

**TCEA Robotics Challenge 2019-2020**

# **Bees, Bots and Beyond!**

**Game Manual**

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Revision 1

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The TCEA Robotics Challenge is a robotics competition for grades 4-12 based on the LEGO brand Mindstorms and SPIKE Prime robotics platforms. This competition is administered by TCEA whose mission is advancing teaching and learning through the use of technology.

Each year, teams of students, sponsored by members of TCEA, receive a set of challenge rules and specifications designed around a theme that varies from year to year. Teams compete against one another in head-to-head competition at regional and state levels.

## Section 1 Game Description

*You are flying at 12 miles per hour (mph) towards a target that is only  $\frac{1}{4}$  - inch b  $-\frac{3}{4}$  - inches, while heavily laden with one of the critical substances that your family needs to survive. Just as you get to the landing pad, you are blown off course by a 20 mph wind. You struggle to reach the target, crawl inside and are met by sisters who take the food from the packs on your back legs to store in cells for future consumption.*

The 2019-2020 TCEA Mindstorms Robotics Challenge game is titled, “Bees, Bots and Beyond!”. This year’s competition has you designing a robotic honey bee. *Honey bees are pollinators, and the U.S. Department of Agriculture estimates that honey bees pollenate up to 80% of the country’s insect-pollinated crops. According to scientific research honey bee colonies have been disappearing at a rate of 90% (according to National Geographic Kids) in some regions, and no one knows why. Honey bees have a complex family structure and a single bee will live only about 5 to 6 weeks on average. By building a robotic honey bee, you will be able to increase the global food supply until scientists find out why the honey bees are leaving.*

*There are three types of honey bees in a hive: worker bees (nurse bees, house bees, forager bees) drone bees, and a queen bee. Your robotic honey bee will help the forager bees by gathering pollen, nectar, and water to place them in the correct frames inside of a Langstroth hive. A traditional Langstroth hive contains 10 frames that the honey bees use to store food and raise new bees. There is a specific location for each of these frames in the Langstroth hive. The outermost frames contain nectar that becomes honey, the very center frames contain brood, larvae, or eggs, and the frames in between normally hold pollen.*

### 1.1 Field Layout Overview

The competition field for “Bees, Bots and Beyond!” is composed of:

- a simple table frame (see Field Construction Manual)
- competition mats (one for each side of the frame)
- double sided duct tape
- PVC couplers (4 for intermediate and 8 for advanced)
- Dixie bathroom cup (2)
- Checkers (10 red and 10 black)
- cotton balls (2 for intermediate and 3 for advanced)
- Standard die (1)

The competition mat that TCEA uses is **similar** to the “Race Against Time” mat **previously** produced by LEGO Education – that mat has been discontinued, but TCEA was given the rights

to reproduce the mat. Mats can be ordered online from the TCEA store.

**WARNING:** Mats made after the 2014 competition season are made of a different mat material than those made by LEGO Education. The pattern printed on the mat is identical to previous years, and there are no distinguishing marks on the mat, so it may be difficult to distinguish a previous year's mat from the current mat. It is recommended that teams mark the underside of their mat as "2014+" mats immediately upon receiving (taking caution not to mark in an area or in a way that shows through to the front of the mat).

The competition mat was chosen to provide a uniform field layout for the game, so that teams and tournaments would be able to reproduce the same field environment for practice and competition.

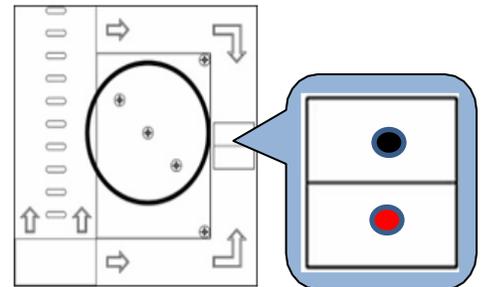


A frame full of capped honey, ready to process.

