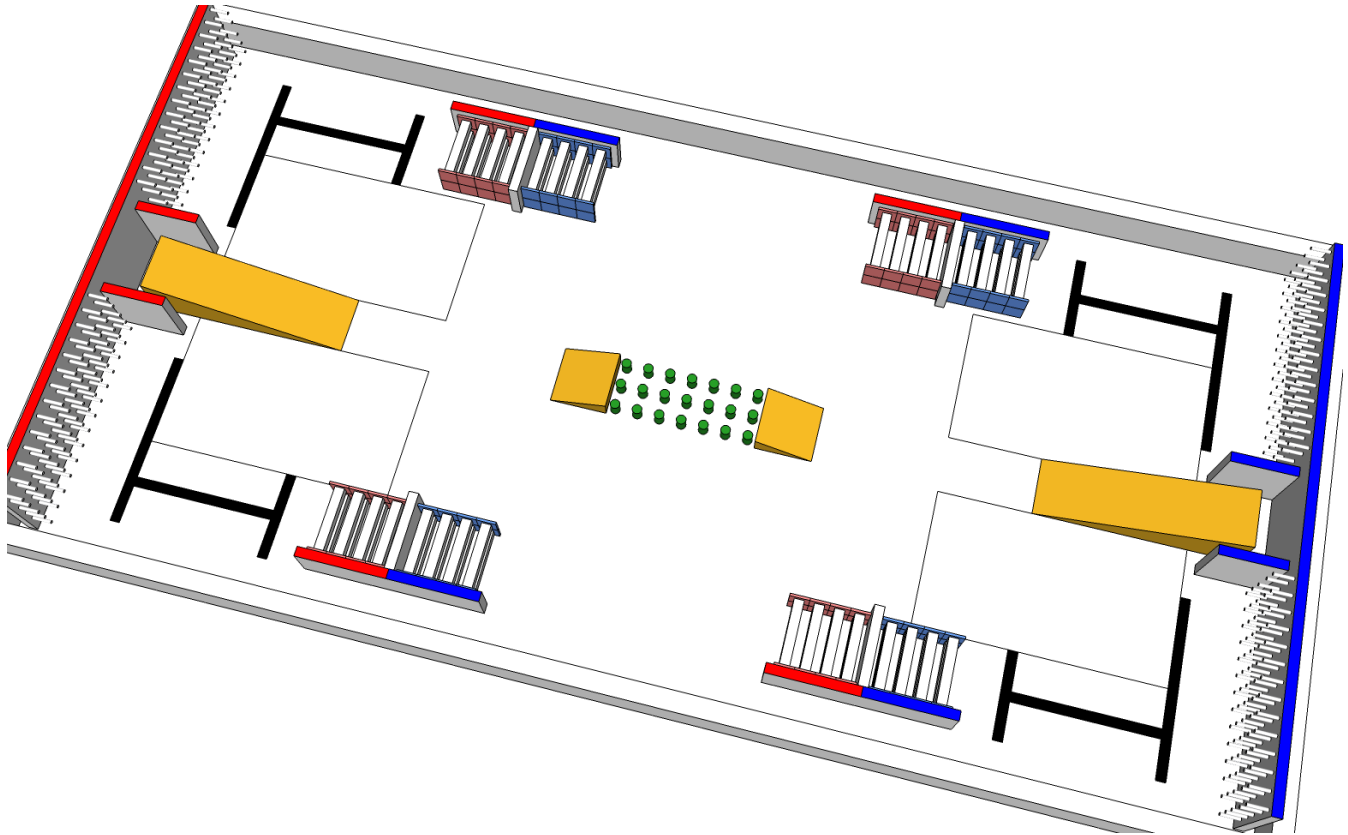


## “Blazing New Paths” (v1.0)

In this challenge, the club members will design a robot which will first run a program written by the club member (“autonomous” mode), followed by a period of time where the club members will be controlling the robot (“teleoperated” mode).

### Summary



There will be two sides per match, a Red team and a Blue team. Each team will have two members. Each team member will earn a score based on the total points earned or lost by that team in that match.

The field has two sides – a Red side, and a Blue side. The Red team will start on the same side as the Red peg wall, and the Blue team will start on the same side as the Blue peg wall.

