

The Game

The game component requires robots to score the greatest number of points while working in teams. It is the main component of the CRC Robotics Competition, giving each school an equal opportunity to demonstrate their robot design, robot construction and strategic playing skills. Refer to the Survival Guide for tips and suggestions.

CRC Robotics reserves the right to modify any and all values outlined in the following subsections at any time throughout the season. All teams will be promptly notified if a modification is made.

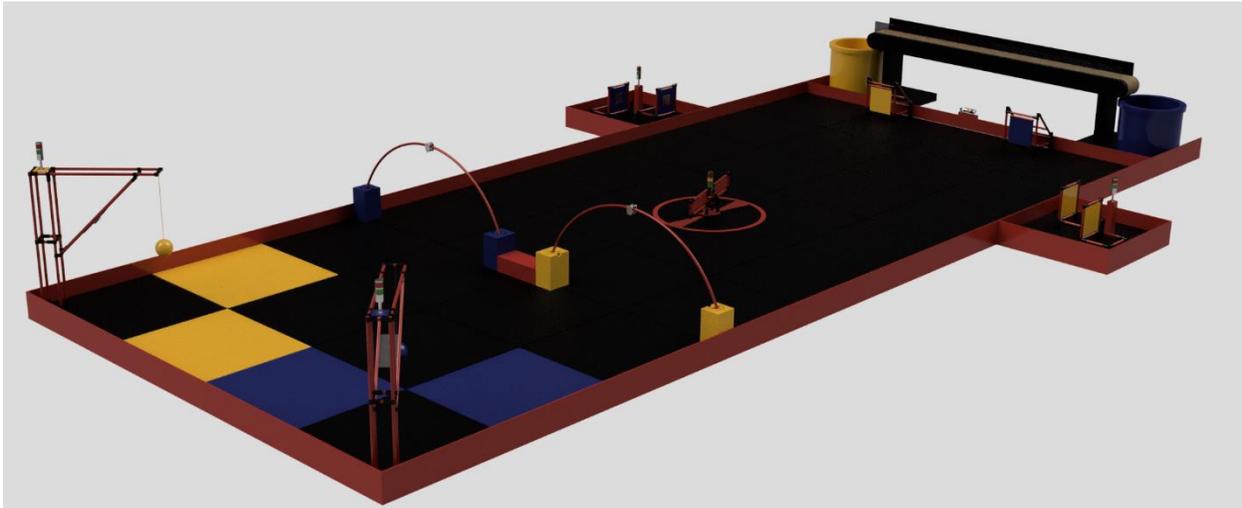
2.1 Teams

- 2.1.01 Two teams, blue and yellow, composed of two robots each, are playing against each other during each heat.
- 2.1.02 Robots will change partners from heat to heat.

2.2 Playing Field

- 2.2.01 The playing field is a single-level rectangle, maneuverable by both teams.
- 2.2.02 Available starting zones are located at one end of the playing field and are represented by the colored tiles.
- 2.2.03 A conveyor belt is located opposite the starting zones and is not accessible to robots.
- 2.2.04 A perimeter is painted on the floor directly below the Twister actuator, identifying the area in which a robot may come into contact with the actuator while the actuator is in motion. Entering this zone is at the robot's risk. However, a deliberate attempt to hit another robot using the Twister actuator will be considered as unsportsmanlike behavior. See Section 2.9 for details on arbitration and penalties.
- 2.2.05 The floor area beneath the Mushrooms actuators is part of the playing field.
- 2.2.06 Unless otherwise communicated by the CRC Robotics Organizing Committee in the event of a modification, measurements of the playing field recorded at Kickoff will be considered accurate. Teams are allowed a certain period of time at Kickoff to measure the different elements of the playing field.

2.2.06 The image below shows a view (not to scale) of the playing field.



2.3 Game Pieces

2.3.01 This year's game pieces (GP) are bean bags.

2.3.02 Robots cannot touch the GPs as they are passive, not active, playing pieces.

2.3.03 There are two types of GPs: red ones, dropped into play at a certain rate during the heat and black ones, dropped into play as a result of a power-up activation.

