot before it returns to base a “Robot Return Penalty” will be given and the robot must be returned to “Starting Position.”

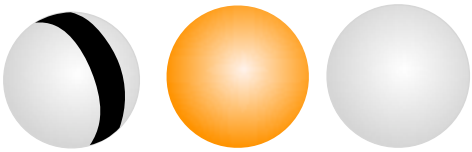
Tips:

- Concentrate on developing a solution step by step. Don’t try to get it all at once or things will get out of hand very quickly.
- Teamwork is crucial. The challenge is too much for one person to get done alone in time. Try dividing up tasks for different team members.
- Test and refine your design as many times as possible. The robot must be ready for whatever comes its way.

Bot Ball

The following is the description for the Bot Ball competition for the National Robotics Challenge. Please keep in mind that the challenge points do not necessarily need to be earned in a specific order.

Ping-Pong Balls

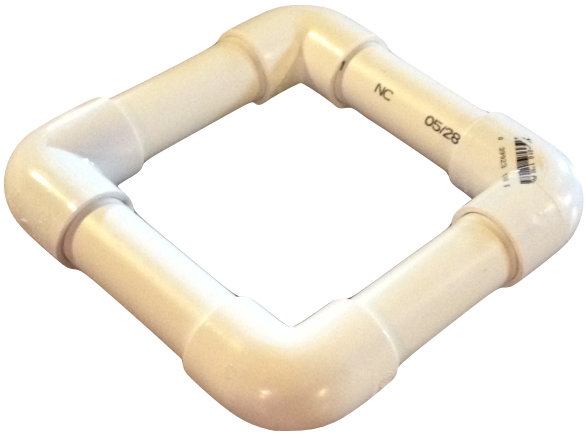


Bonus Ball **Orange Ball** **White Ball**

4” Foam Ball

Nest

Nests are made from four pieces of 1” PVC pipe, each 5” long, and four 1” PVC elbows. The nests have an inside dimension of 5” and an outside dimension of 8”.



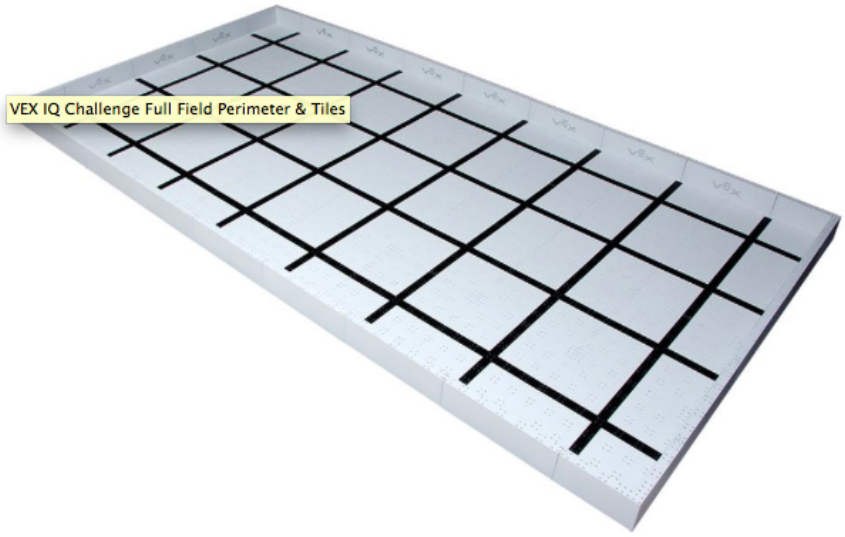
Tube

Standard 1 1/2” PVC pipes 4 1/2” long. Electrical tape on ends to indicate color.

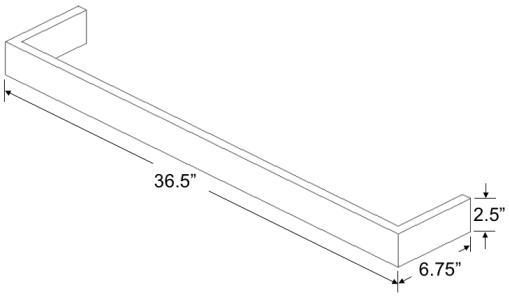
Bonus Tube **White Tube** **Orange Tube**

Playing Field

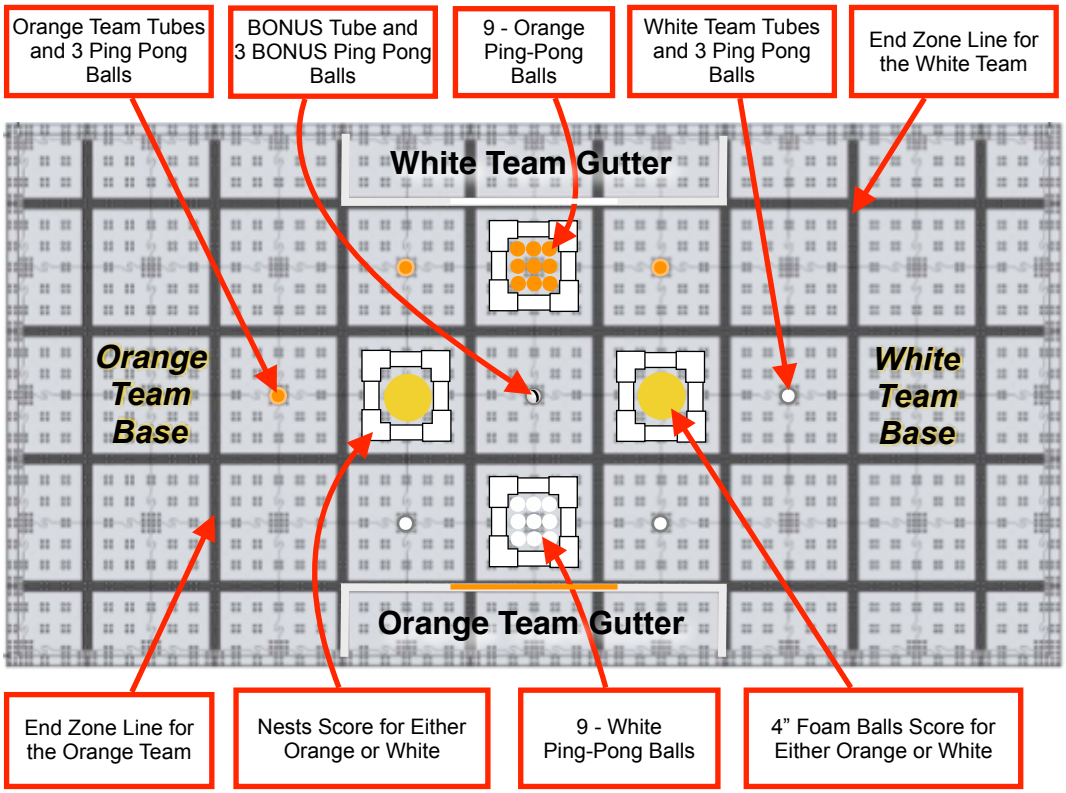
For the main playing field the NRC is using the VEX IQ Challenge Full Field Perimeter & Tiles. You can purchase this product at: www.vexrobotics.com



The gutter will be made from 3/4 inch thick white PVC, 2 1/2 inches high.



Top View of Playing Field



FINAL EVENT – Bot Ball

LEVEL: _____ **Elementary** _____ **Middle School** _____ **High School**

SCHOOL: _____

CAPTAIN: _____

Tasks	Points Each	Scored Objects Round 1	Points Awarded Round 1	Scored Objects Round 2	Points Awarded Round 2	Scored Objects Round 3	Points Awarded Round 3
In Either Gutter -							
• Team Ping Pong Balls	**+5**						
• Team Tubes	**+5**						
In Team's Gutter -							
• Foam Balls	**+5**						
• BONUS Ping Pong Balls	**+10**						
• BONUS Tube	**-30**						
In Team's End Zone-							
• Team Ping Pong Balls	**+3**						
• Team Tubes	**+3**						
• Any Nests	**+3**						
• Foam Balls	**+3**						
• BONUS Tube	**-20**						
Free Ping Pong Balls • *Team Ping Pong Balls outside of the tubes, nests, gutters or end zones*	**+1**						
Robot Return Penalty							
Number of times the robot is handled by a team member outside the end zone.	**-5**						
Total Points							

Highest Total: _____

Judge's Comments:_____

_____

Judge's Signature: _____

Combat Robot

Classes: Antweight, Beetleweight, Beetleweight-Plastic
Middle School, High School, Post-Secondary (Beetleweight ONLY)

Contest Description

In the Robot Combat event students design and create a single custom-built machine that employs one or more methods of destroying or disabling their robot competitor. This robotic device will be remote-controlled but may include some autonomous operations. We are utilizing a modified version of the SPARC Robot Construction Specifications v1.1.

Rules

0. Size Requirements: The Robot must fit inside a 14” x 14” x 14” space. Any robot entered that does not meet the size requirement by the end of the device evaluation or expands beyond that size during competition will be disqualified.

1. Overview and Purpose
- 1.1. The SPARC Robot Construction Specifications was created to provide both builders and event organizers with an up to date and easy to implement ruleset.
- 1.2. The SPARC Standard Ruleset will call out areas where the rules are often altered by the events and will provide the most frequently used options for easy adaptation.
- 1.3. If you choose to utilize the SPARC Robot Construction Specifications and modify the rules to adapt to your event please note specific areas that differ from the standard SPARC rules in section 2.

2. Deviations From Robot Construction Specifications
- 2.1. The Combat Robot rules are a modified version of the SPARC Robot Construction Specifications v1.2. To simplify the understanding for the specifications some section of the original ruleset were completely removed. To view the original rules go to: www.sparc.tools

3. General
- 3.1. All participants build and operate robots at their own risk. Combat robotics is inherently dangerous. There is no amount of regulation that can encompass all the dangers involved. Please take care to not hurt yourself or others when building, testing and competing.
- 3.2. If you have a robot or weapon design that does not fit within the categories set forth in these rules or is in some way ambiguous or borderline, please contact the event organizer. Safe innovation is always encouraged, but surprising the event staff with your brilliant exploitation of a loophole may cause your robot to be disqualified before it ever competes.
- 3.3. Each event has safety inspections. It is at their sole discretion that your robot is allowed to compete. As a builder you are obligated to disclose all operating principles and potential dangers to the inspection staff.
- 3.4. Cardinal Safety Rules: Failure to comply with any of the following rules could result in expulsion or worse, injury and death.
  - 3.4.1. Radios that do not operate using spread spectrum technology may not be turned on at or near events for any purpose without obtaining the appropriate frequency clip or explicit permission from the event.
  - 3.4.2. Proper activation and deactivation of robots is critical. Robots must only be activated in the arena, testing areas, or with expressed consent of the event and it's safety officials.

3.4.3. All robots must be able to be FULLY deactivated, which includes power to drive and weaponry, **in under 60 seconds by a manual disconnect**.

3.4.4. All robots not in an arena or official testing area must be raised or blocked up in a manner so that their wheels or legs cannot cause movement if the robot were turned on. Runaway bots are VERY dangerous.

3.4.5. Locking devices: Moving weapons that can cause damage or injury must have a **clearly visible** locking device in place **at all times** when not in the arena. Locking devices must be painted in neon orange or another high-visibility color. Locking devices must be clearly capable to stopping, arresting or otherwise preventing harmful motion of the weapon.

3.4.6. Weapon locking pins **must be in place** when weapon power is applied during a robot's power-on procedure. This includes **all** powered weapons regardless of the power source or weight class.

3.4.7. It is expected that all builders will follow basic safety practices during work on the robot at your pit station. Please be alert and aware of your pit neighbors and people passing by.

4. Weight Classes

4.1 For 2022 this event will offer three weight classes: Beetleweight, Beetleweight-Plastic Class and Antweight.

An Antweight robot is defined as a:

- 1lb rolling robot (wheels)
- 1.5lb shuffle robot (any walking mechanism derived from continuous rotary motion)
- 2lb non-wheeled robot (linear walking mechanisms or non-rotational motion)

A Beetleweight robot is defined as a:

- 3lb rolling robot (wheels)
- 4.5lb shuffle robot (any walking mechanism derived from continuous rotary motion)
- 6lb non-wheeled robot (linear walking mechanisms or non-rotational motion)

A Beetleweight- Plastic Class (See 4.4) robot is defined as a:

- 3lb rolling robot (wheels)
- 4.5lb shuffle robot (any walking mechanism derived from continuous rotary motion)
- 6lb non-wheeled robot (linear walking mechanisms or non-rotational motion)

(There is a 100% weight bonus for non-wheeled robots. There is a 50% weight bonus for shufflers or other forms of locomotion which do not fall within the definition of non-wheeled robot - see 5.1.2 for a definition of a non-wheeled robot.)

4.4. Plastic Class

4.4.1 The purpose of the plastic class is to allow an easier entry point for those who may not have access to a full shop or just want to try something different. The plastic class is run as a separate class from the other robots, so they will only fight against other robots in the plastic class.
In general, all the normal rules apply to plastic class bots except the construction materials must be plastic as described below:

1. PET, PETG, ABS, or PLA, PLA+ are the only materials that can be used for the chassis and weapons. No other types of plastics or materials allowed (ie. metal, carbon fiber, UHMW, etc)

2. Motors, electronics, axles, fasteners and adhesives can be any material, but cannot be used in such a way to enhance the structural integrity, armor the robot, or enhance any weapon.
3. Not all weight classes will run a separate plastic class. The event organizer will specify if there will be a separate plastic class and if so for which weight class(es), ie "1lb plastic class"

Robot may be disqualified at the Event Organizer's discretion if it is deemed to violate the spirit of the class. Contact the event organizer ahead of time if you are not sure your robot meets the above definition.