**The goal: Map out paths in urban, mountain, and forest environments using the capped beams!**

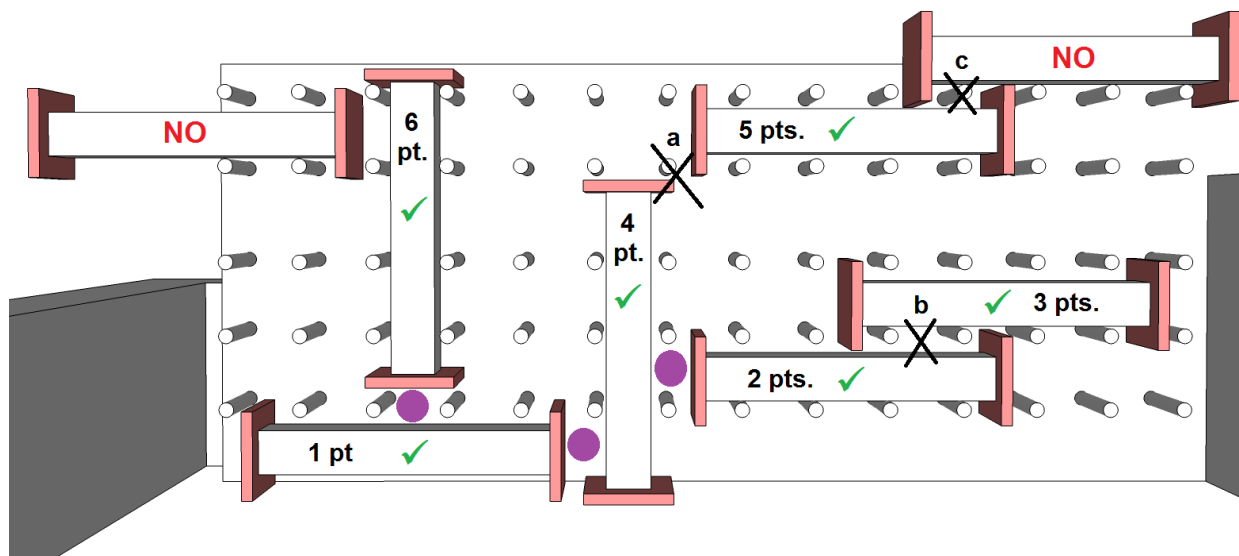
During the autonomous period, the robots may start off with one beam from their quadrant loaded horizontally onto (or placed so that they are touching) the robot. There will be a period where the bots will run a program created by the club member where the robot will try to add items in their quadrant of the field (or on the ‘mountain’ between) using the beams. Scores made during the autonomous period will count double!

When the autonomous period is over, the referee will count up the scores, after which a teleoperated period will start during which the robots will be remotely driven by the club members. While the club members are driving, they will be trying to get *same*-colored beams from the staging pens on the field and use those to create paths on the *same*-colored ‘urban’ peg wall or ‘mountain’ on their side of the field, *or* in the mid-field ‘forest’ pegs.

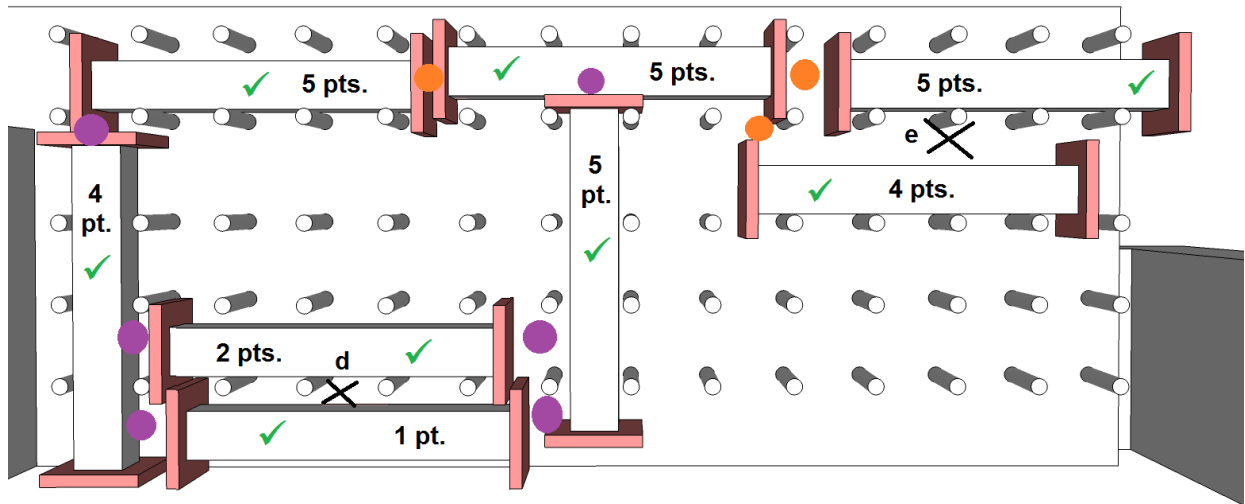
Scoring on the ‘urban’ wall is based on how high the beam is placed if horizontal, or if vertical, what’s the highest level the beam reaches, from 1 to 6. Beams in the ‘forest’ will be 3 points each, and beams representing ‘mountain’ climbs will be 2 points each. Junctions between paths/beams can add 3 or 4 points each!