2.3.04 There are no limits to the number of GPs put into play during the heat.

2.4 The Conveyor Belt

2.4.01 The conveyor speed and direction are two independent variables. These two variables can take different values depending on the power-ups activated during the game. They are represented by the following letter strings and can take the following values.

$$\begin{cases} speed = \{0; 0.5; 1; 1.5; 2\} \\ direction = \{yellow; blue\} \end{cases}$$

2.4.02 One bin is located at each end of the conveyor belt. The yellow bin located to the left of the conveyor belt belongs to the yellow team. The blue bin located to the right of the conveyor belt belongs to the blue team. When *direction* = *yellow*, the direction of the conveyor belt is toward the yellow bin. When *direction* = *blue*, the direction of the conveyor belt is toward the blue bin.

- 2.4.03 At the beginning of the heat, the conveyor does not move ($speed = 0$).
- 2.4.04 The conveyor belt can only be started when a robot triggers their Hinged Board actuator. This initial trigger starts the first conveyor period. If a robot from the blue team triggers its Hinged Board first, then $speed = 1$ and $direction = blue$. If a robot from the yellow team triggers its Hinged Board first, then $speed = 1$ and $direction = yellow$. This initial triggering of the Hinged Board actuator does not count as an activation of the team's single-use conveyor belt direction switch power-up.
- 2.4.05 A conveyor period is a 30-second period where the direction of the conveyor remains the same. When a period ends, the direction is switched ($direction$ is changed to the other possible value) and a new period begins.
- 2.4.06 For reference, when $speed = 1$, a GP takes around 40 seconds to go from one end to the other of the conveyor when the conveyor is empty.

2.5 Putting Game Pieces into Play

- 2.5.01 GPs are put into play via a dispenser. Red GPs are dispensed onto the middle of the conveyor at a certain rate. This drop rate is represented by the following letter strings and can take the following values depending on the power-ups activated during the game.

$$\{rate = \{0.5; 1; 2\}$$

- 2.5.02 At the beginning of the heat, $rate = 1$.
- 2.5.03 For reference, when $rate = 1$, a GP is dropped every 4 seconds.

2.6 Scoring Points

- 2.6.01 A team scores points every time a GP falls into its bin. Red GPs are worth 20 points each and black GPs are worth 200 points each.

GP Color	Points/GP
Red	20
Black	200

2.6.02 The following is a scoring example. It constitutes an integral part of the rules and acts as a reference for scoring disputes. Please note that this image does not represent the real playing field to scale, the various elements of the field, or the positioning of the starting zones. This image is simply to help understand the scoring system. The numbers represent the number of GPs of each color located in each bin at the end of a heat.



	Yellow Team	Blue Team
Black GPs (200 pts)	2 (400 pts)	1 (200 pts)
Red GPs (20 pts)	17 (340 pts)	19 (380 pts)
Total score	740	580

2.6.03 In order to share points with its teammate, a robot must trigger at least one actuator during the entirety of the heat. The robot will then be defined as a sharing robot and will share the team's points.

2.6.04 The total score for each team is assessed at the end of the heat, although an estimated score might appear as the heat is in progress. A robot's final score for a heat represents its total score, minus penalties.

2.7 Power-Ups

2.7.01 Each actuator has a single power-up tied to it. Triggering said actuator will activate the power-up.

2.7.02 While a power-up is active, the green LED located near the corresponding actuator blinks.

2.7.03 There are 4 power-ups that will remain the same for every heat and will be linked to the same actuators.

- The speed of the conveyor belt is now twice or one and a half times its normal speed for 20 seconds, depending on the Mushroom actuator pressed. The furthest Mushroom from the middle of the playing field changes the value of *speed* to 2, while the closest one changes the value of *speed* to 1.5.
- The drop rate of the GP dispenser is twice its normal rate (*rate* = 2) for 20 seconds.
- The current conveyor period is halted immediately. A new conveyor period is started, and the conveyor direction is switched (*direction* changes to the other possible value). This power-up is only available after 1 minute has passed since the triggering of the Hinge Board that initially started the conveyor belt. Each team can use this power-up only once per heat.
- The conveyor is stopped (*speed* = 0) for 10 seconds.