5. Mobility

5.1. All robots must have **easily visible and controlled mobility** in order to compete. Methods of mobility include but are not limited to:

5.1.1. Rolling (wheels, tracks or the whole robot)

5.1.2. Non-wheeled: non-wheeled robots have **no** rolling elements in contact with the floor and **no** continuous rolling or cam operated motion in contact with the floor, either directly or via a linkage. Motion is "continuous" if continuous operation of the drive motor(s) produces continuous motion of the robot. Linear-actuated legs and novel non-wheeled drive systems may qualify for this bonus. If you are intending to enter a non-wheeled robot in any event contact the event as soon as possible to determine what if any weight bonus you will qualify for.

5.1.3. Shuffling (rotational cam operated legs)

5.2. Other methods of locomotion are not permitted, (hovercrafts, Jumping and hopping, flying, etc.)

6. Robot control requirements:

6.1. Tele-operated robots must be radio controlled, or use an approved custom system as described in 6.4.3. Radio controlled robots must use approved ground frequencies, typically 27/49/50/53/75/900/2400 for the United States.

6.2. Tethered control is typically not allowed.

6.3. Pre 1991 non-narrow band radio systems are not allowed.

6.4. Radio system restrictions for this event with corresponding weight and or weapon restrictions:

6.4.1. Radio systems that stop all motion in the robot (drive and weapons), when the transmitter loses power or signal, are required for all robots with active weapons or any robot over 12lbs. This may be inherent in the robots electrical system or be part of programmed fail-safes in the radio. Robots 1 lb and less typically will be required to have drive fail-safes.

6.4.2. All robot radio systems must have a way to change frequencies or coded channels to prevent radio conflicts. Having at least **two** frequencies or coded channels available is **required**. Lack of extra frequencies may result in a forfeit. Digital spread-spectrum radios that use frequency hopping or automatic channel selection qualify under this rule.

6.4.3. If you are using a home built control system, or a control system not covered here, you must first clear it with the event you plan to attend.

6.4.4. Toy radio systems are sometimes allowed at events for robots up to 12 lbs with no active weapons.

6.4.5. RC systems on the AM band are sometimes allowed at events for robots up to 12 lbs with no active weapons.

6.5. This event does not require a separate power switch for the radio, but it is encouraged.

7. Autonomous/Semi-Autonomous Robots: Any robot that moves, seeks a target, or activates weapons without human control is considered autonomous. If your robot is autonomous you are required to contact this event before registration.

7.1. Autonomous robots must have a clearly visible light for each autonomous subsystem that indicates whether or not it is in autonomous mode, e.g. if your robot has two autonomous weapons it should have two "autonomous mode" lights (this is separate from any power or radio indicator lights used).

8. Batteries and Power

8.1. The only permitted batteries are ones that cannot spill or spray any of their contents when damaged or inverted. This means that standard automotive and motorcycle wet cell batteries are prohibited. Examples of batteries that are permitted: gel cells, Hawkers, NiCads, NiMh, dry cells, AGM, LIon, LiFe, LiPoly, etc. If your design uses a new type of battery, or one you are not sure about please contact the event you're planning to attend.

8.2. All onboard voltages above **48 Volts** require prior approval from this event. (It is understood that a charged battery's initial voltage state is above their nominal rated value)

8.3. All electrical power to weapons and drive systems (systems that could cause potential human bodily injury) must have a manual disconnect that can be activated within **15 seconds** without endangering the person turning it off. (E.g. No body parts in the way of weapons or pinch points.) Shut down must include a **manually** operated mechanical method of disconnecting the main battery power, such as a switch (Hella, Whyachi, etc) or removable link. Relays may be used to control power, but there must also be a mechanical disconnect. Please note that complete shut down time is specified in section 3.4.3.

8.4. All efforts must be made to protect battery terminals from a direct short and causing a battery fire.

8.5. If your robot uses a grounded chassis you must have a switch capable of disconnecting this ground. ICE robots are excepted from this rule if there is no practical way to isolate their grounding components. You must contact this event for this exception.

8.6. All Robots must have a light easily visible from the outside of the robot that shows its main power is activated.

9. Pneumatics

9.1. Pneumatic systems on board the robot must only employ non-flammable, nonreactive gases (CO2, Nitrogen and air are most common). It is not permissible to use fiber wound pressure vessels with liquefied gasses like CO2 due to extreme temperature cycling.

9.2. You must have a safe and secure method of refilling your pneumatic system.

9.2.1. SPARC recommends the use of standard paintball fill fittings available at many retail outlets and online. For specs see Part#12MPS from Foster, http://www.couplers.com.

9.4. All pneumatic components on board a robot must be securely mounted. Particular attention must be made to pressure vessel mounting and armor to ensure that if ruptured it will not escape the robot. (The terms 'pressure vessel, bottle, and source tank' are used interchangeably)

9.5. All pneumatic components within the robot must be rated or certified for AT LEAST the maximum pressure in that part of the system. You may be required to show rating or certification documentation on ANY component in your system.

9.6. All pressure vessels must be rated for at least 120% of the pressure they are used at and have a current hydro test date. (This is to give them a margin of safety if damaged during a fight.) If large actuators, lines, or other components are used at pressures **above 250psi** these will also need to be over-rated and are to be pre-approved for this event.

9.7. All primary pressure vessels must have an over pressure device (burst/rupture disk or over pressure 'pop off') set to no more than 130% of that pressure vessels rating. (Most commercially available bottles come with the correct burst assemblies, use of these is encouraged)

9.8. If regulators or compressors are used anywhere in the pneumatic system there must be an (additional) over pressure device downstream of the regulator or compressor set for no more than 130% of the lowest rated component in that part of the pneumatic system.
9.9. All pneumatic systems must have a manual main shut off valve to isolate the rest of the system from the source tank. This valve must be easily accessed for robot de-activation and refilling.
9.10. All pneumatic systems must have a manual bleed valve downstream of the main shut off valve to depressurize the system. This bleed valve must be easily accessed for deactivation. This valve must be left OPEN whenever the robot is not in the arena to ensure the system cannot operate accidentally.
9.10.1. It is **required** to be able to easily bleed all pressure in the robot before exiting the arena. (You may be required to bleed the entire system if it is believed that you have any damaged components.)
9.11. All regulated pneumatic systems must have an appropriate gauge scaled for maximum resolution of the pressure on the low-pressure side of the system. HPA (air, nitrogen, or inert gas) systems must have gauges on both the high AND low-pressure sides of regulators. A gauge or other clear visual indication that the system is charged is strongly recommended for all pneumatic systems. Whether specifically required or not.
9.12. If back check valves are used anywhere in the system you must ensure that any part of the system they isolate can be bled and has an over pressure device.
9.13. Any pneumatic system that does not use a regulator, or employs heaters or pressure boosters, or pressures above 2500psi must be pre-qualified by the event you're planning to attend.

10. Hydraulics

10.1. Robots in the 12 lb class or lighter are exempt from the remaining rules in this section, but good engineering and best practices must be used in all hydraulic systems. **However the pressure for 12 pound or less robots is limited to 250psi and there must be an easy way to determine this pressure.** Contact the event with any questions.
10.2. All hydraulic components onboard a robot must be securely mounted. Particular attention must be made to pump and accumulator mounting and armor to ensure that if ruptured direct fluid streams will not escape the robot.
10.3. All hydraulic components within the robot must be rated or certified for AT LEAST the maximum pressure in that part of the system. You may be required to show rating or certification documentation on ANY component in your system.
10.4. Any accumulators or large reservoir must be rated for at least 120% of the pressure they are used at. (This is to give them a margin of safety if damaged during a fight)
10.5. All hydraulic systems must have an over pressure by pass device set to no more than 130% of the lowest component rating. It must be rated to bypass the full volume of the hydraulic pump.
10.6. All hydraulic systems must have a(n) accessible manual bypass valve(s) to easily render the system harmless.
10.7. All hydraulic systems must have appropriate gauges scaled for maximum resolution of the pressures in that part of the system.
10.8. All hydraulic systems must use non-flammable, non-corrosive fluid and must be designed not to leak when inverted.
10.9. Any hydraulic system using pressure boosters, or pressures above 5000psi (without accumulator) or pressures above 2000psi (with accumulator) must be pre-qualified by the event.

11. Internal Combustion Engines (ICE) and liquid fuels are typically not allowed.

12. Rotational weapons or full body spinning robots are allowed at the events, however:

12.1. Spinning weapons that can contact the arena walls above 5 inches from the arena floor during normal operation must be pre-approved by the event. (Spinning weapons that can contact the arena walls below 5 inches are allowed and do not require prior permission.)

12.2. Spinning weapons must come to a full stop within **60 seconds** of the power being removed using a self-contained braking system.

13. Springs and flywheels

13.1. Springs used in robots in the 12 lbs class or smaller and those loaded simply by the weight of the robot(eg. suspension systems) are excepted from the rules in this section. However safe operation and good engineering are always required.

13.2. Any large springs used for drive or weapon power must have a way of loading and actuating the spring remotely under the robot's power.

13.2.1. Under no circumstances must a large spring be loaded when the robot is out of the arena or testing area.

13.2.2. Small springs like those used within switches or other small internal operations are excepted from this rule.

13.3. Any flywheel or similar kinetic energy storing device must not be spinning or storing energy in any way unless inside the arena or testing area.

13.3.1. There must be a way of generating and dissipating the energy from the device remotely under the robot's power.

13.4. All springs, flywheels, and similar kinetic energy storing devices must fail to a safe position on loss of radio contact or power.

14. Forbidden Weapons and Materials. The following weapons and materials are absolutely forbidden from use:

14.1. Weapons designed to cause invisible damage to the other robot. This includes but is not limited to:

14.1.1. Electrical weapons

14.1.2. RF jamming equipment, etc.

14.1.3. RF noise generated by an IC engine. (Please use shielding around sparking components)

14.1.4. EMF fields from permanent or electro-magnets that affect another robot's electronics.

14.1.5. Entangling Weapons or defenses: these are weapons or defenses that can reasonably be expected to stop drive train and/or weapon motion by being wrapped around rotating parts. This includes nets, tapes, strings, and other entangling materials or devices.

14.1.6. Weapons or defenses that that can reasonably be expected to stop combat completely of both (or more) robots.

14.2. Weapons that require significant cleanup, or in some way damages the arena to require repair for further matches. This includes but is not limited to:

14.2.1. Liquid weapons. Additionally a bot may not have liquid that can spill out when the robot is superficially damaged.

14.2.2. Foams and liquefied gasses

14.2.3. Powders, sand, ball bearings and other dry chaff weapons

14.3. Un-tethered Projectiles (see tethered projectile description in Special Weapons section 15.1)

14.4. Heat and fire are forbidden as weapons. This includes, but is not limited to the following:

14.4.1. Heat or fire weapons not specifically allowed in the Special Weapons section (15.2)

14.4.2. Flammable liquids or gases

14.4.3. Explosives or flammable solids such as:

14.4.3.1. DOT Class C Devices

14.4.3.2. Gunpowder / Cartridge Primers

14.4.3.3. Military Explosives, etc.

14.5. Light and smoke based weapons that impair the viewing of robots by an Entrant, Judge, Official or Viewer. (You are allowed to physically engulf your opponent with your robot however.) This includes, but is not limited to the following:

14.5.1. Smoke weapons not specifically allowed in the Special Weapons section (15.3)

14.5.2. Lights such as external lasers above 'class I' and bright strobe lights which may blind the opponent.

14.6. Hazardous or dangerous materials are forbidden from use anywhere on a robot where they may contact humans, or by way of the robot being damaged (within reason) contact humans. Contact the event you plan to attend if you have a question.

15.Special weapon descriptions allowed at this event:

15.1. Tethered Projectiles are not allowed at this event.

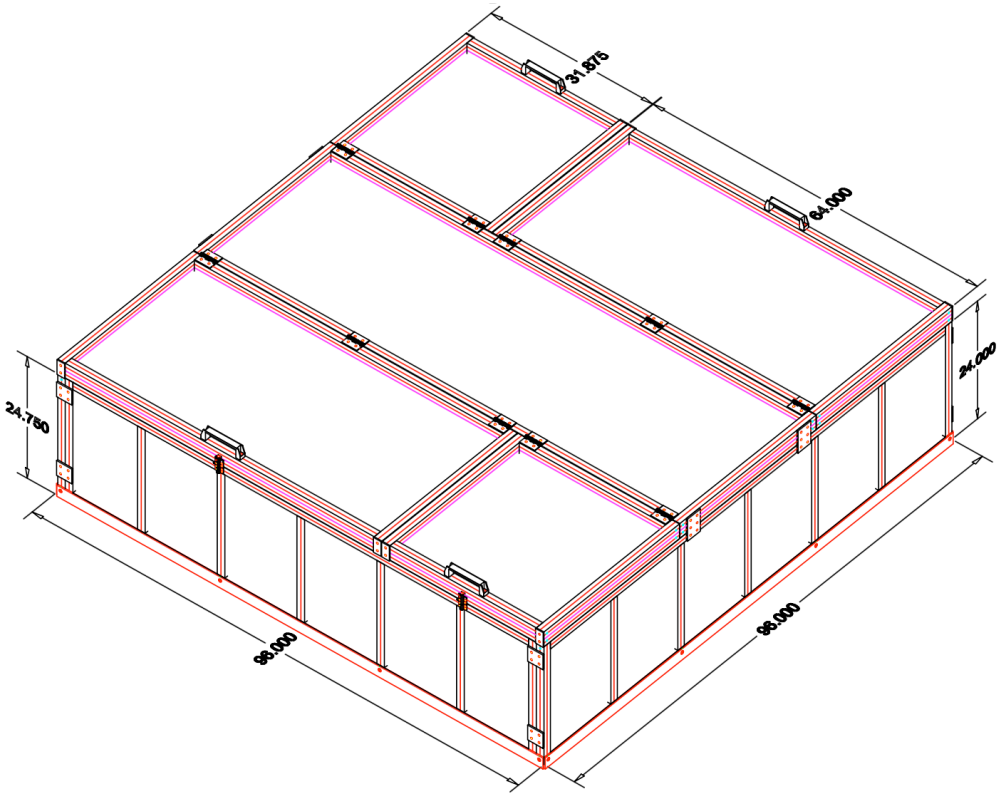
15.2. Heat and Fire are not allowed at this event.