## I. Scoring

- For beams to score as either ‘urban’ or ‘forest’ paths, they must sit *between* at least 3 pairs of pegs.
  - Beams placed under the bottom row of the ‘urban’ pegs are fine if they span at least 3 pegs.
  - The central pillar of the beam (i.e., not counting the caps) must be entirely flush with or inside the ends of the pegs – if a beam “sticks out” from the ‘urban’ or ‘forest’ pegs, it won’t count!
- Beams scored in the ‘urban’ peg wall score points based on the level the beam reaches – from **1 point** for the lowest level, to **6 points** for the highest level. Horizontal beams score points based on the level they are placed in, while vertical beams score based on the *highest* point in their placement.
  - Only red beams can go into the red ‘urban’ zone, and vice-versa for blue.
- “Turning” junctions – that is, beams oriented 90° to each other – are worth **4 points** each. The space containing the end of one beam must be the same as, or *orthogonally adjacent* to, a space containing the other beam.
  - ‘Orthogonal’ refers to directions at right angles – up, down, left, right. Not diagonal!
  - ‘Adjacent’ means next to each other. If there is a full space between the beams, they’re not adjacent.
- “Continuing” junctions – where both beams are oriented in the same direction (e.g., horizontally) – are worth **3 points** each. The space containing the end of one beam must be the same as, or *orthogonally adjacent* to, a space containing the end of the other beam.
  - This means that if two beams are side-by-side with too much overlap, that’s not as interesting a path continuation and it won’t count!
- Scoring examples:

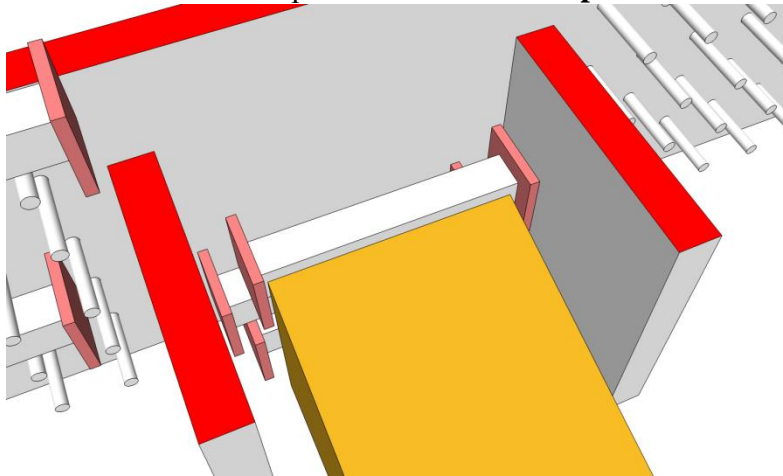


- Beams with green check marks are good & score as many points as noted on the beams
- The two beams marked with red “NO” are not good
  - The beam to the left is only between 2 pairs of pegs, and the beam in the upper-right is not between at least 3 pairs of pegs
- The purple circles mark valid “turning” junctions (worth 4 points each)
  - The ‘a’ junction is not good because it’s diagonal
  - The ‘b’ junction is not good because there’s too much overlap, the “ends” are not adjacent
  - The ‘c’ junction is not good because the “ends” are not adjacent (besides, that’s a “NO” piece)