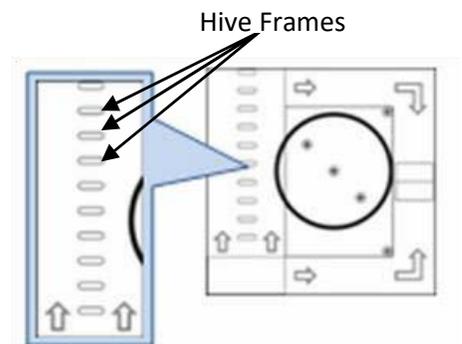
The mat has 5 primary areas that are of interest to Bees:

- Feeding Station
- Hive Frames
- Crop Field
- Honey House
- Water Hole

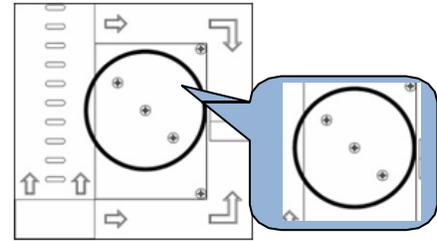
**1.1.1 Feeding Station** – *Sometimes it is necessary to feed honey bees in times of a shortage of food. So beekeepers will provide pollen patties and sugar water for the bees.*



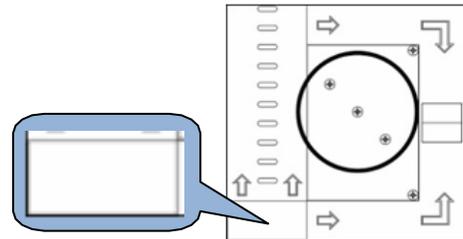
**1.1.2 Hive Frames** – *There are 10 frames in a Langstroth hive and honey bees will store nectar/honey, pollen and larvae in a particular order. The center frames are used to store larvae and eggs. The next frames, looking outward, contain pollen, and the very outside frames contain nectar and honey.*



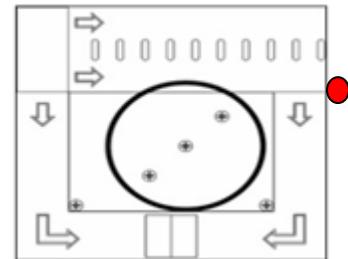
- 1.1.3 Crop Field** – This is where your robotic honey bee will gather both pollen and nectar. As with a crop covered in flowers, this area will have both pollen and nectar scattered throughout.



- 1.1.4 Honey House** - This is where your robotic honey bee will park for the night. It is close enough to the hive, yet not in the hive.



- 1.1.5 Water Hole** - *In order for any animal or insect to survive, they need water. Honey bees are no different. Honey bees also need water to turn nectar into honey. Honey is comprised of approximately 80% nectar and 20% water.* The water hole is shown on the right as a red circle.



## 1.2 Game Pieces

It is recommended that kits are obtained from TCEA. This will assist with standardization and reduce the possibility of different equipment at competitions.

- 1.2.1 Double-sided duct tape** – approximately 3 inches.
- 1.2.2 Red and black checkers** – Ten (10) interlocking black and ten (10) interlocking red plastic checkers, about 1 ¼ inch diameter and ¼ inch thick.
- 1.2.3 Cotton balls** – Three (3) standard fluffy cotton balls approximately 1 inch in diameter, not the compact wrapped cotton balls.
- 1.2.4 Dixie bathroom cup (3 ounce)** Two (2) 3-ounce Dixie bathroom cups.
- 1.2.5 Dura ¾" schedule-40 PVC pipe couplers** – Four (4) standard ¾" PVC pipe couplers for the intermediate and eight (8) for the advance competition that can be found at home improvement stores for less than 50 cents per coupler. The Dura ¾" schedule-40 PVC pipe coupler is designed as a slip-slip coupler that joins two ¾" PVC pipes. A coupler is roughly 2.125" long (2 1/8" in height) and have a 1.3125" outer diameter (1 5/16"). The height can vary +/- ¼", and the outer diameter can vary no more than 1/16".
- 1.2.6 Standard Die** – One (1) standard 16mm die, color does not matter.
- 1.2.7 Team-provided game piece** – “Bees, Bots and Beyond!” allows for a team-