16. Surrender Rule

16.1. Each team will have a towel that can be thrown onto the Combat Arena to forfeit a match. This can be done at anytime once the judges have started the match.

17. Decisions of the judges are final and binding.

Battlefield - The field measures 8' square with a 24" interior height on a steel, concrete or plywood floor. The frame of the enclosure is made from 80/20 with clear Lexan panels for added safety and easy viewing. The floor may include trap doors that can be activated during the match. Other hazards may also be included.



FINAL EVENT - Combat Robot

LEVEL: _____ Middle School _____ High School _____ Post Secondary

WEIGHT CLASS: _____ Antweight (1#) _____ Beetleweight (3#) _____ Beetleweight- Plastic (3#)

SCHOOL: _____

CAPTAIN: _____

Size Requirement Passed: _____ Robot Size Requirement: 14” x 14” x 14”

Weight Requirement Passed: _____

Robot Safe to Compete: _____

Evaluation Form

Criteria	Approved
Spinning weapons come to a full stop within 60 seconds of the power being removed using a self-contained braking system.	_____
Spinning weapons can not contact wall above 5 inches.	_____
All springs, flywheels, and similar kinetic energy storing devices fail to a safe position on loss of radio contact or power.	_____
Moving weapons that can cause damage or injury have a clearly visible locking device. Locking devices are painted in neon orange or another high-visibility color. Locking devices are clearly capable to stopping, arresting or otherwise preventing motion of the weapon.	_____
Weapon locking pins in place for robot’s power-on procedure.	_____
Robot can be **FULLY** deactivated, which includes power to drive and weaponry, in under 60 seconds by a **manual disconnect**.	_____
Electrical power to weapons and drive systems (systems that could cause potential human bodily injury) has a **manual disconnect** that can be activated within 15 seconds without endangering the person turning it off. (E.g. No body parts in the way of weapons or pinch points.)	_____
Radio system stops all motion in the robot (drive and weapons), when transmitter loses power or signal.	_____
Onboard voltages is less than 48 Volts	_____
Pneumatics and/or Hydraulics meets requirements (if applicable)	_____

Judge’s Comments:

_____

_____

Judge’s Signature: _____

Manufacturing Workcell (Virtual)

Middle School, High School, Post-Secondary

(Updated for 2022)

Contest Description

In the Manufacturing Workcell contest, the participants design, construct, and operate a system that performs one or more manufacturing processes. The manufacturing workcell may include operations that demonstrate both fundamental and/or advanced applications.

Rules

Each manufacturing workcell shall include:

1. Mechanical devices such as transfer and clamping devices.
2. Electronic controlling device(s) such as computers or PLC's.
3. Each manufacturing workcell must fit within an 15' x 15' footprint.
4. All items manufactured by students must be marked with a red dot.
5. Decisions of the judges are final and binding.

Judging

1. Submit a 3-7 minute video outlining the rules above and address the evaluation criteria on the contest rubric.
2. Cover the mechanical devices and electronic controlling devices, identifying student designed and built items. Video should include a demonstration of the workcell in operation.
3. Teams may also want to submit a written report or design brief to assist the judges with their review.
4. If necessary, NRC Judges may request an online team interview to get additional clarification.

FINAL EVENT - Manufacturing Workcell

Rubric and Evaluation Criteria

Rubric and Evaluation Criteria for Standards-Based Robotics Competitions & Related Learning Experiences

Evaluation Criteria	Expert = 4	Proficient = 3	Emergent = 2	Novice = 1	Assessment			Comments
					Self	Peer	Instructor	
Design & Process Criteria								
Creating Viable Solutions to a Variety of Human Wants, Needs, and Challenges.	Multiple, well developed solutions exist meeting all critical criteria	Multiple solutions are evident & one is developed meeting majority of criteria	Multiple, undeveloped solutions are evident	A solution that may or may not be developed is evident				
Simple and Complex Systems	All simple & complex systems are identified & function efficiently	Functioning simple and complex systems exist	Multiple simple systems exist that may function	One functioning simple system exists				
Design Process (scientific method, technological problem solving process, etc.)	Formal design process utilized, documented & enhances efficiency	Formal design process utilized and fully documented	Formal design process utilized consistently	Some evidence that formal design process was utilized				
Utilization of Resources: (Tools/Machines, Materials, Information, People, Capital, Energy, & Time)	Resources used within constraints, efficiency maximized, environmental harm minimized	Resources utilized to maximize efficiency	Evidence that some resources utilized meeting intended purpose	A few resources (e.g., tools & materials) utilized randomly				
Technical Criteria								
Programming (Autonomous and/or tele-op)	Efficiency and sophistication evident in multiple programs	Consistency evident in one or more programs	Functional, but inconsistent programming	Programming incomplete or rarely functional				
Control Systems	Completely functional and consistent control systems	Consistently functional control systems	Functional, but inconsistent control systems	Non-functional or incomplete control systems				
Electrical Systems	Completely functional and consistent electrical systems	Consistently functional electrical systems	Functional, but inconsistent electrical systems	Non-functional or incomplete/unsafe electrical systems				
Mechanical Systems	Completely functional and consistent mechanical systems	Consistently functional mechanical systems	Functional, but inconsistent mechanical systems	Non-functional or incomplete/unsafe mechanical systems				
Fluid Systems (pneumatics, hydraulics, etc)	Completely functional and consistent fluid systems	Consistently functional fluid systems	Functional, but inconsistent fluid systems	Non-functional/incomplete/unsafe systems				
Unifying Themes (This area emphasizes the Interaction of Science, Technology, & Human Endeavor)								
Communication (written and oral)	Sophisticated and highly efficient communication for all audiences	Purposeful, consistent, effective communication	Purposeful, fairly consistent communication	Communication very inconsistent and lacks purpose				
Teamwork	Integrated teamwork that maximizes outcomes is evident	Participants fully define roles, goals, & work together	Participants partially define roles, goals, & work together	Participants function separately within a group				
Ethics in Decision-Making	Ethical behavior is fully exhibited and advocated for throughout the process	Decisions guided by design constraints, Asimov's laws, and interpersonal ethics	Ethical decisions concerning design constraints evident	Ethics considered, but not applied to decisions				

FINAL EVENT - Manufacturing Workcell

LEVEL: **_____ Middle School** **_____ High School** **_____ Post Secondary**

SCHOOL: _____

CAPTAIN: _____

Judging Criteria	Expert	Proficient	Emergent	Novice	**Points Awarded**
Creating Viable Solutions to a Variety of Human Wants, Needs, and Challenges.	50	40	30	20	
Simple and Complex Systems	50	40	30	20	
Design Process (scientific method, technological problem solving process, etc.)	50	40	30	20	
Utilization of Resources: (Tools/ Machines, Materials, Information, People, Capital, Energy, & Time)	50	40	30	20	
Programming (Autonomous)	50	40	30	20	
Control Systems	50	40	30	20	
Electrical Systems	50	40	30	20	
Mechanical Systems	50	40	30	20	
Communication (written and oral)	50	40	30	20	
Teamwork	50	40	30	20	
Ethics in Decision-Making	50	40	30	20	
Total points available	**550**				
Total points awarded					

Judge's Comments:

_____

_____

Judge's Signature: _____

Micromouse Contest

Middle School, High School, Post-Secondary

Contest Description
In the Micromouse Contest, the contestant or team of contestants design and build a small self-contained robot (Mouse) to negotiate a right/left turn maze in the shortest possible time.

The following rules were adapted from the 1986 official rules for the North American Micromouse Contest.

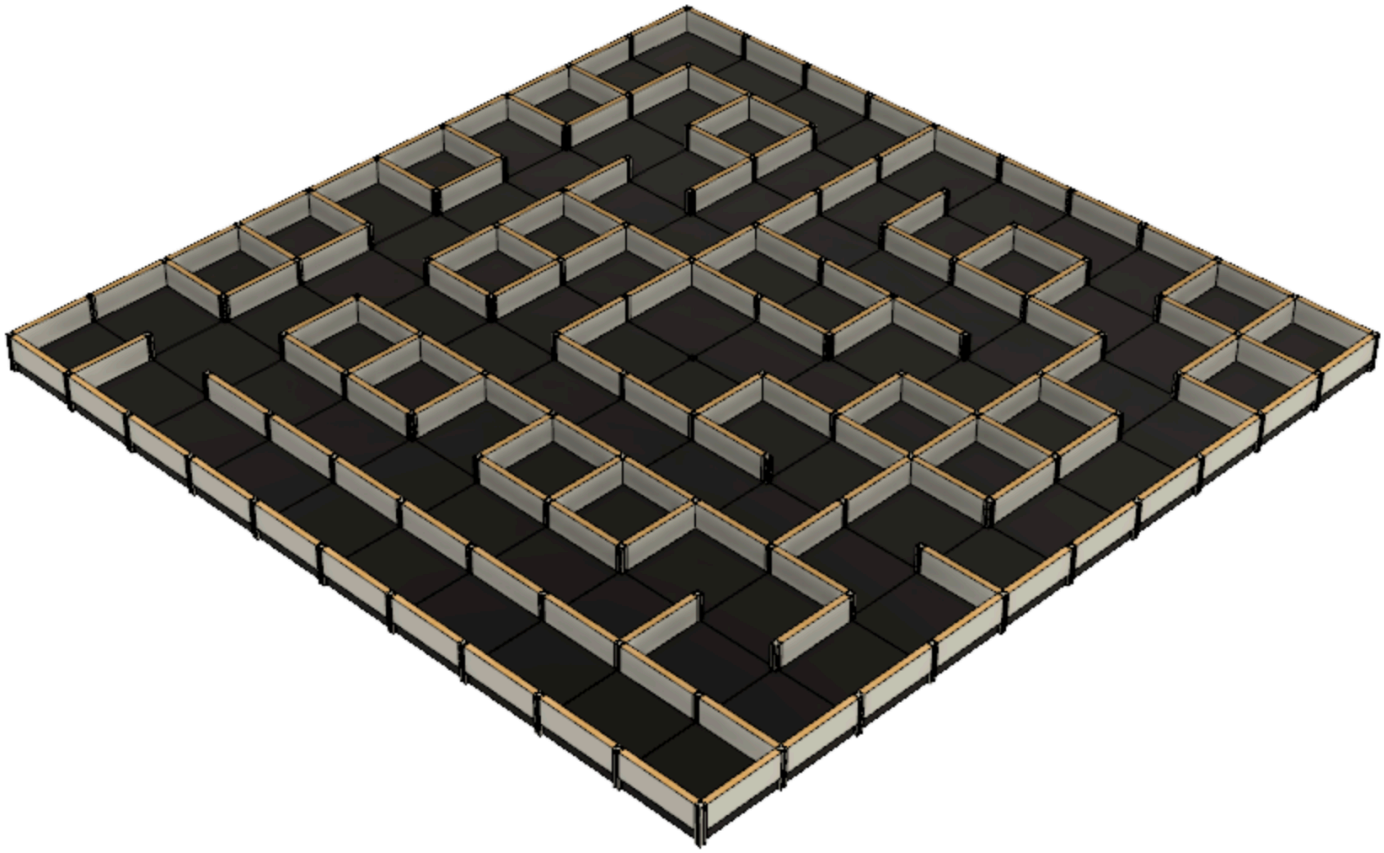
Rules

1. The micromouse robot shall be self-contained (no remote controls). A micromouse robot shall not use an energy source employing a combustion process.
2. A micromouse robot shall not leave any part of its body behind while negotiating the maze.
3. A micromouse robot shall not jump over, fly over, climb, scratch, cut, burn, mark, damage, or destroy the walls of the maze.
4. A micromouse robot shall not be larger than 7” x 7” x 7”
5. Micromouse robots outside the criteria in rules 1 through 4 must be brought into compliance before being allowed to compete.
6. The maze is composed of multiple 10 inch by 10 inch square sections. The walls of the maze are 3 inches high and .75 inches thick (**assume 5% tolerance for mazes**). Thus, the internal navigable area within a square is 9.25 inches by 9.25 inches. The maze comprises up to 10 x 10 unit squares, for a total maze size of up to 100 sections. The outside wall encloses the entire maze.
7. The sides of the maze walls, are painted white, the floor of the maze is painted black and the and the top of the walls may be any color or unpainted. The maze is made of wood, finished with non-gloss paint with aluminum 80/20 posts on each corner of the 10” x 10” sections.
8. **WARNING:** Do not assume the walls, the tops of the walls, or the floor are consistently white or black. Fading may occur; parts from different mazes may be used. Do not assume the floor provides a given amount of friction. It is simply painted plywood and may be quite slick. There may be a seam between the two sheets on which any low-hanging parts of a robot may snag.
9. The start of the maze is located at one of the four corners. The start square is bounded on three sides by walls. The start line is located between the first and its second squares. That is, as the robot exits the corner square, the time starts. The destination goal is the four cells at the center of the maze. The destination square has only one entrance.
10. Multiple paths to the destination square are allowed and are to be expected. The destination square will be positioned so that a wall-hugging robot will not be able to find it.
11. Each robot is **not** allocated any time to access the maze prior to their first run. Contestants have 10 minutes total to complete as many runs as they wish. Any time used to adjust a robot between runs is included in the 10 minutes. Each run (from the start cell to the center zone) in which a robot successfully reaches the destination square is given a run time.
12. The minimum run time shall be the robot's official time.
13. If a robot is in mid-run when the ten minute total time elapses, that attempt is finished and does not count. If no robots (or less that 3) finish their runs in under ten minutes, ranking will be determined by the sole discretion of the judges.
14. Robots that do not enter the center square will be ranked by the maximum number of cells they consecutively transverse without being touched. However, judges are not required to give any rankings to robots who do not finish, and may declare no winners or declare less than 3 winners at their discretion.
15. Two timers are used for each contestant. One for the ten-minute total time, and a separate timer for each run within the total time.
16. The initial run shall be made from a random one of the four possible starting squares. Following runs within the 10 minutes allowed shall all be from the same starting square as the first run.
17. If a robot has already crossed the finish line, it may be removed at any time without affecting the run time of that run. If a robot is placed back in the maze for another run, a one-time penalty of 30 seconds will be added to the robot's best time.