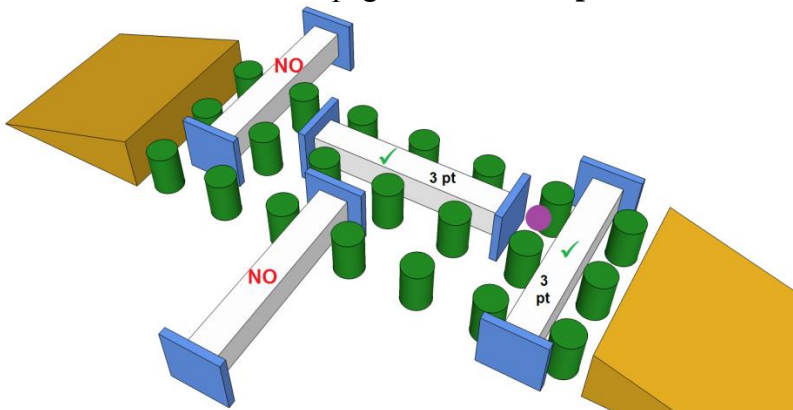
- The purple circles mark valid “turning” junctions (4 points each) and the orange circles mark valid “continuing” junctions (3 points each)
  - ‘d’ and ‘e’ are not “continuing” junctions because the beam “ends” are not adjacent

6. Beams dropped behind the peaks of the “mountains” at either end of the field (up to 4 per mountain) are considered ‘mountain paths’ and count for **2 points each**.



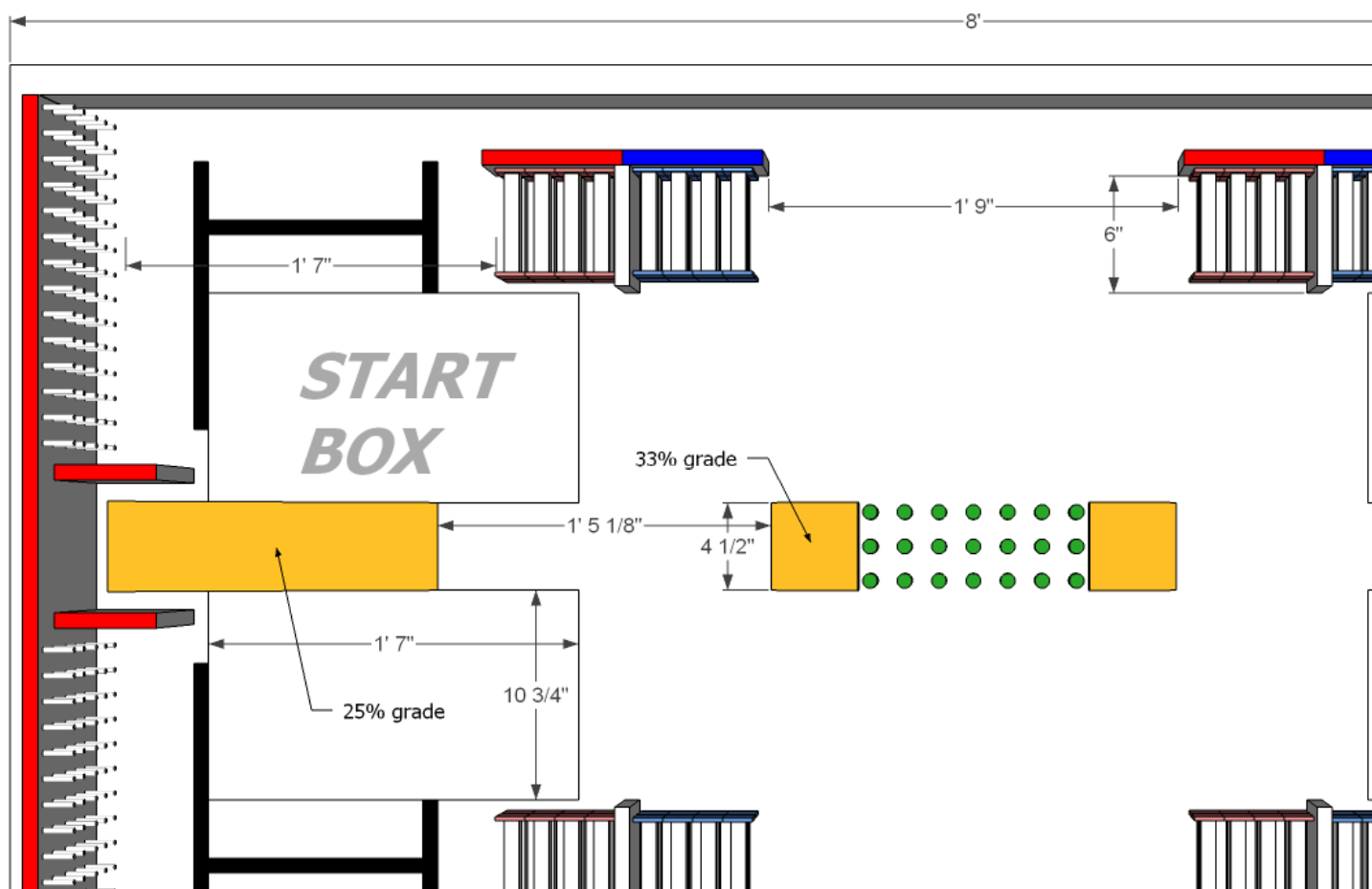
- a. Only red beams can go into the red ‘mountain’, and vice-versa for blue.

