1. Objective
To design and build a radio and autonomously-controlled robot that will defeat your opponents in competition.

The winner of the competition is defined as the coalition that wins all best two-out-of-three rounds in the elimination bracket.

2. The Game

2.1 Definitions:

2.1.1 Coalition: Two teams which work together to defeat another coalition in competition. Coalitions are chosen randomly (in qualification rounds) or drafted (in elimination rounds). A coalition's teams always share a color.

2.1.2 Coalition Colonels: The top-ranked teams at the end of the qualifying matches.

2.1.3 Starting Zones: Two 18" x 18" starting areas of infinite height for each coalition, located against the GAP of that coalition's color.

2.1.4 FOAM (Foam Of Advanced Manipulation): one of 30 red or 30 blue 2" foam cubes used for scoring.

2.1.5 CUBE (Central Uber Block Element): a box 12" on edge with 2 green sides, 2 blue sides, and 2 red sides.

2.1.6 LUGS (Low Universal Goal Scoring): the area within the trapezoid shaped area at the center of the back wall defined on one side by the outside edge of white tape and on the inside by the border of the Low Goal.

2.1.7 MUGS (Middle Universal Goal Scoring): the trapezoid area defined within the 2" high white barriers and the back by the field wall.
2.1.8 HUGS (High Universal Goal Scoring): the elevated area located 12" above the floor and above the MUGS with additional 2.5" walls on each side, with a net bottom.

2.1.9 UGGS (Universal Great Goal Scoring): Any one of the LUGS, MUGS, or HUGS goals.

2.1.10 GAP (Gradual Ascent Platform): one of two 14" x 4' ramps, specific to each coalition, located along the sides of the field.

2.1.11 BOWLS (Big Object With Little Sponges): one of two coalition-colored bowls used as scoring goals.

2.1.12 RAP (Referee Assisted Platform): one of two contraptions, one for each coalition, that may be activated by the referee to dispense additional FOAMs.

2.2 Field Description

2.2.1 The field is 8' x 12'. A wooden frame that is approximately 2.5" high and 0.75" thick forms the field wall (the outer boundaries of the playing area).

2.2.2 The main surface of the playing area is "high-traffic" carpet that may have minor bumps and surface irregularities.

2.2.3 Robots will begin the match with every part of their robot within the boundaries of one of their coalition's Starting Zones. Teams will be designated to be on either "Red" or "Blue" coalition on a match-by-match basis as noted on the Match List.

2.2.4 Each coalition's GAP is a wooden incline directly behind the starting areas, up against the side field wall. The Rap is 4' long, 14" wide, and 7" tall at the higher end. The higher end is located 18" from the front field wall. 14" from the higher end of the GAP there is a strip of tape perpendicular to the angle of the ramp.

2.2.5 Ten (10) FOAMs per coalition start on the field. Six (6) of these start in a triangle along a front side of the CUBE, closer to the opposite coalition's starting areas. The other four (4) start in a line in the center of the corresponding coalition's GAP.

2.2.6 Twenty (20) FOAMs per coalition start in each coalition's RAP.

2.2.7 The CUBE begins the match in the middle of the field, rotated such that the sides of the CUBE form a 45 degree angle with the field walls, with the green side upwards.

2.2.8 All field dimensions should be considered to be +/- 0.5"

2.3 Match Timing

2.3.1 Each match will consist of the following time periods:

- Autonomous - The first 15 seconds of the match, where robots are controlled by only onboard programming and sensor inputs.
- Driver control - The remaining 2 minutes during which robots are teleoperated.

2.4 Match Play

- During the match, the coalitions attempt to score points using their robots.
- When a coalition scores their first FOAM during the match, a referee will lift their RAP, causing the rest of their FOAMs to fall onto the floor.

2.5 Match Scoring

2.5.1 Scores will be calculated when all items on the field have come to rest.

2.5.2 A FOAM is considered scored in a LUGS if it is completely within the plane formed by
the outside boundary of the tape and is not in contact with a robot of its coalition color.

2.5.2 A FOAM is considered scored in the MUGS or HUGS if it is completely supported by the goal structure and/or other objects scored in that same goal.