18. The operator may abort a run at any time. If an operator touches the robot during a run, it is deemed aborted, and the robot must be removed from the maze.
19. If a robot has already crossed the finish line, it may be removed at any time without affecting the run time of that run.
20. After the maze is disclosed, the operator shall not feed information on the maze into the robot however, switch positions may be changed for the purpose of changing programs within the robot (changing algorithms is allowed. Entering info on the maze is not allowed and does not constitute "changing algorithms".).
21. The amount of sunlight, incandescent light, or fluorescent light that may be present at the contest site will vary based on the contest location and environmental factors. Teams should plan accordingly.
22. The run timer will start when the front edge of the robot crosses the start line and stops when the front edge of the robot crosses the finish line.
23. The start line is at the boundary between the starting unit square and the next unit square. The finish line is at the entrance to the destination square.
24. Every time the robot leaves the start square, a new run begins. If the robot has not entered the destination square, the previous run is aborted. For example, if a robot re-enters the start square (before entering the destination square) on a run, that run is aborted, and a new run will be deemed begun, with a new time that starts when the starting square is exited.
25. The robot may, after reaching the destination square, continue to navigate the maze, for as long as their total maze time allows.
26. If a robot continues to navigate the maze after reaching the destination square, the time taken will not count toward any run. Of course, the 10-minute timer continues to run. When the robot next leaves the start square, a new run will start. Thus, a robot may and should make several runs without being touched by the operator. It should make its own way back to the beginning to do so.
27. The judges reserve the right to ask the operator for an explanation of the micromouse robot. The judges also reserve the right to stop a run, declare disqualification, or give instructions as appropriate (e.g., if the structure of the maze is jeopardized by continuing operation of the robot).
28. A contestant may not feed information on the maze to the micromouse robot. Therefore, changing ROMs or downloading programs is NOT allowed once the maze is revealed.
    However, contestants are allowed to:
    a. Change switch settings (e.g. to change algorithms (for example from left-turning to right turning - again, entering data on maze size or content is NOT inclusive of this rule.)
    b. Replace batteries between runs
    c. Adjust sensors
    d. Change speed settings
    e. Make repairs
29. A contestant may not alter a robot in a manner that alters its weight (e.g. removal of a bulky sensor array or switching to lighter batteries to get better speed after mapping the maze is not allowed).
30. All robots, whether or not they have competed in previous contests, compete on an equal basis.
31. The robot must meet all other qualifications and must be presented to the judges by the original design team at the time designated in the official contest schedule.
32. Once checked in, the robot will remain at the judges station until the team's time to run.
33. A pit area, with access to 110-volt standard outlet, will be provided.
34. Decisions of the judges are final and binding.

EXAMPLE - Maze

NOT ACTUAL MAZE LAYOUT



Pre-Competition Device Evaluation/ Interviews – Micromouse Contest

LEVEL: **_____ Middle School** **_____ High School** **_____ Post Secondary**

SCHOOL: _____

CAPTAIN: _____

Judging Criteria

Size Requirements	
(maximum) 7" wide 7" long 7” high	Check if the requirement has been met. _____
Fastest Maze Run	

Entries not meeting any of the above criteria must be brought into compliance before being allowed to compete.

Judge’s Comments:

_____

_____

Judge’s Signature: _____

Pick and Place Programming (Virtual)

(Updated for 2022)

Payload- 3Kg or Less, Payload- Greater than 3Kg
Middle School, High School

Contest Description
In the Pick and Place Programming Contest, the team is required to pick and place designated objects. There are two sections: arms with a maximum payload of 3Kg or less and arms with a maximum payload greater than 3Kg. During the event each team is required to program their robot by teach pendant or computer pendant to pick and place the designated objects.

Rules

1. The team will be required to pick and place objects using a programmable robotic arm.
2. Scoring will be based on programming time, "run" time, and accuracy of the placement of the designated objects.
3. The robot is expected to start from a designated "home" position and return to the "home" position.
4. Each team is to supply a tabletop robot, computer and power strip.
5. The footprint will be provided at the competition.
    - An example Pick and Place Contest Footprint and dimensioned drawing is pictured on the next page.
6. The decisions of the judges are final and binding.

Challenge Description

5. Dice (cubes) start at the top of the drawing in the 48 squares. Students need to create a program that moves the dice from the top starting location down to the letters “NRC” (you only need 36 dice to complete the “NRC” letters). Once all of the dice have been moved down, they need to be moved back to their starting location.
6. Students may not start the contest with any part of their program completed.
7. You need to use 48 - 16mm (5/8") dice or cubes. Dice can be bought almost anywhere (Walmart) or cubes can be purchased online https://www.gameparts.net/counting-cubes.htm
8. You will use this drawing to compete with. (.pdf) (.dxf) (SolidWorks)
9. If a dice placed in the boxes for “NRC” touches the black lines, the dice will be considered not properly placed and a time penalty will be added for each one touching a line. This is also the case when you move dice from the “NRC” back to the top - any dice touching the outer black square will incur a penalty.

Judging

1. Teams will submit a 2-5 minute video showing the student team working on their pick and place programs. At the end of the video, include their elapsed programming time as well as the "run-time" of their final solution. Also include an overhead view of their completed solution.
2. Use a tool like StopwatchVideo to record a video of your robot completing the final solution program. (must show stopwatch in video)
3. If necessary, NRC Judges may request an online team interview/demonstration to get additional clarification.

FINAL EVENT - Pick and Place Programming

EVENT: _____ **≤ 3Kg Payload** _____ **> 3Kg Payload**

LEVEL: _____ **Middle School** _____ **High School**

SCHOOL: _____

CAPTAIN: _____

1. Programming and Automatic Sequence Phase Timing

Programming Time		**Total Time** *(in minutes)*
Start time:	End time:	
Automatic Sequence Time		**+**
Start time:	End time:	
	Subtotal Programming Time + Sequencing Time	
	Time Subtotal	

2. Accuracy of Placement

Accuracy of Placement	**Total**
Number of objects positioned outside of designated placement footprint	
Penalty time	**X 10 minutes**
Accuracy Subtotal	

3. Final Scoring Totals ***(Note, lower scores are better than higher scores)***

Final Score	**Totals**
Subtotal Time (from #1)	
Subtotal Accuracy (from #2)	
FINAL SCORE	

Judge's Comments:

_____

_____

Judge's Signature: _____

Rescue Robot

Middle School, High School

Contest Description

In the Rescue Robot contest, the participants build a remote controlled vehicle able to operate within a 18-foot long and 10-foot wide playing field. The vehicle is to travel the field and pick up four colored ping-pong balls from four holding devices (pick pylons) locations and place them into a receiving jig (drop pylons). The event is intended to simulate the environment a robot might be required to navigate in the event of a building collapse.

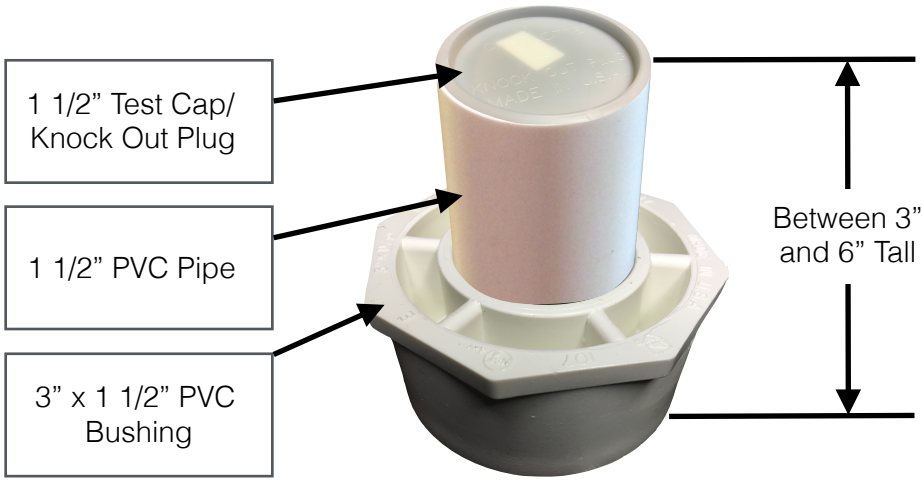
Rules

1. Each remote controlled vehicle (RCV) must be designed and constructed by the student(s).
2. Out-of-Box RCV's are not allowed, however, out-of-box RCV's may be dismantled and components used to construct a modified RCV, maximum out-of-box content shall be 40%.
3. The RCV shall not exceed 18" in width, 18" in length and 10" in height at the beginning of each match. Vehicles outside the size criteria must be brought into compliance before being allowed to compete. Once the match has begun the RCV can expand beyond the beginning size. **Device evaluation will take place at the time indicated on the Official Schedule.**
4. Each vehicle must have the ability to change between at least 2 different frequencies. Consider investing in a 2.4 GHz system such as Futaba's FASST system (https://www.futabarc.com/technology/fasst.html) or Spectrum system (https://www.spektrumrc.com/)
5. Double elimination matches will decide the winner of the contest.
6. At the beginning of the match the judge will flip a coin to determine which color ping pong ball each robot will retrieve. There are four (4) pick pylons for each robot, one set of orange and one of white. There will be two drop pylons, one orange and one white, that the team must place their color ball onto.
7. The starting line for the RCV shall be 24" from the corner of the playing field.
8. **ONE** team member will be the designated operator during the timed evaluation. Once the match has begun only the designated operator and/or the judge(s) may contact the vehicle, controller, and any part of the vehicle or playing surface.
9. The designated operator must stand on the narrow end of the field closest to their team starting position.
10. Each robot must stay on their own side of the middle barrier. Any robot crossing mid-field will forfeit that match.
11. The robot should incorporate some type of imaging sensor or camera that can wirelessly transmit visual data to the operator for navigation inside the "cave".
12. If a ping-pong ball is dropped inside the playing field the robot can retrieve it and continue play.
13. If a ping-pong ball is dropped outside of the playing field the judge will return it to its original holding device.
14. If a vehicle becomes immobilized for any reason, the designated operator may ask a judge to return the vehicle to the start position. If the vehicle is in the process of moving a ball, that ball must be returned to the holding device that it originated from. There will be no penalty other than having to begin from the start position.
15. Each match will be 3 minutes in length. If one team retrieves all four ping-pong balls of their designated color the match ends and they are declared the winner.
16. If at the end of 3 minutes both teams have the same number of ping-pong balls in the receiving jigs then both robots are returned to the starting position for a sudden death match. The first team to deposit one of their ping-pong balls in a receiving jig is the winner.
17. At the start of judging for this competition, all teams must turn in their controller to the judges. If any member of a team removes and operates their controller thereby interfering with another robot they will be disqualified from the competition.
18. A pit area, with access to 110-volt standard outlet, will be provided.
19. Decisions of the judges are final and binding.

NOTE: A team/robot could enter in both an NRC event such as "Rescue Robot" and the "Sea, Air and Land Challenge".

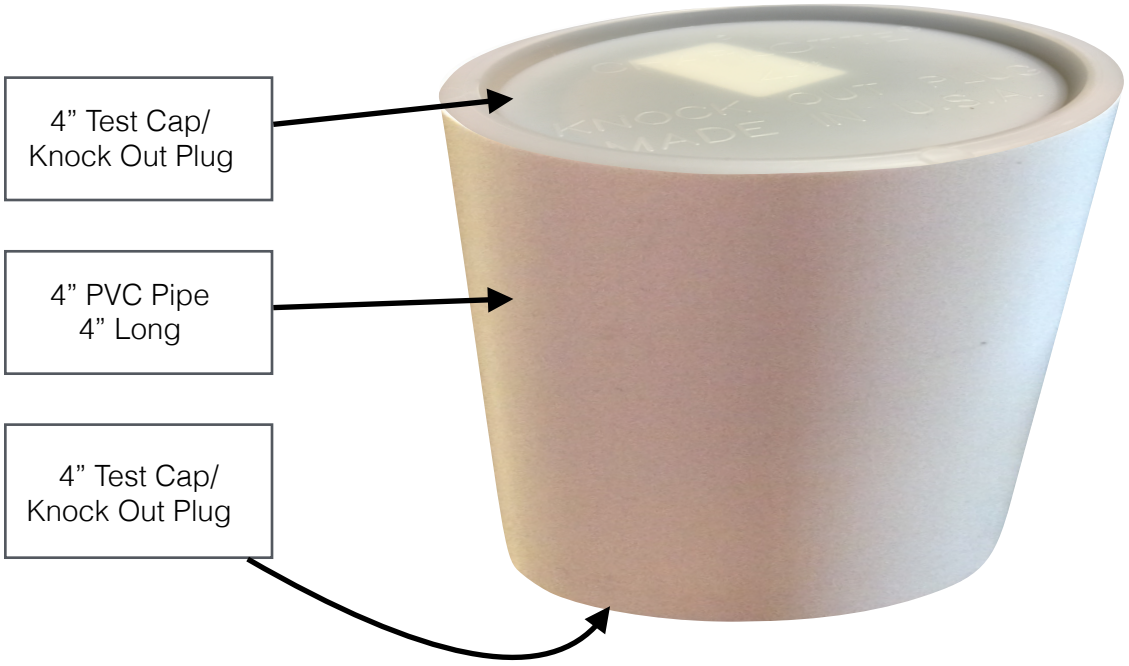
Pick Pylon – Rescue Robot

Note: Height of Pick Pylons will be between 3” and 6” off of the base surface.