7. Beams scored in the ‘forest’ peg zone will be **3 points** each.



- a. Junctions between beams of different colors in the ‘forest’ zone will count for **both teams**.

## II. Field



### A. Key measurements

1. The capped beams are made of a 5" long segment of  $\frac{3}{4}$ " square wooden dowel with two  $1\frac{1}{2}$ " x  $\frac{3}{16}$ " squares attached as endcaps.
2. At the start of a match, robots **must** fit within the 'START BOX' (19" by 10  $\frac{3}{4}$ ") and be under 12" tall.
3. The ramps for the 'mountains' (and the 'hills' next to the 'forest') are 4  $\frac{1}{2}$ " wide.
  - a. The 'mountains' have a 25% (4:1, ~14° steep) grade, and the 'hills' are 33% (3:1, ~18° steep)
4. The thick black lines making up the four "H"s are  $\frac{3}{4}$ " thick.

## III. Matches

Each match will be a total of 3:00 minutes. The first part of the match will be a thirty-second (0:30) autonomous period, followed by a two-and-a-half minute (2:30) teleoperated period.

After the club members start their autonomous program, they should not touch their robot again until after the match is over. If the club member touches the robot after the start, or if a referee has to touch the robot to resolve an issue, that team will incur a touch penalty of **minus 2 points** (see below). *Exception: A referee clearing accidental entanglement between two robots does not incur any touch penalties.*

Matches will have two referees, each one watching either the Red side or the Blue side of the field. They will tabulate scores and remove/relocate beams on the field in specific situations (see below). The referees will also perform other duties as directed by the rules.

## A. Touch penalties

1. If a club member touches a robot or field element during a game (either during the autonomous period or during the teleoperated period), they will incur a **'touch penalty'** worth **minus 2 points**. *A robot which was touched will be returned by a referee to its home base, and any of that team's beams that the robot was touching will be returned to the beam staging area on the field.*
  - a. In some cases, a referee may have to move a robot or field element. This may also incur a touch penalty for one of the teams. The specific circumstances when referees might need to move robots are listed in the sections below.

## B. Autonomous mode

1. At the start, both robots on a team **must** be entirely within the outline of their "start box" (see the diagram – the area 10¾" wide by 1' 7" long), as if there were glass walls around the box.
  - a. They also can't extend higher than 12" from the surface of the field
2. The club member may pre-load one beam from their quadrant *horizontally* onto the robot prior to the start of the autonomous period – or alternatively, may place one beam *horizontally* on the field such that the beam is touching the robot.
  - a. Any additional beams must be picked up or handled by the robot from the field.
3. The club member must be able to initiate the main program execution without lifting the robot, by doing one of the following:
  - a. Set up the robot program selector such that the desired autonomous program is selected, so pushing a button on the brick will start the program; or,
  - b. Write a program which, when started, waits on a touch sensor before proceeding with the primary autonomous operation.
4. During autonomous mode, the robots build constructions using the beams of their color on their **own** side of the field.
  - a. Each robot should try to score on the 'urban' peg wall in the same quadrant that the robot started in, and/or on the 'mountain'. Drivers are advised to discuss if they have a program for the 'mountain' – if both players run programs trying to autonomously do the mountain, they may crash into each other! (It may help to have a 'mountain' option and a 'no-mountain' option.)
  - b. Robots should not enter into the other team's side during the autonomous period. If any part of a robot partially crosses over the center line during the autonomous period, a referee will move it back to its home base and that team will incur a *touch penalty*.
5. Scores earned during autonomous mode are worth **double**.
6. At the end of the autonomous period, the constructions and towers will be scored by the referees and then left in place. This means any autonomously scored elements will be counted *again* after teleop!
  - a. The robots will remain where they are at the end of the autonomous period – unless a referee needs to move a robot per the rules (this may incur a touch penalty).