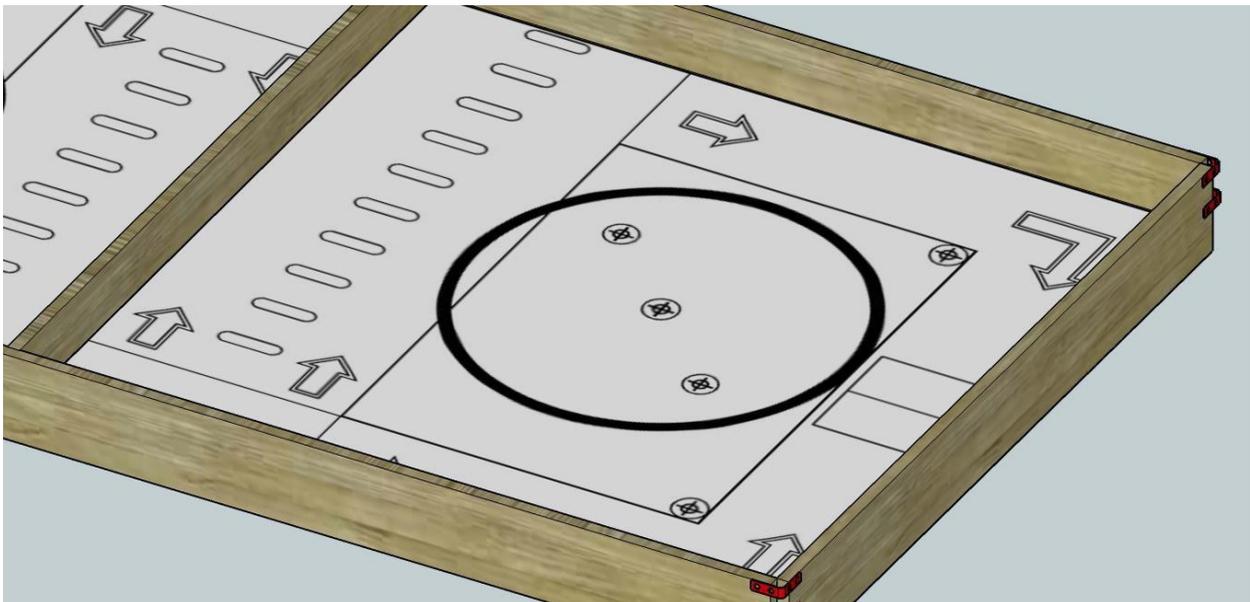


provided game piece that functions as the Queen Bee. The Queen Bee should fit completely within a 3-ounce Dixie bathroom cup. *The Queen Bee controls the hive through the release of pheromones. Without a queen, a hive can become unruly and sting people and animals, even if unprovoked.*

Team-provided game pieces are built or bought by teams to the competition table when the team is scheduled to compete, used during the game, and are returned to the team after each competition match. The team-provided game pieces are built or bought using any allowed materials, **MUST** be factored in the team's allowance, accounted for in the Bill of Materials (BOM), and fit within the robot start configuration.

### 1.3 Field Mat Setup

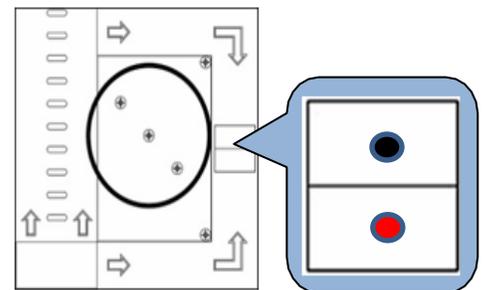
The Field Mat for "Bees, Bots and Beyond!" will be oriented such that the Feeding Station is closest to the south wall. If the frame space you're working with is not exactly 4'x4', the mat should be centered on the field such that there is an equal amount of space between the wall and the mat on the 3 sides, except the south wall. In these cases, double-sided tape (such as double-sided duct tape) is recommended to help keep the mat in place.



### 1.4 Game Piece Setup

Most game pieces are placed by the referee before each match. This year, we are replenishing nectar and pollen in the Feeding Station as the robotic honey bee uses it. The only other game pieces that aren't placed by the referee are the team-provided game pieces, the Queen Bee and the wax caps (that are used in state play only).