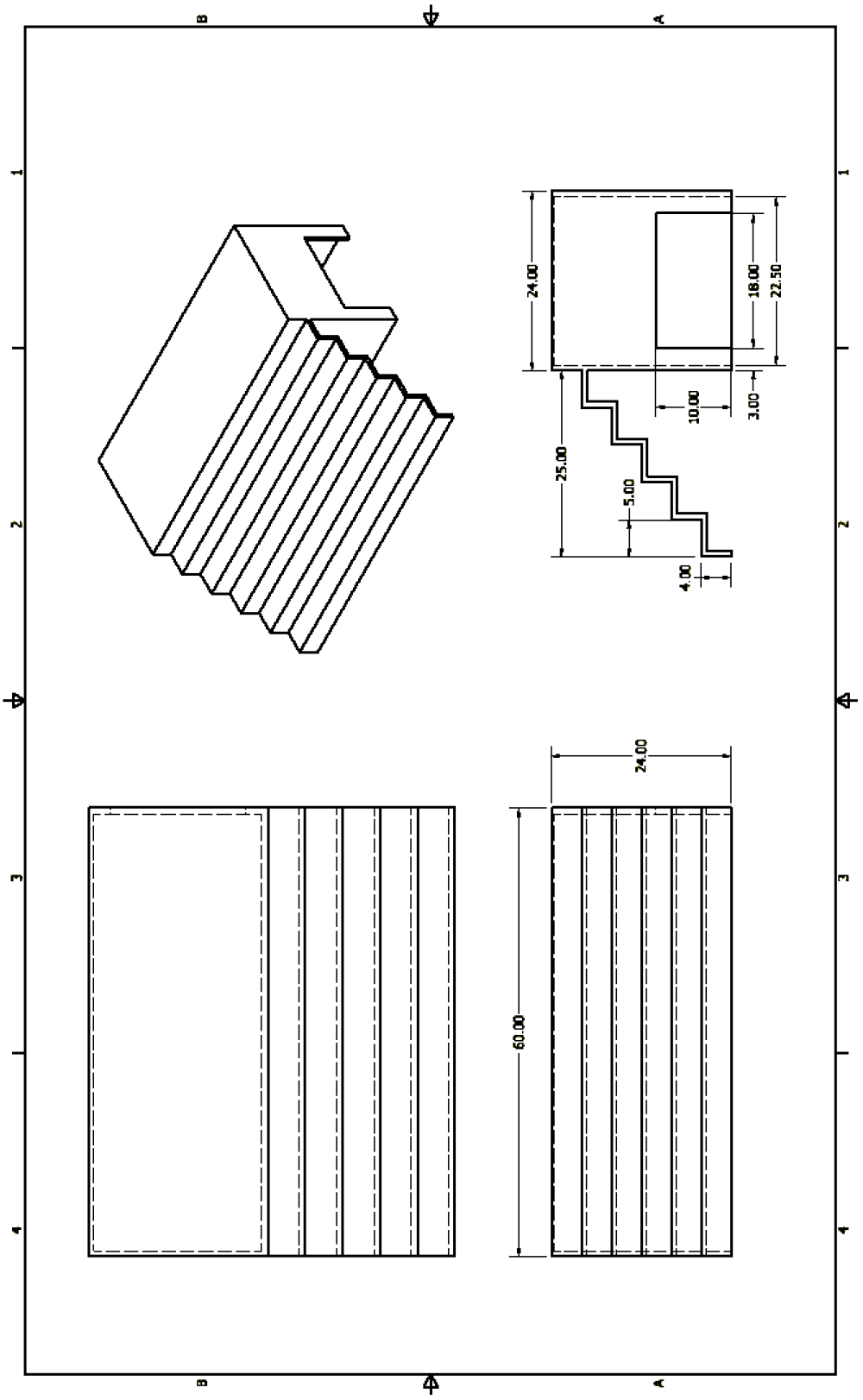
Drop Pylon – Rescue Robot

Note: Drop Pylons will be filled with dry sand for mass and stability. Pylon is 4 inches high.



Rescue Robot

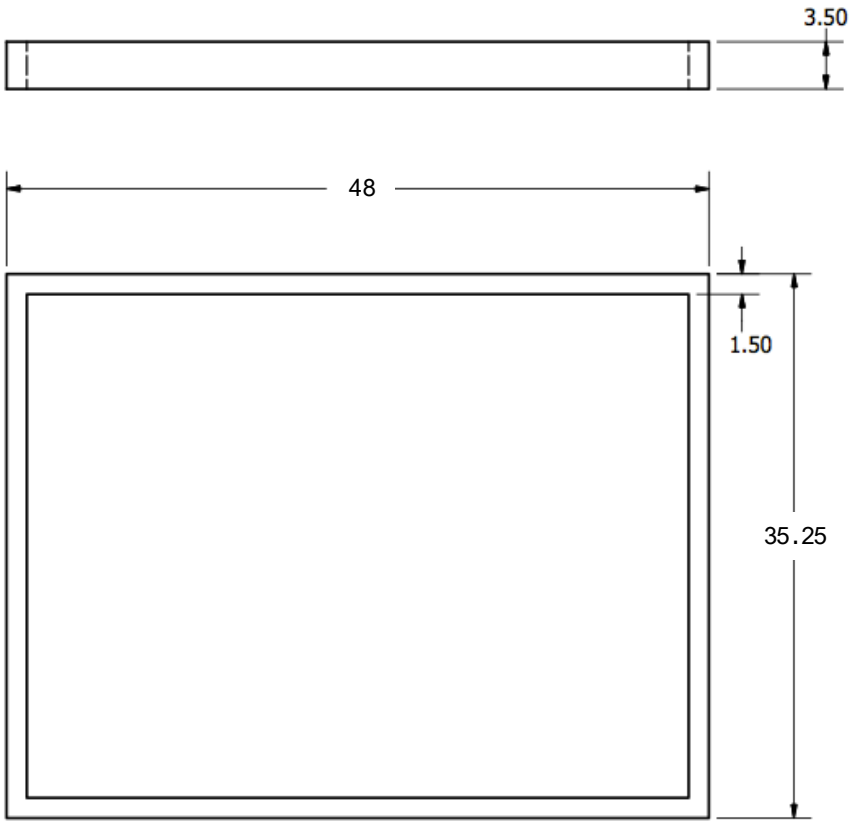
Cave



Rescue Robot

Middle School, High School

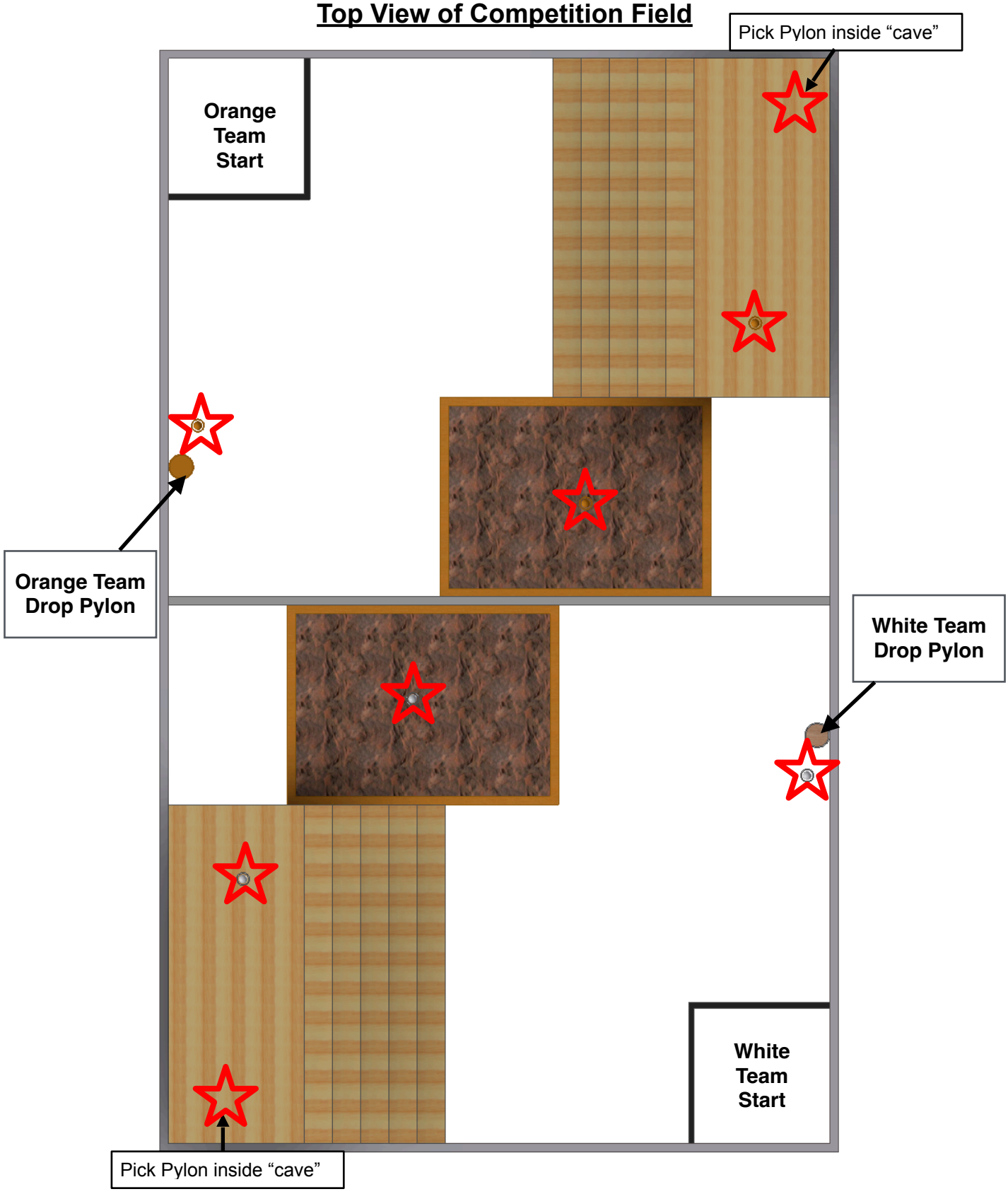
Gravel Pit



Rescue Robot

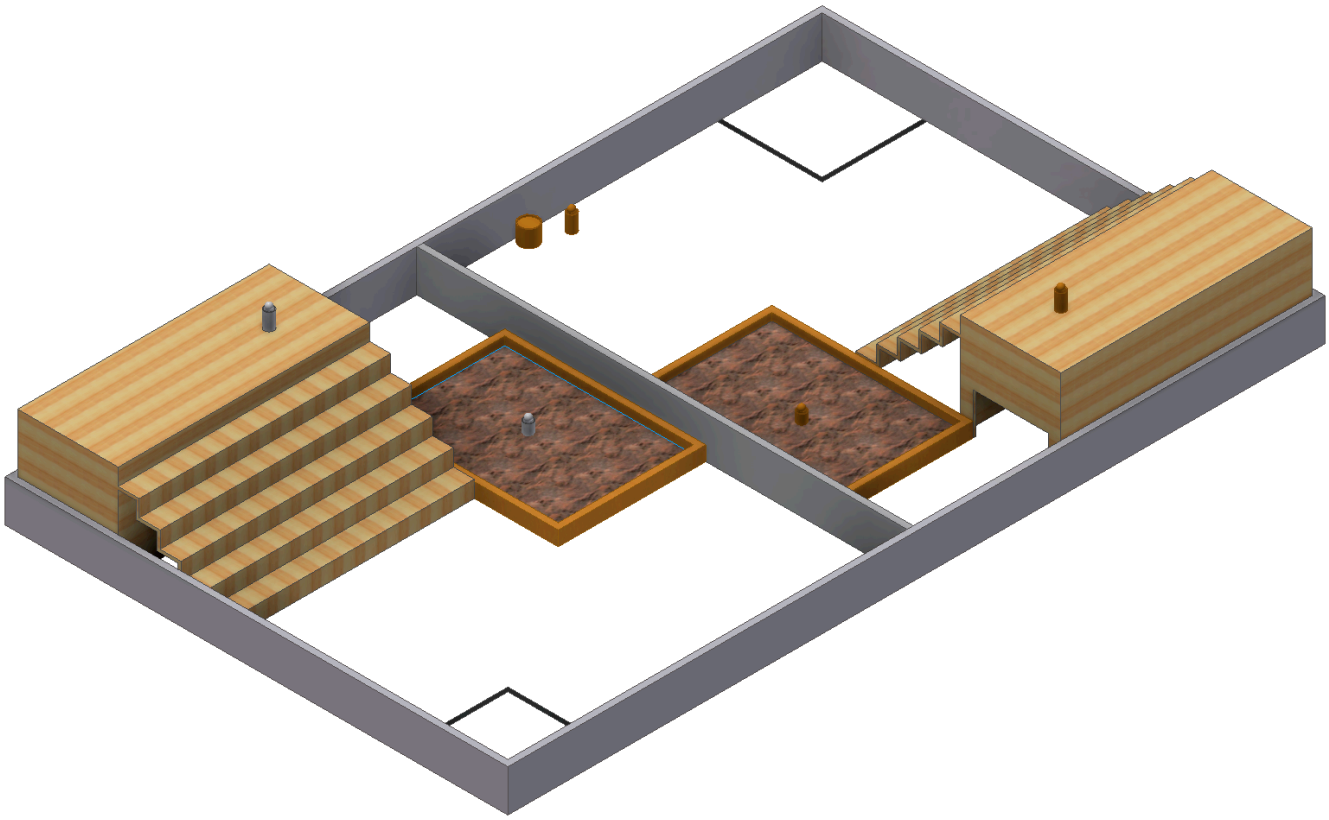
Middle School, High School

Top View of Competition Field



Rescue Robot

Isometric View of Competition Field



Pre-Competition Device Evaluation/ Interviews – Rescue Robot

LEVEL: **_____ Middle School** **_____ High School**

SCHOOL: _____

CAPTAIN: _____

Judging Criteria

Rescue Robot	
(Maximum out-of-box content is 40%)	Check if the requirement has been met. _____
Size Requirements	
(maximum) 18" wide 18" long 10” high	Check if the requirement has been met. _____

Entries not meeting any of the above criteria must be brought into compliance before being allowed to compete.