2.4.3 A FOAM is considered scored in a BOWLS if it is in contact with the inside of the BOWLS and/or other FOAMs scored in the BOWLS.

2.5.4 A BOWLS is considered scored in an UGGS if it is fully supported by the area within the UGGS and/or other scored objects within the UGGS.

2.5.4 A robot is considered scored in a starting zone if it is at least partially breaking the outer plane of a starting zone AND there is no other robot from your coalition breaking the plane of that starting zone.

2.5.5 A FOAM may not be scored in more than one BOWLS or UGGS at a time.
   2.5.5.1 If a FOAM is scored in more than one UGGS, the higher scoring area is counted.
   2.5.5.2 If a FOAM is scored in more than one BOWLS, it is considered to be scored in neither.

2.5.6 At the end of Autonomous, scores will be calculated as follows:
   - Each robot that is scored in its coalition's starting zone which it did not begin the match in - five (5) points.
   - Each robot that is fully supported by their coalition's GAP - five (5) points.
   - Each robot that is fully supported by their coalition's GAP and is only in contact with the GAP beyond the bottom edge of the tape - additional ten (10) points.

2.5.7 At the end of the match, scores will be calculated as follows:
   - Any FOAM scored within the coalition's colored BOWLS - two (2) points each.
   - Any BOWLS scored within the UGGS: five (5) points.
   - FOAM Scoring in UGGS:
     - Any FOAM scored within the LUGS: one (1) point each.
     - Any FOAM scored within the MUGS: three (3) points each.
     - Any FOAM scored within the HUGS: five (5) points each.
     - The coalition whose color matches the top face of the CUBE scores ten (10) points. If the highest face is green or it cannot be determined, neither coalition scores any points for the CUBE.
     - Each robot that is not touching the carpet: ten (10) points
   - Penalties will be assessed.

2.5.8 The winner of the match is the coalition that has the most points after the match has been scored.

2.6 Competition Structure

2.6.1 The competition will consist of Qualifying Matches followed by Elimination Matches.

2.6.2 Qualifying Matches
   2.6.2.1 All teams will play in the same number of Qualifying Matches. The number of qualifying matches at each event will be determined by the length of the event and the number of teams competing.
2.6.2.1.1 For all teams to have an equal number of official matches, some teams may be required to play an extra match, known as a surrogate match. This match does not count in the official ranking of any surrogate teams participating. Surrogate matches will be indicated on the match list.

2.6.2.2 Teams will be given their schedule of qualification matches no later than the start of the first match of that day's event.

2.6.2.3 Teams will be randomly assigned to coalitions during qualifying matches. The qualification match schedule will show the match number, the four teams competing in each match, and the color they are assigned for that match.

2.6.3 Ranking: At the end of the qualifying matches, teams will be ranked based on the following:
   - Greatest number of wins
   - If tied, opposing coalition's average point score (before penalties)
   - If still tied, team's average point score (before penalties)
   - If still tied, opponent's average ranking

2.6.4 Elimination Matches

2.6.4.1 The number of coalitions participating in elimination matches will be no less than four, but may be increased prior to the start of the event based on the number of teams participating.

2.6.4.2 Coalition Drafting
   2.6.4.2.1 At the conclusion of the qualifying matches, the top-ranked teams will be designated as Coalition Colonels. In order of their ranking, each Coalition Colonel will draft one team. An additional drafting round may take place at the discretion of the tournament director, increasing the teams per elimination coalition to three.
   2.6.4.2.2 Coalition Colonels may not draft other teams designated as Coalition Colonels or those already drafted into service for other coalitions.
   2.6.4.2.3 If a team declines the draft of any Coalition Colonel, they WILL NOT be allowed to play in the elimination matches.

2.6.4.3 During elimination matches, the #1 ranked coalition will play the lowest ranked coalition entering the elimination matches (i.e. if there are eight coalitions, #1 will play #8). The #2 coalition will play the second-to-lowest ranked coalition and so on.