- 1.4.1 Located in the Feeding Station (section 1.1.1), (approximately centered in a rectangle) at the start

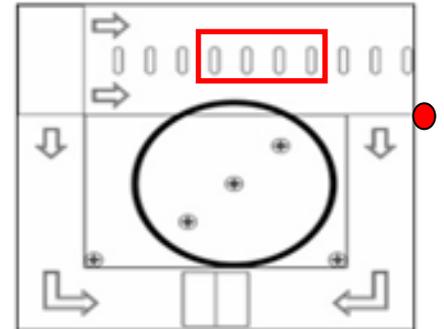


of the match, is one drop of nectar (red checker) in the left hand side rectangle and one piece of pollen (black checker) in the right hand side rectangle. **Each of these items will be replaced once the robotic honey bee removes them and itself from the Feeding Station, up to 5 times.** The replacement of nectar is independent of replacement of pollen.

**1.4.2** Located within the Crop Field (section 1.1.3) are four (4) pieces of pollen (black checkers) and four (4) drops of nectar (red checkers). These eight (8) checkers are placed randomly by the referee.

**1.4.3** The larvae and eggs (PVC couplers) are placed on the four center brood frames in the hive, shown in the red box in the picture on the right.

- **Intermediate only** – the four (4) PVC couplers are placed in the middle of the (4) center hive brood frames.
- **Advanced only** – the eight (8) PVC couplers are placed one each on the ends of the four (4) hive brood frames.



**1.4.4** The water hole (3-ounce Dixie bathroom cup) (section 1.1.5) is taped to the outside of the competition frame in line with the solid black line separating the Crop Field from the Hive Frames. The three-inch piece of double-sided duct tape is oriented vertically to the top of the wooden frame. The top of the cup will be flush with the top of the wooden frame. Once the water hole is in place, two drops of water (cotton balls) for the advanced and three drops of water (cotton balls) for the intermediate will be placed gently inside.

**1.4.5** A wasp (standard 16mm die) is part of the mystery task and will be placed by the referee before rounds two and three of the competition.

**1.4.6 Team-Provided Pieces** - The team will provide a queen bee. The queen bee must be part of or contained within the robotic honey bee PRIOR to being measured for compliance. The team-supplied game pieces are considered part of the robot prior to competition start. The Team Captain must indicate to the referee what comprises the team-provided pieces prior to robot measurement and show the referee how this is represented on the Bill of Material (BOM).

Once the team-provided pieces are no longer in contact with the robot, these items are considered game pieces from that point on (and **NOT** as part of the robot). Game pieces are **NEVER** allowed to be touched during the match by team members once they are on the game field.

## 1.5 Game Tasks

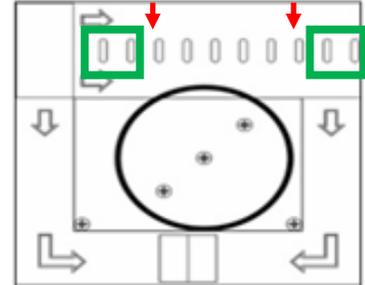
In “Bees, Bots and Beyond!”, a robotic honey bee must perform specific forager bee tasks on the game field within the 2-minute time limit. There are five (5) possible tasks to perform in round 1 and six (6) possible tasks to perform in rounds 2 and 3. All but the mystery task can be completed in any order. Each task completed by the robotic honey bee accumulates points, though some of the tasks are not evaluated until the end of the match. If a task that is to be evaluated at the end of the match is

completed and then undone before the end of the match, then the task is considered not completed.

Each black line on the mat is considered a plane. When a task calls for something to be within an area on the mat shown by black lines, it must not "break the plane."

**1.5.1 Take nectar to the outside four (4) hive frames** – Nectar is denoted by the red checkers.

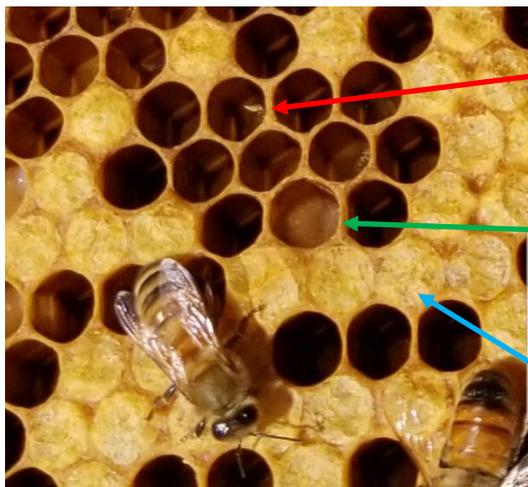
It is to be moved to the outside four (4) frames (shown on the right by the green boxes). Points will be awarded for any red checkers that are inside (breaking the plane) the outside four frames. *These hive frames are where the house bees make honey using the nectar and water in the hive. A single bee will make 1/12 of a teaspoon of honey during her short life.*