2.7.04 The blue and yellow team are also allowed to choose a custom power-up from the following bank of power-ups prior to the start of each heat. This customizable power-up is always associated to the same actuator.

- The speed of the conveyor belt is now half its normal speed (*speed* = 0.5) for 20 seconds.
or
- The drop rate of the GP dispenser is now three times its normal speed (*rate* = 3) for 20 seconds.
or
- A black GP is dropped in the middle of the conveyor.

2.7.05 Each power-up is linked to a certain actuator.

Actuator	Power-up	Duration
Chained Ball	The drop rate of the GP dispenser is twice its normal rate ($rate = 2$).	20 seconds
Arch	The speed of the conveyor is now half its normal speed ($speed = 0.5$).	20 seconds
	<i>or</i>	
	The drop rate of the GP dispenser is now three times its normal speed ($rate = 3$).	20 seconds
	<i>or</i>	
	A black GP is dropped on the conveyor.	N/A
Twister	Conveyor belt freeze ($speed = 0$).	10 seconds
Mushrooms	1.5x conveyor speed for the mushroom nearest to the middle of the playing field ($speed = 1.5$).	20 seconds
	<i>or</i>	
	2x conveyor speed for the mushroom farthest from the middle of the playing field ($speed = 2$).	20 seconds
Hinged Board	Single-use conveyor direction flip.	N/A

2.7.06 The activation of the 0.5x conveyor speed power-up, the 1.5x conveyor speed power-up, the 2x conveyor speed power-up, or the conveyor freeze power-up terminates any ongoing power-ups affecting the speed of the conveyor. The new power-up then activates for its normal duration. Mathematically speaking, when the value of *speed* is changed, the ongoing power-up is terminated and replaced with the new power-up for its normal duration.

2.7.07 The activation of the 0.5x drop rate power-up or the 2x drop rate power-up terminates any ongoing power-ups affecting the drop rate of the GP dispenser. The new power-up then activates for its normal duration. Mathematically speaking, when the value of *rate* is changed, the ongoing power-up is terminated and replaced with the new power-up for its normal duration.

2.7.08 The direction of the conveyor belt can change during the duration of power-ups as a result of the triggered of a Hinged Board actuator or due to the normal end of a conveyor period. The power-ups will continue to be active for the respective remaining time, but with the conveyor direction flipped. Mathematically speaking,

because they are two independent variables, *direction* can change without *speed* being affected, and vice-versa.

2.8 Actuators

2.8.01 During the heat, teams must trigger actuators in order to activate their corresponding power-up.

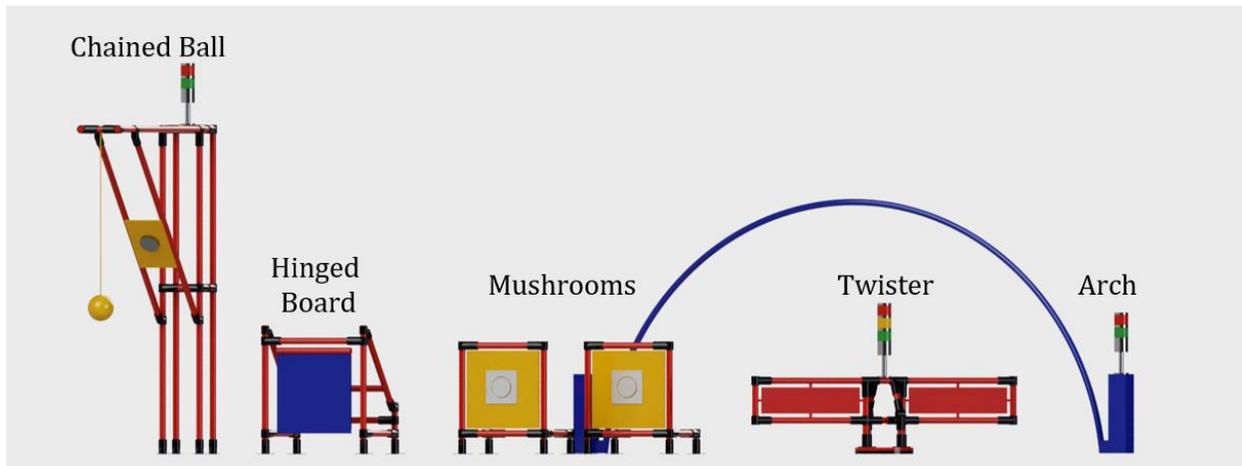
2.8.02 Teams can only trigger the common actuator or an actuator that is the same color as their team.