2.6.4.4 Elimination matches will be a best 2-of-3 format.

2.6.4.5 Each coalition partner must play at least once during the first 2 matches of a best two-of-three round. If a robot becomes seriously damaged, the Coalition Colonel must inform the head referee immediately after the match in which the damage occurred. The head referee will then decide if the robot is exempt from this rule. The damaged robot must be re-inspected by the head referee before each best two-of-three round and must be re-declared inoperable in order to continue receiving the exemption.

2.7 Driver Rotation

2.7.1 During each match, teams will be required to switch their drivers halfway through the driver control period. There will be a ten-second period during which the drivers must complete the switch or power will be shut off for the duration of the match.
2.7.2 Teams may choose to have another student operating other non-driving functions of the robot during the match. This optional position is not required to switch during a match.

2.7.3 Teams must have at least four different students to rotate through the driver position. In the event that fewer than four students attend the competition, teams must still place four students in the ordered list and forfeit the driving time of the missing student(s).

2.7.4 Four student participants of a team must drive their robot within the first two official matches in which the team places a robot on the field. Once the required number of team members have driven the robot, teams must continue switching drivers during their matches but any team member may come to the field to drive.

2.7.5 If it is known in advance that a student will be late to the event, please contact the tournament director at savage@wpi.edu as soon as possible to discuss possible alternatives.

2.8 Match Sequence
- Each match is two minutes and 15 seconds long
  - 0-15 seconds - Robots enabled under Autonomous Control
  - 15 seconds - Coalitions are awarded points scored in autonomous.
  - 15-70 seconds - Robot under first Driver Control
  - 70-80 seconds - Driver switch period
  - 80-135 seconds - Robot under second Driver Control
  - 135 seconds - Match ends, robots disabled.

2.9 General Rules
2.9.1 All referee decisions regarding rules of play and judgments are final.

2.9.2 Definitions
2.9.2.1 Pinning: A robot is considered pinned when it is being held against a field obstacle or another robot by a robot from an opposing coalition and cannot move in any direction. The closest referee will begin counting the pin from the moment the pin begins.

2.9.2.2 Penalty: Fifteen (15) points are added to the opposing coalition's score.

2.9.2.3 Disqualification: Robots may be disqualified based on their actions that violate the rules of the game. If a referee calls for a disqualification the offending robot will receive a loss. The remaining members of both coalitions will receive their win/loss in qualification matches. If a team is disqualified during an elimination match, the coalition will receive a loss and the opposing coalition will receive a win.

2.9.3 Robot and Field Interaction Rules
2.9.3.1 Any game element which leaves the playing area during a match will be returned to the field in a non-scoring position as close to where it exited the field as possible.

2.9.3.2 Robots may NOT descore FOAMs or BOWLSs from the MUGS or HUGS
- If a team violates this rule they will receive one penalty and the descored objects will be returned.

2.9.3.3 Robots may not intentionally tip an opposing team's robot. The tipping robot will be disqualified from the match if, in the referee's opinion, they initiated a lifting action that results in tipping. In incidents where the tipped robot initiates the action or both robots are in motion, the involved robots may be disabled.
2.9.3.4 Robots will be disabled for physically interacting with anything outside of the field.

2.9.3.5 If a robot is pinned for five seconds, the pinning team receives a penalty. An additional penalty will be applied every 5 seconds until the offending robot has moved at least 12" away from the pinned robot. Per rule 2.9.5, robots that accumulate multiple pinning penalties in a match are subject to immediate disqualification from the match.

2.9.3.6 All parts of the robot must remain attached to the robot for the duration of the match and must not cause any hazard of entanglement to the other robots. Any infraction of this rule may result in an immediate disqualification. Minor pieces that unintentionally become detached from the robot, do not affect the outcome of the match, or are the result of improper design/construction will not cause a disqualification.

2.9.3.7 Teams are allowed to modify their robots between matches as long as the robot remains compliant with all specifications and rules after the modification. Any significant modification should be brought to the attention of the referees or head inspector prior to the start of the team's next match. Teams may be subject to re-inspection at the discretion of the referees/head inspector. While teams are allowed to modify their robots between matches, multiple robots per team are not allowed.

2.9.4 Safety Rules

2.9.4.1 Team members may interact with their robot during a match only through the transmissions of the radio-controller. Only designated Drivers or Operators may be in contact with the controls during the match.