Judge’s Comments:

_____

_____

Judge’s Signature: _____

Robo Hockey

Remote-Controlled

Middle School, High School

Contest Description

The Robo Hockey contest requires a student team to build ***two*** remote controlled robots that will compete in a simulated hockey event against two robotic opponents. The team that scores the most goals in a three minute match wins. The event is held in a double elimination format tournament.

Rules

1. The robot must be powered by electrical storage batteries. No other power sources will be allowed. These batteries must be sealed and all possible precautions must be incorporated into the design to prevent accidental spills.
2. Each robot must be radio-controlled with the ability to change between at least 2 different frequencies. We recommend that teams invest in a 2.4 GHz system such as Futaba's FASST system (https://www.futabarc.com/technology/fasst.html) or Spectrum system (https://www.spektrumrc.com/)
3. The robot must fit inside a 12" x 12" x 12" space and cannot exceed 15 pounds. Any robot entered that does not meet the size requirement by the end of the device evaluation will be disqualified.
4. Only the shooting mechanism may expand beyond the 12" x 12" x 12" size during competition. This mechanism may extend for shooting the "puck" ONLY and must immediately withdraw to within the 12" x 12" x 12" envelope. At no time may the shooting mechanism be extended to block the goal, another robot, or as a defensive move.
5. **Device evaluation will take place at the time indicated on the Official Schedule**
6. The robot drive wheels **must** be non-destructive to the playing surface.
7. This event is a full contact sport. Robots may suffer damage due to the rough nature of the match. In the event that both robots on a team are damaged beyond repair the team must forfeit the match.
8. Any robot that is deemed too dangerous to the hockey field, judges or spectators by the NRC staff or judges will be disqualified.
9. At the conclusion of each match the winning robot must be weighed to ensure that legal weight has been maintained.
10. Robots may have a maximum speed of 10 feet per second.
11. Double elimination contests will decide the winner.
12. At the beginning of each competition the robot handler(s) will position their robot on the playing surface. Each robot will start in one of the four corners of the playing surface. At the command of the judge/facilitator, the handler(s) will begin the contest.
13. Each robot may have a maximum storage of 200 PSI and a maximum kinetic PSI of 100
14. A robot may not at any time enclose more than 50% of the hockey puck (sides or top)
15. A robot may never intentionally lift the hockey puck.
16. Each match will be three minutes in duration. Time will **NOT** stop on a penalty or score.
17. A team is automatically declared the winner if they score eight goals more than the opposing team.
18. In the event of a tied score at the end of time, the match will be determined with a shootout. Each team will shoot one foot from the goal line and will continue moving back from the goal one additional foot until a team fails to score.
19. Matches will use a Franklin NHL Roll-A-Puck Street/Roller Hockey Puck.
20. At the beginning of the match the puck will be placed in the center of the playing surface.
21. Each robot must have an actuator that can "shoot" the puck when the robot is in a stationary position.
22. A point will only be scored if the puck was shot outside of the goal's perimeter.
23. No robot is allowed inside either team's goal perimeter.
24. A pit area, with access to 110-volt standard outlet, will be provided
25. Decisions of the judges are final and binding.

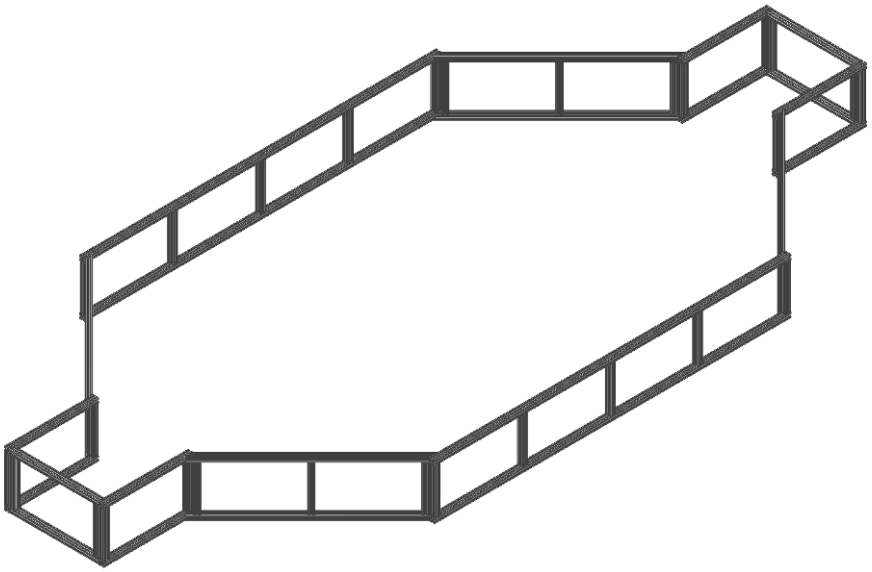
Penalties:

1. If a team gets two penalties, their opponent scores one point.

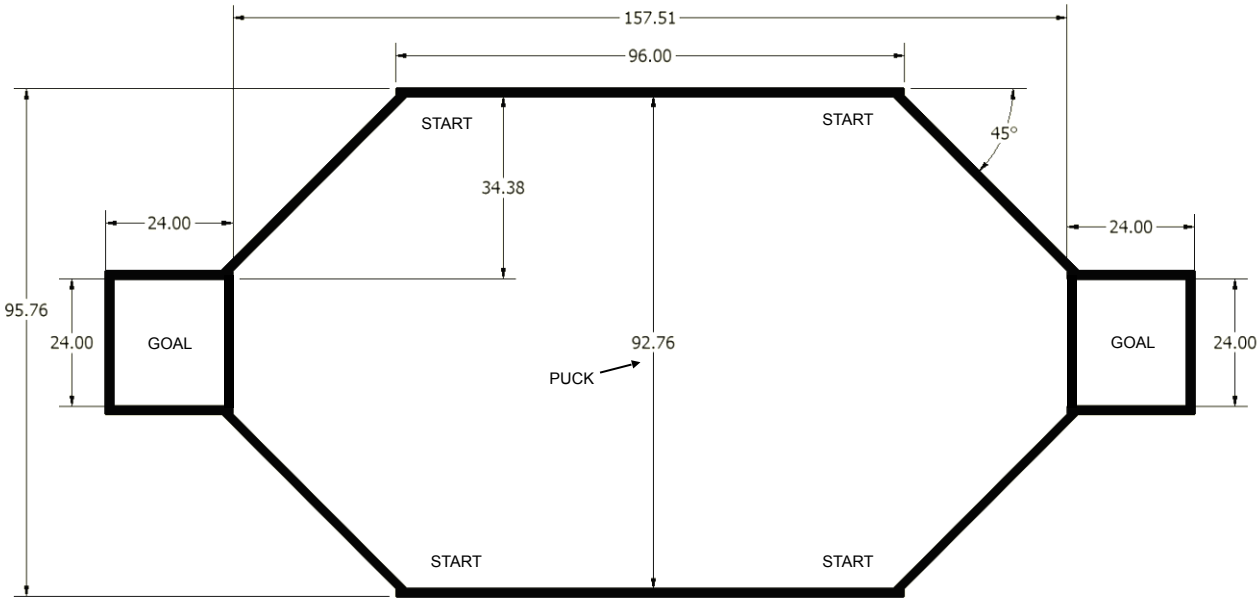
Grounds for a Penalty:

a. Intentionally going within a goal perimeter
b. Extending the Shooting mechanism to block or as a defensive move

Arena Specifications:



Top View of the Arena



Pre-Competition Device Evaluation/ Interviews Robo Hockey

LEVEL: **_____ Middle School** **_____ High School** **_____ Post Secondary**

SCHOOL: _____

CAPTAIN: _____

1. Criteria

Robot Weight	Robot 1	Robot 2
Weight Requirements ***(≤ 15 Pounds)***	Weight =	Weight =
Robot Requirements	Check if the requirement has been met.	
Size Requirements ***(maximum 12" x 12" x 12")***	_____	_____
Energy Storage Requirements maximum storage of 200 PSI	_____	_____
maximum kinetic PSI of 100	_____	_____

Entries not meeting any of the above criteria must be brought into compliance before being allowed to compete.

Judge's Comments:

_____

_____

Judge's Signature: _____

Robot Maze Contest

Elementary, Middle School, High School

Contest Description

In the Robot Maze Contest, students use a robot to navigate a right/left turn maze.

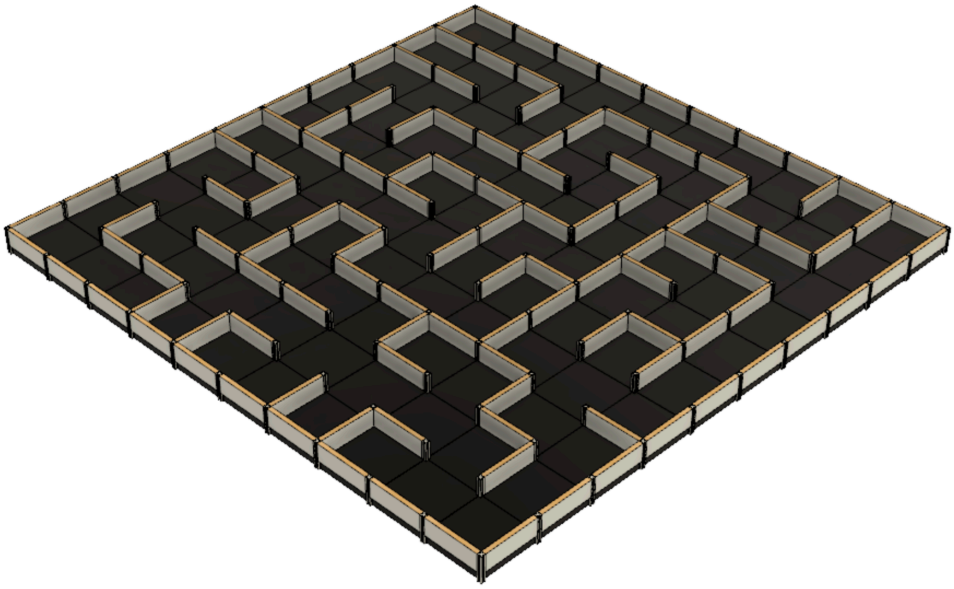
Rules

1. A single level right and left turn maze will be used.
2. Any type of commercially available or student-fabricated robot is eligible. Umbilical cords and wireless control devices **will not** be allowed. A listing of companies who sell maze robot kits is available at: www.thenrc.org
3. The maximum physical size of the robot shall not exceed 7" x 7” x 7" high. For each one-half inch (1/2") that exceeds the maximum limitation, five (5) seconds will be added to the robot’s elapsed time. Note: The maze runways are approximately 9.25 inches wide and wall are 3 inches high. **Device evaluation will take place at the time indicated on the Official Schedule**.
4. The maze is composed of multiple 10 inch by 10 inch square sections. The walls of the maze are 3 inches high and .75 inches thick (assume 5% tolerance for mazes). Thus, the internal navigable area within a square is 9.25 inches by 9.25 inches. The outside wall encloses the entire maze.
5. The sides of the maze walls, are painted white, the floor of the maze is painted black and the and the top of the walls may be any color or unpainted. The maze is made of wood, finished with non-gloss paint with aluminum 80/20 posts on each corner of the 10” x 10” sections.
6. WARNING: Do not assume the walls, the tops of the walls, or the floor are consistently white or black. Fading may occur; parts from different mazes may be used. Do not assume the floor provides a given amount of friction. It is simply painted plywood and may be quite slick. There may be a seam between the two sheets on which any low-hanging parts of a robot may snag.
7. Each robot is allowed three (3) runs with the best time being considered the official time.
8. Maximum time to complete the maze is five minutes.
9. Once a run begins, touching the robot ends that attempt.
10. A blueprint of the maze listing the exact dimensions is on the next page.
11. Scoring is based on the following:
    a. The shortest elapsed time for completion of the maze from starting line to finish line will be used to determine the winner in each division. The time will start when the front of the mouse crosses the start line and will stop when the robot completely crosses the finish line.
    b. In the event of a tie for first place, each team will be allowed two additional runs. The team with the best time is the winner and the other team is awarded second place.
    c. If the results of the second run are also a tie, contestants will be asked to make an oral presentation showing the logic used to develop the robot and how the robot uses information received by the sensors to determine the path through the maze.
12. A pit area, with access to 110-volt standard outlet, will be provided.
13. Decisions of the judges are final and binding.