2.8.03 There are a total of 9 actuators on the playing field. Both teams have 4 actuators specific to their team's color:

- A Hinged Board actuator;
- A Chained Ball actuator;
- An Arch actuator;
- A set of two button actuator (referred to as the Mushrooms actuator);

And a common one:

- A Twister actuator.



2.8.04 The Hinged Board actuator is a rectangular board hinged at its top. The board must be pivoted so that it triggers a pressure plate, activating the corresponding power-up.

2.8.05 The Chained Ball actuator is a weighted ball attached to a chain. The ball must come in contact with a pressure plate to trigger the actuator, activating the

corresponding power-up. Whether intentional or not, robot parts cannot touch the Chained Ball actuator pressure plate. See Section 2.9 for details on arbitration and penalties.

- 2.8.06 The Arch actuator is an arc that goes from one side of the playing field to the middle. Initially, bringing the carriage riding on the arc to the bottom of either side will activate the corresponding power-up. The carriage will activate the power-up by triggering a pressure plate. Afterwards, the carriage must be brought to the bottom of the other side of the arc for the corresponding power-up to be activated again. The carriage cannot be moved during the downtime of the actuator corresponding to the power-up. Whether intentional or not, robot parts cannot touch the Arch actuator pressure plate. See Section 2.9 for details on arbitration and penalties.
- 2.8.07 The Mushrooms actuator is a set of two pressure plates. The triggering of either pressure plate activates the corresponding power-up.
- 2.8.08 The common Twister actuator rotates around its vertical axis. Teams must keep it perpendicular to the conveyor belt for an uninterrupted duration of 3 seconds to activate the corresponding power-up. The actuator must be pushed, not hit. However, if right after its downtime, the Twister remains perpendicular to the conveyor for an uninterrupted 3 seconds, the corresponding power-up will reactivate again.
- 2.8.09 The red LED located near the corresponding actuator will light up during the 30 (or 50, refer to 2.8.14) seconds following its triggering, indicating that it is in a downtime state. Power-ups cannot be activated while the corresponding actuator is in downtime. At the end of the downtime period, an actuator must be triggered again in order to activate its corresponding power-up once again, except for the common actuator. In other words, the actuator must read a rising-edge on its pressure plate outside of its downtime in order to activate its corresponding power-up.
- 2.8.10 Downtimes are actuator- and team-specific. For example, if the yellow team triggers the yellow Chained Ball actuator, the yellow Chained Ball actuator will be in a downtime state for 30 seconds. During this time, the blue Chained Ball actuator will still be available to be triggered by the blue team if not itself already in a downtime state from a previous triggering by the blue team.
- 2.8.11 The Twister actuator, being a common actuator, has a single downtime affecting both teams. Its corresponding power-up cannot be activated until the Twister downtime ends.

2.8.12 The following represents the LED light logic associated with the state of each actuator. Note that the yellow LED associated with the Twister actuator does not represent the yellow team.