**Regarding ultrasonic sensors:** Be aware that if multiple robots try to use ultrasonic sensors at the same time, they might cause interference and disrupt the operation of the autonomous program. Club members who choose to use an ultrasonic are accepting this potential risk.

also... **Note that the field quadrants are "handed"**, i.e. there is a 'left-hand' side and a 'right-hand' side for each team. Club members are going to be paired with different people over the course of the event, so they will need autonomous programs which will work for either the "left" side or the "right" side. Two suggestions:

- A. The club member creates a suitable program for one side of the field; then, a leader assists them in making a copy of that program, changing all the turning commands in the copy to go in the opposite direction.
- B. The club member might instead write a single program which can do either the “left” side or the “right” side, and then enable the program to be told which side it’s on when it’s run (either using two touch sensors, or using different brick buttons, etc.)

### C. Teleoperated mode

1. When the autonomous period is over, there will be a short pause as the referees perform scoring duties, and then the team members will begin remotely controlling the robots using the game controllers.
  - a. Remote operation of robots can be done only by way of the game controllers. No using infrared controllers or other methods to influence the robots! **Doing so would result in being removed from the match AND that player getting zero credit (wins / points) for the match.**
  - b. If there is a problem with the start of the teleoperated period such that one or more robots are not responding to the assigned game controllers, that player should immediately let the Director know; the Director will halt the match and the referees will (to the best of their ability) return robots and game elements back to where they were at the end of the Autonomous period.
2. During the teleoperated period, the robots score beams on the ‘urban’ and ‘mountain’ areas on their side of the field using their team’s colored pieces.
  - a. Don’t put red beams in the Blue areas, or blue beams in the Red areas! Beams placed using different-colored Red or Blue areas & beams during the teleoperated mode will be removed by a referee, and that robot will be put back into its home base, incurring a touch penalty for that team.
3. Robots should **not** disrupt the other team’s scored paths! If a robot interferes with one of the opposing team’s successfully scored paths/beams, a referee will [to the best of their ability] replace the beams and put the offending robot back in its home base, incurring a touch penalty for that team.

*Things to keep in mind #1:* This is intended to be a **non-contact game**. Some accidental bumping is expected to occur, but in general the robots should not physically interfere with each other.

*Things to keep in mind #2:* Sometimes two robots may both want to go through the same space at the same time. Note that the goal is not just to win the match, but for each team to get the highest score they can! It could be a strategic move to temporarily back up and let someone go by, instead of waiting there stuck in a traffic jam (and thus not getting more scoring done!)

*Things to keep in mind #3:* Everybody is there to have fun. Just remember that sometimes, what one person thinks is funny isn’t fun for the other person!

### D. Construction & technical requirements

1. Robots must be built only out of parts manufactured by LEGO, *except*:
  - a. The batteries which power the robot do not need to be manufactured by LEGO
  - b. Robots have the option to use the string which has been procured by the 4H Robotics Division
  - c. Robots can be decorated with stickers, flags, etc. so long as those decorations do not have an effect on the robot’s performance (i.e., they can’t be helpful).

- d. Also: Robots are limited to using one (1) NXT or (1) EV3 brick
  - i. NXT bricks can have no more than three (3) motors, EV3 bricks can have no more than four (4) motors.
  - ii. The driving motors must be plugged into the “B” and “C” outputs.
  - iii. If there are action motors, they should be plugged into the “A” output and/or the “D” output respectively. Note that only EV3 bricks have a “D” output.
2. Robots **must** be able to fit entirely within the outline of a “start box” (see the diagram – the area 10 ¾” wide by 1’ 7” long) as if there were glass walls around the box, and extend no more than 12” high
3. **Required:** Each robot must have a 4H clover visible on it somewhere!
4. **Recommended:** Each robot should be labeled with the club member’s name and their club name (so if a robot needs to get to its owner, we know who to find!).
5. **Required:** Each brick must have a unique name. (They can be named from the programming environment while the brick is USB connected).
6. **Required:** Each brick will have the latest firmware installed.