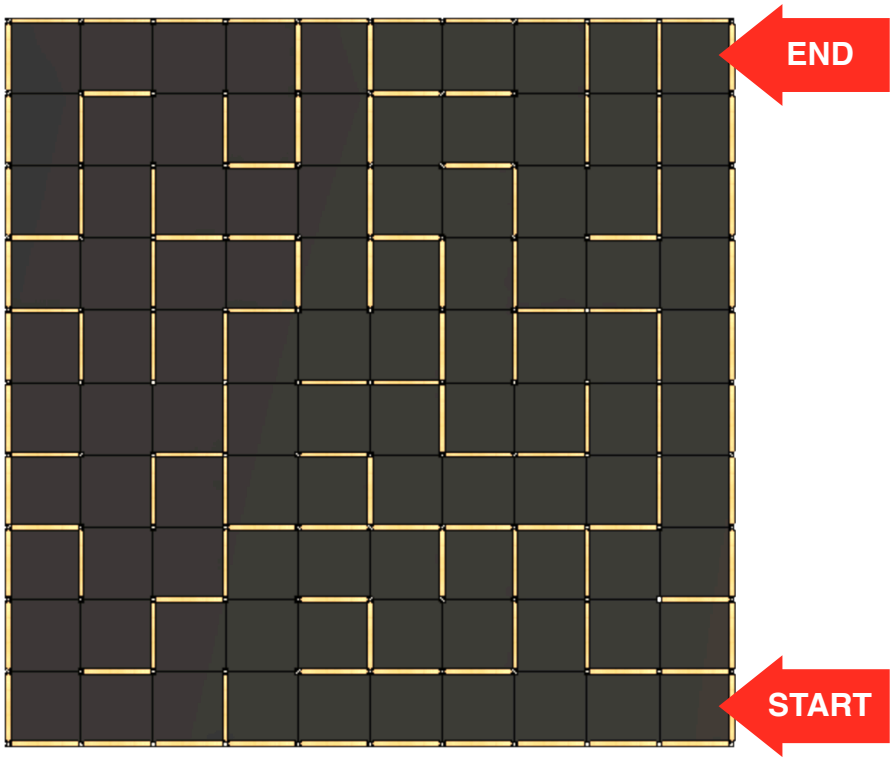
Robot Maze

High School

Isometric View of Complete Maze



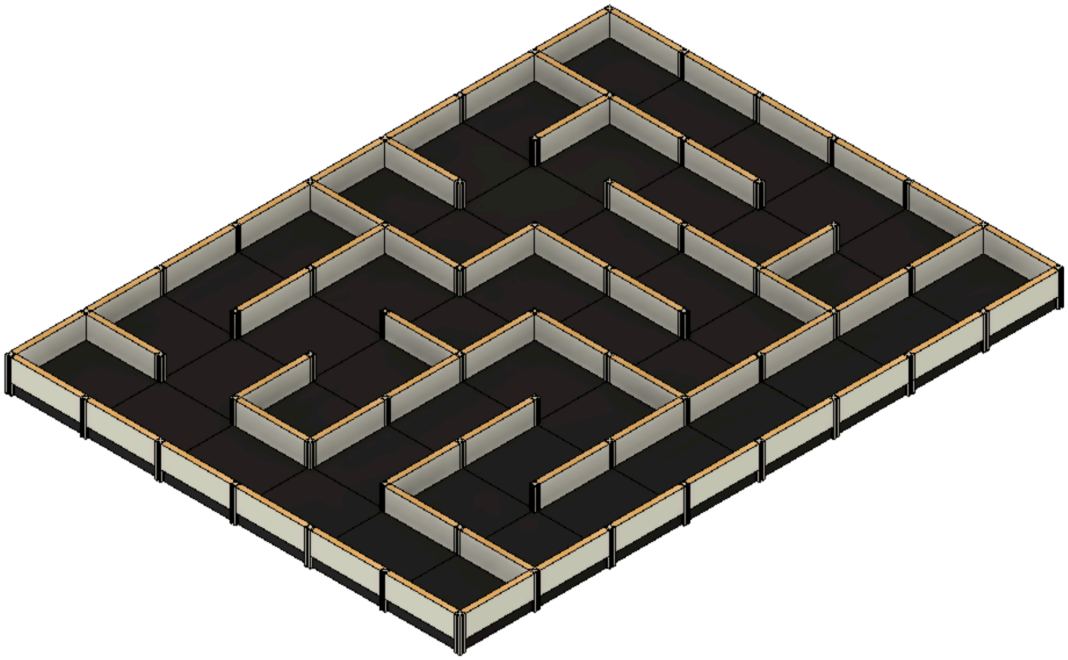
Top View of Complete Maze



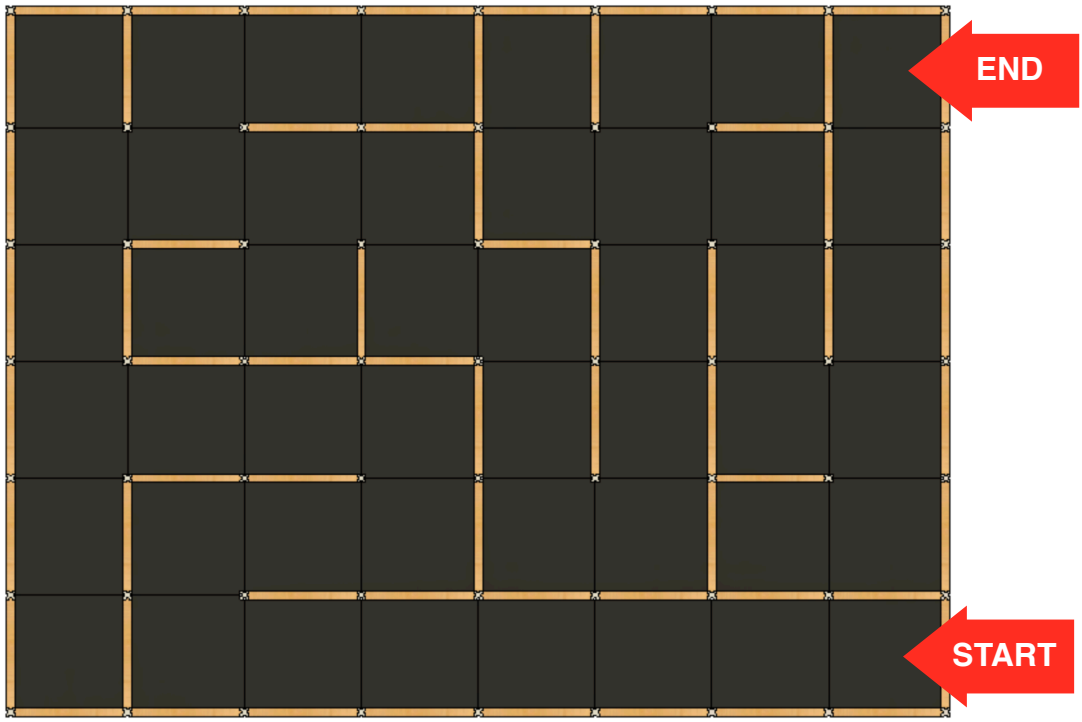
Robot Maze

Elementary / Middle School

Isometric View of Complete Maze



Top View of Complete Maze



FINAL EVENT - Robot Maze Contest

LEVEL: _____ Elementary _____ Middle School

SCHOOL: _____

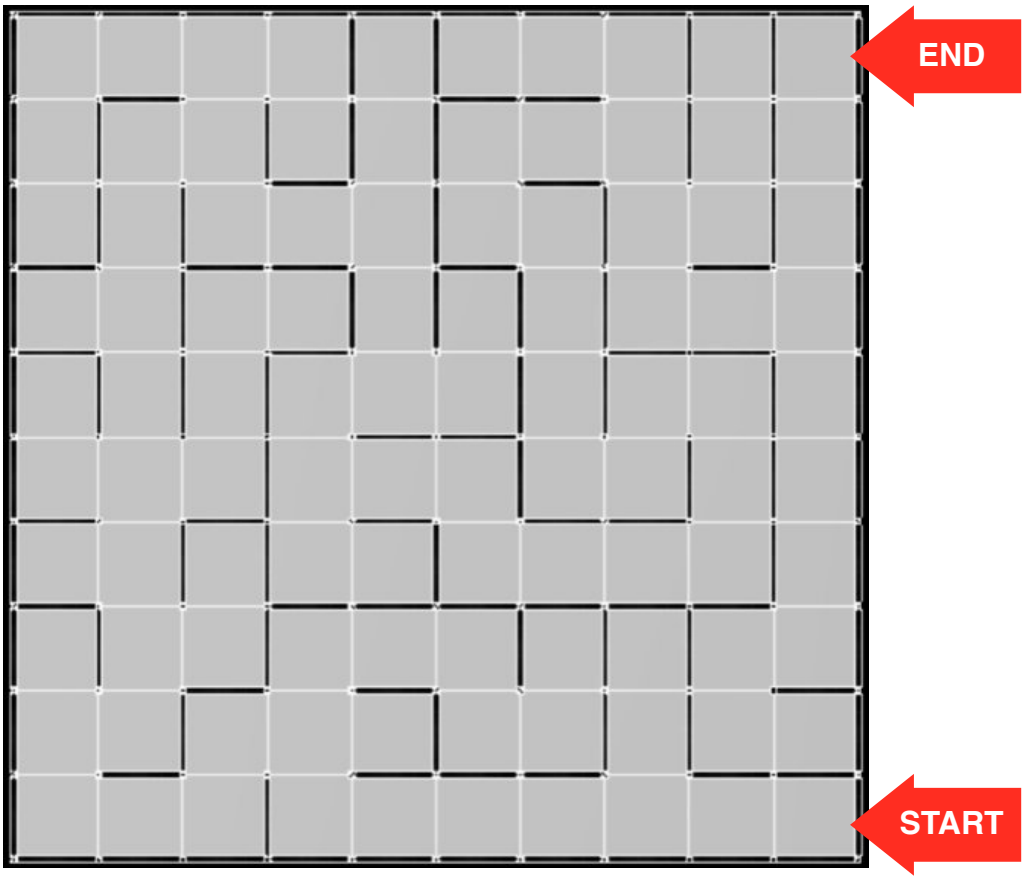
CAPTAIN: _____

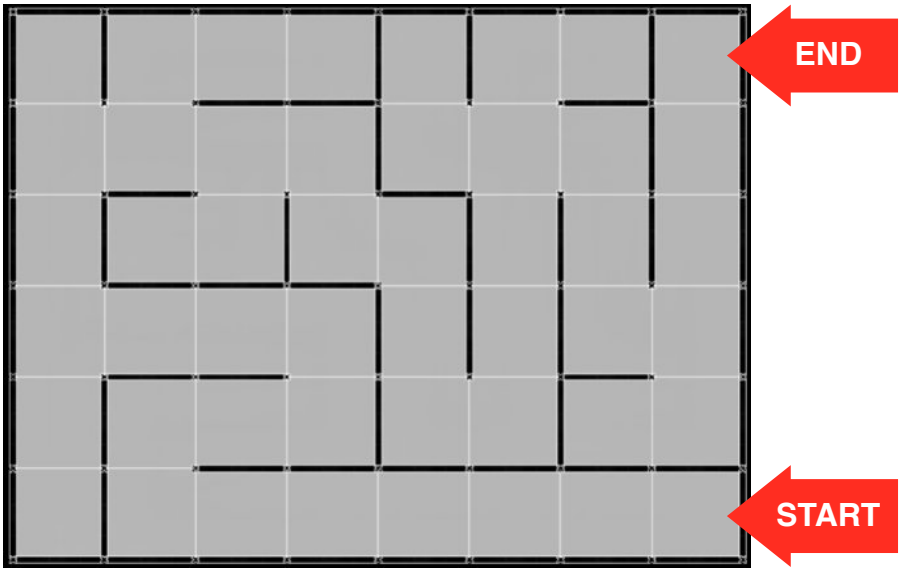
1. **Penalty for Oversize**
2. **Time required to complete course (seconds): Best time out of 3 runs will be official time**
3. **Final Scoring Totals** ***(Note, lower scores are better than higher scores)***

Criteria	Size requirement 7”x7”x7” high	Measure and indicate if it exceeds size requirement by number of one-half inches (1/2”)	**Total**
		Number of one-half inches (1/2”) entry exceeds size requirement	
		Penalty Seconds	**x 5**
		1. Total Penalty Seconds for Oversize To Add to Elapsed Run Time	

First Run	**Subtotal**
Time required to complete course	
Total Time for First Run	
Second Run	**Subtotal**
Time required to complete course	
Total Time for Second Run	
Third Run	**Subtotal**
Time required to complete course	
Total Time for Third Run	
Best Run (From Run 1, 2, or 3)	**Total**
2. Time required to complete course	

	Total Points
Penalty for Oversize (if any) (from #1)	
Best Time in Seconds (from #2)	
FINAL SCORE	





Judge's Comments:

_____

_____

Judge's Signature: _____

Sumo Robot

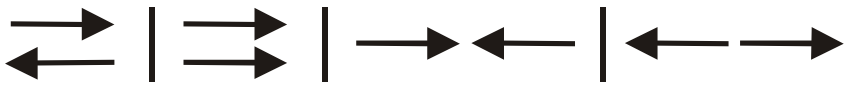
Self-Controlled - Middle School, High School, Post-Secondary

Contest Description

The Sumo Robot Contest requires a student team to build a self-propelled, autonomous, sensing robot, designed to force another Sumo Robot outside a ring. The competition ring will be a square painted flat black, measuring 8' across. There is an inside square surrounded by a two-inch (2") wide, painted or taped, flat white square. Another white one-inch (1") wide, line will surround the inner ring with 2 inches (2") between them. When any part of the robot crosses completely over the 1" white outer ring while being pushed by the opposing robot, it will lose the heat.