Actuator	Green LED	Red LED	Yellow LED
Arch	Power-up available	Power-up in downtime	N/A
Chained Ball	Power-up available	Power-up in downtime	N/A
Mushrooms	Power-up available	Power-up in downtime	N/A
Twister	Power-up available	Power-up in downtime	Twister actuator is perpendicular to conveyor
	Blue LED	Yellow LED	
Hinged Board	Blue team's single-use conveyor direction switch bonus available	Yellow team's single-use conveyor direction switch bonus available	

2.8.13 To represent the fact that the initial Hinged Board actuator triggering (the one that starts the conveyor) doesn't count as an activation of the single-use conveyor direction switch power-up, both the yellow and blue LED will be turned off at the beginning of the heat. 1 minute after the initial triggering of the Hinged Board actuator, both LEDs will start flashing, representing the fact that both teams now have access to their single-use bonus. When the single-use bonus is activated, the LED associated to that team's color will turn off.

2.8.14 If a team chooses the 0.5x conveyor speed as their custom power-up, the team's Arch actuator has a downtime period of 50 seconds. The downtime period of the other custom power-ups as well as all the other actuators is 30 seconds.

2.9 Arbitration and Penalties

2.9.01 Our referees are experts in calling and assessing penalties and always have the final word on the playing field. However, during the 15 minutes following the end of a heat, a team can challenge its final score if it has video evidence to support its claims. A team may be deprived by the referees of its right to challenge if they find it is unnecessarily abusing it.

2.9.02 The referees on the playing field have full authority to judge all aspects of the game. In particular, the referees will:

- Prevent robots, robot extensions and dropped robot parts from negatively blocking other robots;
- Prevent robots from damaging the playing field and GPs;
- Prevent robots from violating the air space on the edges of the playing field;
- Try their best to make sure the numbers displayed on the screens are accurate and updated as soon as possible; however, their ruling overrides whatever is displayed on the screens.

2.9.03 Any robot that is deemed dangerous (based on its design or behavior) by any of the referees runs the risk of being disqualified.

2.9.04 While we trust that all participants will provide clear intentions, certain conducts may occur that require sanctions, especially during the heat of battle. To avoid such penalties, remain courteous. These penalties are considered as Unsportsmanlike Conduct and have a series of escalating consequences, depending on the severity of the issue. The number of points deducted from the robot's total score for that heat will be at the discretion of the head referee and will be proportional to the severity of the action. Some examples of the types of behavior that signal a lapse of sportsmanlike behavior are:

- A deliberate attempt to disable or damage another robot;
- A deliberate attempt to hit another robot with a GP, robot part or playing field element;
- Inappropriate behavior directed at an official, another participant or a spectator;
- A deliberate attempt to block the triggering of team-specific actuators.

2.9.05 The minimum score that can be awarded for any given heat is 0 points; therefore, if a penalty brings a robot's total score to below 0, the final score awarded to the robot for the heat will be 0.

2.9.06 If liquid seeps from a robot onto the playing field, the robot's final score for the heat will be reduced to 0.

2.9.07 Various robot parts (items) may be placed, intentionally or not, on or around the playing field by a robot, on the condition that they are removed from the playing field or from its surroundings by the robot before the end of the heat. If items are no longer in contact with the robot by the end of the heat, the robot that released

these items will be liable to an individual junk penalty of 4% of its total score for the heat for each item left on or around the playing field.

- 2.9.08 If a team judges that its robot needs assistance on the playing field during a heat, its pilot may ask the referee to assist their robot. The assisted robot will be liable to an assistance penalty of 20% of its total score for the heat. The referees reserve the right not to assist the robot even if asked to do so by the pilot.
- 2.9.09 Whether intentional or not, if a robot or one of its parts triggers an actuator belonging to the other team, or activates a power-up by touching the Chained Ball or Arch actuator pressure plate, it will be liable to an actuator penalty of 50% of its total score for the heat.