#### ***IV. Tournament organization***

Tournaments will be played in a round-robin style for several rounds, followed by the top four scorers choosing teammates and facing off in a set of elimination playoffs using best-2-out-of-3 face-offs. [Details may be subject to change at the Tournament Director’s discretion based on circumstances]

#### **A. Eligibility to play in the finals**

1. For a club member to be able to play in the playoffs in a tournament, they need to be a member in good standing as per the Robotics Fair Exhibitor Guide.
2. The playoffs in each tournament will be played out by the top four scoring members in good standing and the team partners they choose.

#### **B. Number of tournaments**

1. There will be a ‘Junior’ tournament [on Wednesday night] and a ‘Senior’ tournament [on Thursday night].
  - a. If one of these nights is canceled due to weather, the make-up night will be Friday.
  - b. If no make-up is required, Friday night will be an “open” tournament.
2. Generally, the ‘Junior’ competition is for members with less experience and ‘Senior’ for more experienced members.
  - a. Club leaders should determine the roster lists in advance, taking care to keep them reasonably balanced (i.e., the number of members in the Junior tournament should be around the same as the number of members in the Senior tournament).
  - b. Leaders should exercise their judgment if a newer club member should probably be promoted into the Senior tournament (due to their high skill level), or if a long-time club member might be better suited to compete in the Junior tournament.

#### **C. Round-robin**

At the start of the tournament, all club members present and competing will be listed in the “4H 2019 Tournament” spreadsheet. **The spreadsheet will be used to manage team pairings and track cumulative scores.**

1. During the round-robin, each member will play in four (4) matches.
2. After each match, each team member on a team will earn the total score that their team achieved (in both the autonomous and the teleoperated periods).
3. Throughout the tournament, club members will earn a total score which will be the sum of all the scores they earned during the round-robin matches.
4. In any given match, members could be either Red or Blue, and could be placed in either the left quadrant or the right quadrant of their side of the field.
5. Members will be paired with different partners in each match (unless instructed otherwise by the tournament director).
6. Members will not play successive matches back-to-back (unless instructed otherwise by the tournament director).
7. At the end of the round-robin period, members will be ranked as follows:
  - a. Total win/tie points – 1 point for each win, 0.5 points for each tie. Higher is better.
  - b. If two members are tied for win/tie points, then whoever has the **most** total points scored *for*. Higher is better.
  - c. If two members are also tied for points scored for, then whoever has the **fewer** total points scored *against*. Lower is better.
  - d. If two members are still tied at this point, then the higher ranking is pseudo-randomly determined by the spreadsheet.

## D. Playoffs

After the round-robin rounds are completed and the tournament director has determined the four players moving on, those members will compete in the playoff rounds to determine 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> place.

**Each face-off will ideally be settled via ‘best out of 3’ – however, if there is insufficient time [based on the tournament Director’s judgement] face-offs will be a single match**

1. The four players will be the #1 through #4 “seeds” (#1 will be the player with the highest round-robin rank, followed by the other members in descending order).
2. The members going on to the playoffs will choose partners from the remaining pool of participants (unless instructed otherwise by the tournament Director).
  - a. They will play all the remaining matches with the same partner.
  - b. The #1 seed will choose a partner **first**; followed by the #2 seed; then the #3 seed; and lastly, the #4 seed will choose his or her partner.
3. The first two sets of matches will be the #1 and #4 seeds facing off, and the #2 and #3 seeds facing off.
  - a. The #1 seed gets to choose whether he or she wants to play the #1–#4 match sets first, or if the #2 & #3 seeds will play first.
4. After those two matches are completed, there will be a 3<sup>rd</sup> place of match followed by the final.
  - a. The seeds who lost the #1–#4 match and the #2–#3 match will face off for 3<sup>rd</sup> place
  - b. The seeds who won the #1–#4 match and the #2–#3 match will then face off in the final for 1<sup>st</sup> and 2<sup>nd</sup> place (winner of that match gets 1<sup>st</sup>, the other seed will get 2<sup>nd</sup>)