2.9.4.1.1 Only team members who will be using the controls during the match will be allowed at the field. No coaches or human players are allowed at the field during a match.

2.9.4.1.2 All team members who will be driving during the match must stay within their coalition station for the entirety of the match. Repeat violations of this rule may result in disqualification at the discretion of the referees.

2.9.4.1.3 Teams must place their controls at a designated location before the beginning of the match. Team members may only touch these controls during driver control after the referees have signaled the start of driver control.

2.9.4.2 Team members may not extend any part of their body onto the field. Violations of this rule may lead to disqualification.

2.9.4.3 Referees will disqualify any robot they deem to be a safety hazard.

2.9.4.4 Referees may request that teams alter any portion of their robots that are considered safety hazards or damaging to the playing field or scoring objects at any point during the competition. It is the right of the referees to prevent teams from playing in matches until such changes are made to the robot.

2.9.4.5 Damage to the playing field, the objects, or the control system may result in the disabling or disqualification of the robot at the discretion of the referees. If the referee determines that further movement of the robot would result in field damage, it will be disabled. Intentional removal of FOAM or BOWLS from the field will be considered field damage.

2.9.4.6 Strategies aimed solely at the destruction of or damage to an opponent's robot or the field are not in the spirit of the competition and will not be allowed. This includes intentionally removing game objects from the field. Repeat violations of this rule may result in disqualification at the discretion of the referees.
2.9.5 Repeated or intentional receiving of penalties will result in a disqualification.

2.9.6 All questions or request for rules clarifications should be submitted via email to savage@wpi.edu. Questions and answers will be publicly posted on the event website.

3. The Robot

3.1 Size Restriction
3.1.1 At the start of each match, every part of the robot except for the flag holder (drinking straw, as specified in rule 3.4.4) must fit, unconstrained, in a stable position, within a box 15.25" by 15.25" by 18" in any orientation. The robot must be fully self-supported, in contact only with the horizontal, carpeted (or taped) surface of the playing field.

3.2 Weight Restriction
3.2.1 Each robot's weight must not exceed 10.0 lbs.
3.2.2 The 10 lb. limit does not include the robot battery, the radio transmitter (i.e. the 75 MHz transmitter or VEXNet Joystick) or the color-designating flag.

3.3 Controls
3.3.1 Teams will each bring and provide their own controls to the competition. Crystals will be provided at the competition at the start of each match. Teams that use VEXNet must provide their own, known working VEXNet Keys.
3.3.2 Radio operation of the robots is not permitted in the pits. Teams should bring their phone cords/tethers for testing and operating in the pits. It is advisable that teams not bring their radio crystals to the competition.

3.4 Construction Rules
3.4.1 A robot must be designed to operate by reacting only against features within the confines of the playing field boundaries.
3.4.2 Gaining traction by use of adhesives or by abrading or breaking the surface of the playing field is not allowed and will be considered field damage and subject to disqualification.
3.4.3 Teams must have their assigned team number clearly marked on their robot such that it is visible from 15' away. The numbers should be at least 3" high, 3 1/4" thickness and be on opposing sides of the robot. Team numbers will be assigned via the Savage Soccer website team list.
3.4.4 Teams must place a standard drinking straw, cut to 6" long, such that the straw is perpendicular to the ground on their robot. The top of the straw must extend above the top of the robot while in its starting configuration. This straw will have a colored flag inserted into the top to designate the coalition color. Prior to each match, teams must place the correct color flag on their robot, as indicated on the match list. Flags will be provided at the start of the match and must be removed from the robot before leaving the playing field. Multiple infractions of this rule may result in a disqualification at the discretion of the referees.
3.4.5 A robot may not intentionally contaminate the playing field or an opponent's robot with lubricants or other debris.
3.4.6 Robots may only be designed and built after the initial kickoff event.

3.5 Building Constraints
3.5.1 Each team will be expected to use parts only from the VEX Robotics System unless specified below.
3.5.2 Teams may NOT modify any of the VEX electronics or motors. Modification of items on the additional materials list is permitted.