Rules

1. The robot must be powered by electrical storage batteries. No other power sources will be allowed. These batteries must be sealed and all possible precautions must be incorporated into the design to prevent accidental spills. The judges may disqualify any design that is determined to be unsafe.
2. If a design incorporates non-electric actuators (ie. pneumatics, hydraulics) all power must come entirely from on-board sources, powered by electricity. For example: if a robot uses a pneumatic cylinder to run an arm, the robot would need to include an on-board air pump to provide the air pressure for operation.
3. Robots must be self-controlled and use sensing devices to govern their motion. Robots must use sensors to either detect the other robot and/or the white line.
4. The Sumo drive wheels **must** be non-destructive to the playing surface.
5. Any robot that is deemed too dangerous to other robots, the playing surface, or competitors will be disqualified.
6. **(New for 2022)** Robot Size Limitations:
   a. Middle School Division: The robot must fit inside a 15" x 15" x 15" space and weigh less than 10 lbs.
   b. High School Division: The robot must fit inside a 20" x 20" x 20" space and weigh less than 15 lbs.
   c. Post-Secondary Division: The robot must fit inside a 20" x 20" x 20" space and weigh less than 15 lbs.
7. Any robot entered that does not meet the size requirement by the end of the device evaluation will be disqualified. **Device evaluation will take place at the time indicated on the Official Schedule**
8. A robot may expand in size after a match begins, but must not physically separate into pieces, and must remain a single centralized robot. Robots violating these restrictions shall lose the match. Screws, nuts, and other robot parts with a total mass of less than 15 grams falling off from a robot shall not cause the loss of match.
9. Robot operation must begin automatically **no less than** five seconds after being started by the user. Robots starting before the five second mark, forfeit the match.
10. Excluding wheels/tracks, all robot parts must maintain a minimum 5mm ground clearance from the playing surface.
11. Weight may not be added after the robot has been weighed and evaluated by the judges.
12. Robots must be carried or carted to and from the competition ring. Robots may not be driven outside of the competition ring.
13. Double elimination contests will decide the winner of each division.
14. At the beginning of each competition, with the robot deactivated, the Sumo handler(s) will position their Sumo one foot apart as instructed by the judges. Four start configurations will be possible:



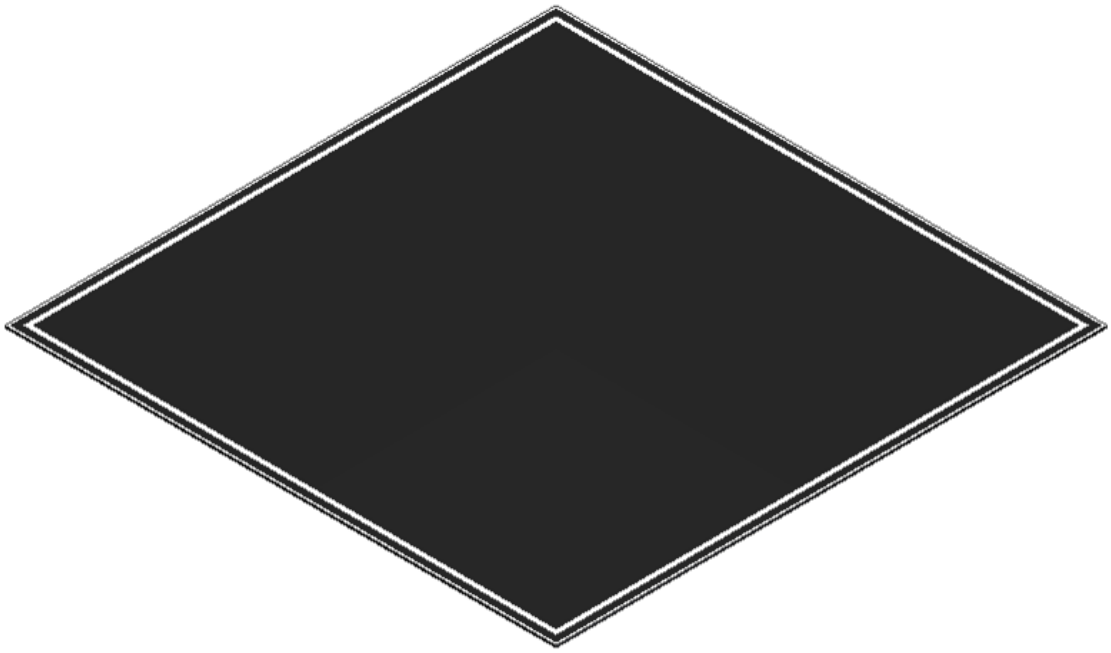
15. At the command of the judge/facilitator, the handler(s) will activate their robot.
16. All High School and Post-Secondary division robots must have a visible **RED** latching emergency stop button on **top** of the robot in case of a malfunction.

Example Emergency Stop (see rule 16)

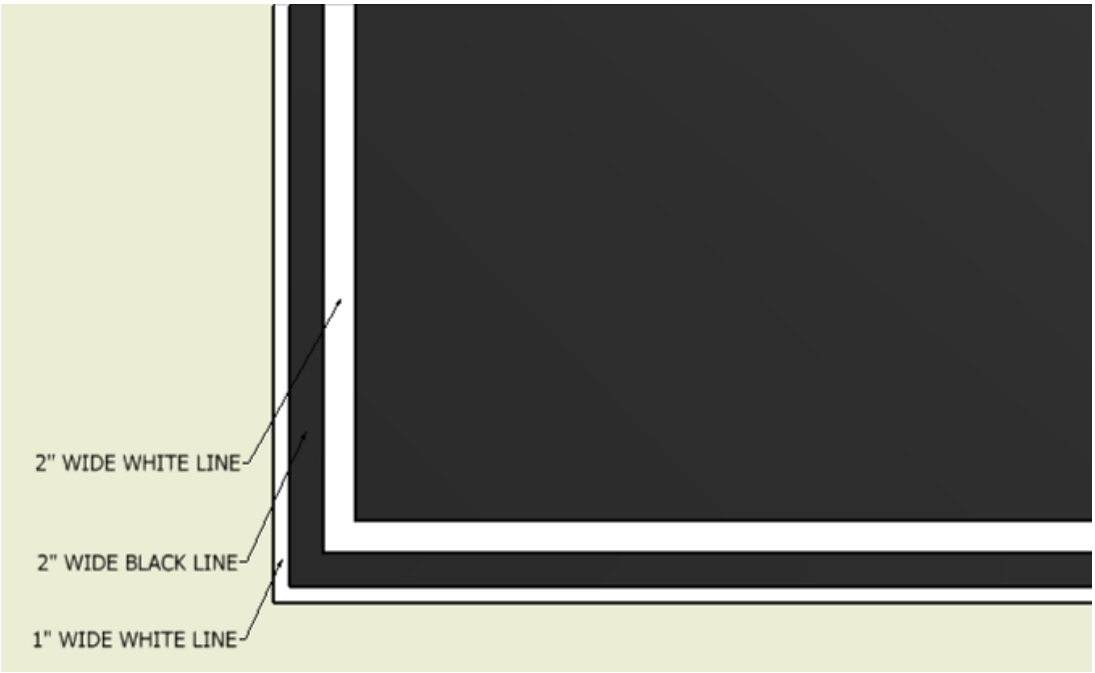
17. When one robot causes **any part** of their opponent to go past the outer white line, that robot is declared the winner of that engagement. To be a loss the robot must have been pushed out by the opposing robot. Driving beyond the outer white line while not under direct contact with an opponent does not constitute a “win” and is declared a “fault”.
18. If a fault is declared the robots are positioned in the same starting position and the contest begins anew.
19. If a robot causes three faults in a row, the other robot is declared the winner of the match.
20. If both Sumos leave the ring at the same time, a "no-contest" is declared and the two Sumos are repositioned and the contest begins anew.
21. If, after two minutes, no winner is declared, the contest is determined to be a “draw” and the two Sumos are randomly repositioned in one of the possible start configurations and the contest begins anew. If three encounters in a row end in a “draw”, the judges shall declare a winner based on action observed within the ring and on the design of the selected Sumo robot.
22. A pit area, with access to 110-volt standard outlet, will be provided.
23. At the conclusion of each match the winning robot must be weighed and measured to ensure that legal size limits have been maintained. Failure to pass this verification will result in a forfeiture of the match.
24. Decisions of the judges are final and binding.

Sumo Ring Details

Isometric View of the Sumo Competition Ring



Close-up detail of the lines with dimensions



Pre-Competition Device Evaluation/ Interviews Sumo Robot

EVENT: **Sumo Robot**

LEVEL: **_____ Middle School(10 *lbs*)** **_____ High School(*15 lbs*)** **_____ Post Secondary(*15 lbs*)**

SCHOOL: _____

CAPTAIN: _____

1. Criteria

Sumo Weight	
Weight Size Requirements ***Middle School ≤ 10 lbs)*** ***High School / Post Secondary ≤ 15 lbs***	Weight = _____lbs
Sumo Size	
Size Requirements ***Middle School = 15" x 15" x 15"*** ***High School = 20" x 20" x 20"*** ***Post-Secondary = 20" x 20" x 20"***	Check if the requirement has been met. _____
Safety Regulations	
RED latching emergency stop button on **top** of the robot	Check if the requirement has been met. _____
Five Second Delayed Start Tested	Check if the requirement has been met. _____

Entries not meeting any of the above criteria must be brought into compliance before being allowed to compete.

Judge's Comments:

_____

_____

Judge's Signature: _____

Additive Manufacturing RemotEDx SME/NRC Challenge

Middle School, High School, Post-Secondary

(NEW for 2022)

OVERVIEW

The goal of the Additive Manufacturing RemotEDx SME/NRC Challenge is to challenge competitors is to give students to additional opportunities to experience simulated manufacturing projects that will enable to use the skills learned from the SME/ToolingU training while in the RemotEDx program. The event focuses on an additive manufacturing design with strict requirements on form, fit, and function of compact and intricate designs.

This contest has been designed with the upcoming National Robotics Challenge competition April 7th, 8th and 9th, 2022 in mind and is designed to challenge students understanding of and skills in Additive Manufacturing.

Participants use basic engineering techniques to evaluate designs they have modeled, 3D printed and tested. Each team researches, designs, and tests models to determine superior engineering. Teams research, model, and test a structure designed to hold the greatest load. Each team is given the selected height to be tested and must plan, 3D print, and submitted a model for destructive testing.

MATERIALS AND SUPPLIES NEEDED

Materials to be Provided by Student Competitor:

- Printed 3D designed structure
    - Structures can submitted in person by 10:00 AM Eastern Time on Friday, April 8th, 2022 at the National Robotics Challenge in Marion, Ohio or they can be postmarked by March 18th and mailed/shipped to:

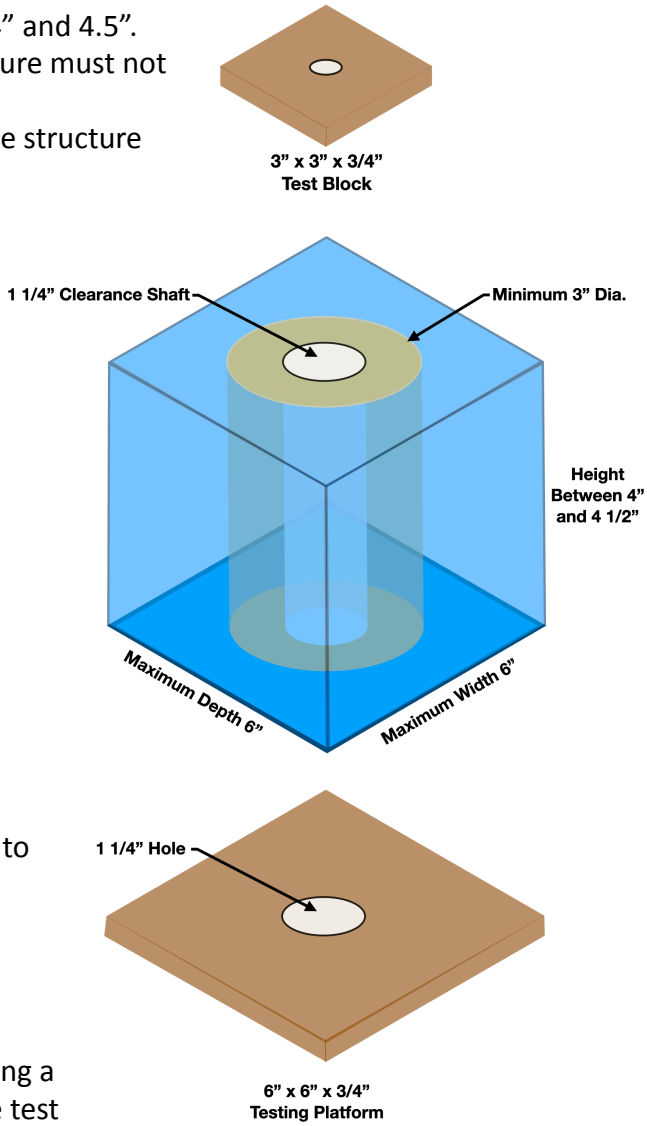
      Ritch Ramey
      268 Thew Ave
      Marion, Ohio 43302

- In addition to the printed structure, the following items must be submitted via email to ritchramey@gmail.com by 4:00 PM on April 1, 2022.
    - Computer design rendering files in STL or CMB format.
    - Digital Engineering notebook
    - Video Presentation showing structure in printing process and students describing why they made design choices specific to their submitted structure.

  Note: If needed, students may have an online interview with a panel of judges to further evaluate their project.

REGULATIONS

1. Structure Specifications
    1.1. The height is the distance from the bottom of the base plate to the top of the structure. On the final submitted model this measurement must be between 4” and 4.5”.
    1.2. The maximum width and depth of the structure must not exceed 6” by 6”.
    1.3. The minimum outside width and depth of the structure must not be less than 3” in diameter.
    1.4. The structure must support the 3" x 3" x ¾" test block at the top of the structure.
    1.5. The center of the structure must have an internal clearance shaft to allow passage for the test rod. The clearance shaft must allow for a 1¼" outside diameter cylinder to pass completely through the structure from top to bottom.
    1.6. Structures that do not permit the passage for a 1¼" test rod are not tested.
    1.7. Maximum total weight of the submitted structure is 50 grams.
2. Materials
    2.1. All structures must be printed in a single print as one piece from PLA, ABS or Nylon.
    2.2. Build material can be removed after the print is complete, but nothing may be added to the structure.



EVALUATION

1. Testing
    1. All structures are destructively tested by attaching a testing device of the coordinator’s choice to the test block and adding resistance until the structure fails.
        1.1. Structures are NOT tested if:
            1.1.1. Center is blocked.
            1.1.2. Test block will not rest on top.
            1.1.3. Structure is outside of stated size limitations.
    1.2. Weight will be added to the test block until the structure fails.
    1.3. The structure will be deemed to have “failed” once the bottom of the test block reaches 3 1/2” away from the base of the structure/testing platform.
    1.4. Structure will be evaluated by a strength to weight efficiency ratio. The total weight held in pounds will be divided by the total weight of the structure. The structure with the highest strength to weight ratio will be deemed the winner.