2.10 Heat Progress

- 2.10.01 Each blue robot starts the heat in one of the two blue starting zones on the playing field, while each yellow robot starts the heat in one of the two yellow starting zones on the playing field. Only one robot can start in each starting zone.
- 2.10.02 All heats are 5 minutes in duration. When the heat time is over, all parts of all robots must stop moving, and the conveyor is stopped (*speed* = 0). GPs will be considered only when they stop moving, even if that occurs after the heat time is over. All the points generated by a team due to the motion of their robots after the heat ends will be canceled. Although an estimate might appear on the screens near the playing field, the remaining time until the end of a heat is controlled by the head referee.
- 2.10.03 Team members may not interfere with or touch any element of the playing field, robots or GPs during the heat.
- 2.10.04 Robots may not damage the GPs or any playing field element.
- 2.10.05 All robots must be labelled with the school's name (either full or shortened) and number, as well as its assigned team color for the heat using the provided flags. These three elements must be clearly visible to the crowd and referees. If these elements are not all visible, the robot will not be allowed to participate in the heat. Adding the robot's name (if any) is optional.
- 2.10.06 If a robot is not able to fully exit its starting zone during the heat for whatever reason and is not actively trying to score points from its starting zone, or if it is simply absent, it will be considered as an inactive robot. A robot teaming up with an inactive robot will see its score multiplied by 1.25 to compensate for the

disadvantage of playing alone. Inactive robots will be removed from the playing field after 30 seconds of inactivity to prevent them from blocking play.

- 2.10.07 If a robot makes it out of its starting zone and stops moving for whatever reason, it will be considered a broken robot. If the robot breaks before it meets the sharing requirements, then it will not share the team's score, but the other robot's score (from the same team) will not be multiplied by 1.25, because, initially, the broken robot was an active robot. Broken robots will be removed from the playing field after 30 seconds of inactivity to prevent them from blocking play.
- 2.10.08 Following the buzzer signaling the end of play, team members are not allowed to enter the field, to touch any robot, or to touch the GPs before they are cleared to do so by the head referee. It is essential that the configuration of the GPs, at the end of the heat, remains intact for scoring purposes. The head referee will indicate when the team members are allowed to enter the playing field.

2.11 Pilot and Co-Pilot

- 2.11.01 Each team's pilot, co-pilot (spotter), and robot participating in the next heat must be in the "On Deck Area" when the buzzer sounds to end the previous heat. If not, a penalty is assessed to the offending robot. It is the team's responsibility to make sure the team is on time, even if the schedule is delayed.
- 2.11.02 If a robot, pilot, or co-pilot of a team is not ready to start, the heat will start without the team in question.
- 2.11.03 The pilot and co-pilot must remain seated during the entire game in their designated seats provided by CRC Robotics, which are placed within the designated areas surrounding the playing field.
- 2.11.04 Each person is responsible for taking all necessary precautions to ensure their own safety.
- 2.11.05 Before the start of the heat, the referees will ask each team for their choice of one of the 3 custom power-up options. The blue team will make their choice without knowing the choice made by the yellow team, and vice-versa. The custom power-ups are team-specific, and not robot-specific. If one team cannot agree on a power-up, a random one will be set as their choice.

2.12 Tournament Progress

2.12.01 The tournament consists of 5 stages:

- a. **Preliminary Round:** These heats are played on Thursday night and throughout the day on Friday by all teams. After all the preliminary heats have been completed, each robot will cast out their two lowest-scoring heats. Heats affected by an unsportsmanlike penalty cannot be cast out. The total of all other heats will be summed to determine each robot's final rank for the preliminary round. Depending on a team's rank, teams can advance directly to semi-finals or quarterfinals, or they will play in the knock-out round.
- b. **Knock-Out Round:** These heats are played on Saturday morning by teams that did not directly advance to quarterfinals or semi-finals. This round provides teams with an opportunity to advance further in the tournament. The final score of all the heats played by a robot in the knock-out round will be added to determine its ranking in this round.
- c. **Quarterfinals:** Top teams from the preliminary and knock-out rounds advance to this stage of the tournament. The final score of all the heats played by a robot in the quarterfinals will be added to determine its ranking in this round.
- d. **Semi-Finals:** Top teams from the preliminary rounds and quarterfinals advance to this stage of the tournament. The final score of all the heats played by a robot in the semi-finals will be added to determine its ranking in this round.
- e. **Finals:** Top teams from the semi-finals advance to this stage of the tournament. The final score of all the heats played by a robot in the finals will be added to determine its ranking in this round.

2.12.02 The schedule for the various rounds will be published at the beginning of the Competition at robo-crc.ca/participant-portal/.