3.5.3 Teams may use any 7.2V battery, up to approximately 3500 mAh. Only one battery may be used on the robot at a time.

3.5.4 Robots may only use publicly available VEX parts, found at www.vexrobotics.com/vex, and parts listed on the additional materials list. Robots may not use VEX IQ components, or VEX Pro parts that do not qualify under the additional materials list.

3.5.5 Robots may only use up to $50 of materials listed on the Additional Materials List. Robots that utilize materials from the Additional Materials list (see 3.6.2) must provide a Bill of Materials with the appropriate retail cost of each item.

3.5.6 Robots may use up to seven VEX motors, and an unlimited number of VEX servos.

3.5.7 Teams may purchase pneumatics kits, provided it is equivalent to any kits or portions thereof shown at http://www.vexrobotics.com/products/accessories/motion,

3.6 Materials

3.6.1 Any amount of materials in the Additional Materials List will be allowed provided the total costs of all items on the robot is within the budget specified in 3.5.4 and it does not violate any other rules.

3.6.2 Additional Materials List

3.6.2.1 Plastic sheet, up to 0.25" thick
3.6.2.2 Aluminum or steel sheet, up to 0.125" thick
3.6.2.3 Any aluminum, steel, or plastic round shaft or tubing up to 0.5" diameter
3.6.2.4 Any bearings
3.6.2.5 Plywood or wood up to 0.5" thickness
3.6.2.6 "Foam rubber" or styrofoam like materials up to 0.75" thickness
3.6.2.7 Cardboard or foam-board
3.6.2.8 String or twine
3.6.2.9 Any springs or elastic bands (must be designed to release energy no faster than it was input)
3.6.2.10 Fasteners, washers, adhesives, and tape
3.6.2.11 Lubricants used to reduce friction within parts of your robot
3.6.2.12 Non-functional decorations
3.6.2.13 Paper, plastic-wrap, aluminum foil, fabric or any paper or cloth-like material
3.6.2.14 Plastic 3D printed parts no bigger than a 1" in length width or height and all 3D printed parts must weigh less than 0.25lbs.
3.6.2.15 Any sensors

3.6.3 Materials that are not official VEX materials, or are not listed as approved additional materials must be approved via email to savage@wpi.edu. Responses will be posted publicly. Robots that attend the competition with unapproved materials on their robot will not be given approval at the event and will not pass inspection until the offending materials have been removed.
3.7 Energy Sources
   3.7.1 The energy used by the devices in the competition must come solely from:
      3.7.1.1 A change in altitude of the center of gravity of the device
      3.7.1.2 Energy stored by deformation of any approved materials.
      3.7.1.3 Electrical energy delivered by the battery to the electronics and motors provided
          with the kit.
      3.7.1.4 Pressure stored in the pneumatics system, not to exceed 100 psi.

3.8 Electronics
   3.8.1 Teams must keep clear and easy access to their robot controller, specifically the power
       switch. The indicator lights on the front or top of the controller must also be clearly visible.
   3.8.2 Teams must keep clear and easy access to the crystals in their robot receiver. Crystals will
       need to be exchanged quickly prior to each match. Inspectors or referees may request a team
       move the receiver to provide easier access before they are allowed to play.
   3.8.3 Prior to each match, teams using the PIC (old) controller will receive a crystal set from the
       Field Captain. The crystals must be returned before the team leaves the field at the end of the
       match.
       3.8.3.1 Multiple infractions of 3.8.3 may lead to a disqualification at the discretion of the
           head referee.
   3.8.4 All teams are required to program their robot such that the robot will start and stop while
       under the control of a standard VEX field control system. The event is able to offer on-site
       support to teams using an appropriate easyC Template. Specifically, VEX Net or Cortex robots
       must use a WIFI template, while PIC robots must use a timed competition template with a 10
       second autonomous mode and a 254 second operator control mode. Teams will not pass
       inspection unless they are able to demonstrate their robots can be enabled and disabled by the
       field.

4. Alternatives for Game Play
   4.1 Play the game without coalitions in a one vs. one format.
   4.2 For a less expensive field:
      ○ Reduce the number of FOAMs by half
      ○ Remove the CUBE
      ○ Remove the RAP