**1.5.2 Take pollen to the 3<sup>rd</sup> or 8<sup>th</sup> hive frames** – Pollen is denoted by the black checkers. Pollen is to be placed in the 3<sup>rd</sup> or 8<sup>th</sup> hive frames (shown on the right by the red arrows). *Honey bees use pollen to make more bees.*

**1.5.3 Place the Queen** – *The queen bee can lay 2,000 eggs a day.* For this reason, the queen bee should remain with the brood. Place your queen bee on one of the four (4) brood frames without disturbing the brood (PVC couplers).

The brood consists of eggs, larvae and capped brood (PVC couplers) and is already in place on the brood frames, don't move the brood or you will be penalized.



Egg laid by Queen Bee

Larvae ready for wax cap

Larvae with wax cap, ready to hatch

**1.5.4 Move water to the hive** – Water is necessary for honey bees to cool down the hive and to turn nectar into honey. Move the water (cotton balls) from the water hole to any frame in the hive. If the water hole becomes polluted (ripped, torn or disturbed in any way) then you will lose all points accumulated for moving water to the hive.

**1.5.5 Park the robotic honey bee in the honey house** – Your robotic honey bee must finish in the honey house so as not to disturb the real honey bees. Your robotic honey bee must cross the plane in order to be considered "in the honey house".

- **Intermediate only** – the robotic honey bee may touch the frame walls

- **Advanced only** – the robotic honey bee may **NOT** touch the frame walls
- 1.5.6 Mystery Task** - An unknown additional task will be given at the end of round 1 that must be accomplished at the beginning of rounds 2 and 3. This will be a simple programming task involving the wasp (the die) such as: have your robot perform a 360 degree turn before accomplishing any other task.

## Section 2 General Game Rules

The “Robot” is defined by everything the team brings to the table for the game (including team-supplied game pieces). There is no weight limit on the robot. While the robot is active in play, there is no restriction on the size of the robot.

### 2.1 Robot Set Up

- 2.1.1 The team will set their robot up; touching the mat, touching the south wall, and touching either the east or west wall without touching the Feeding Station (section 1.1.1).
- 2.1.2 Once the team is finished setting up their robot, the referee will measure to ensure that the robot fits within a 12” x 12” x 12” imaginary cube and within the game frame, no part of the robot may hang over the frame at the start of the competition.

Nothing on the robot may extend past the inner plane of the walls of the competition frame. The referee will measure twelve (12) inches from the south wall and twelve (12) inches from either the east or west wall (team captain’s choice). The robot shall not extend beyond these twelve (12) inches in either direction. The robot shall also not be taller than twelve (12) inches as measured from the surface of the mat. **The robot must stand alone during referee measurement and no team member may touch the robot during or after measurement, except to start the robot.**

- 2.1.3 Once the referee determines that the robot is compliant with the rules, the team may not touch the robot again until the match starts. Then only to initiate start.

### 2.2 Robot Recovery

During match play, team members are allowed to “recover” their robot from anywhere on the game field. If a team decides to recover their robot (by initiating touch contact with the robot):

- 2.2.1 Any game piece(s) touching the robot (except team-supplied game pieces not yet deployed from the robot) are left where they lie.
- 2.2.2 Any game piece(s) moved by the robot or team members during the recovery will be removed from play by the referee.
- 2.2.3 The robot is “disabled” and must immediately be prepared to be restarted according to manual section 2.1.
- 2.2.4 The team will incur a touch penalty of 10 points every time the robot is touched during the match.
- 2.2.5 A team is allowed to “recover” their robot up to 10 times. Once a robot begins motion, the robot is considered “active” and if touched will incur this touch penalty.
- 2.2.6 While the robot is “disabled” and being prepared to restart, the team may change programs or repair/rebuild the robot. No new outside parts may be added to the robot, but parts may be removed. Once they are removed and the robot is restarted, they may not be re-added to the robot.

- 2.2.7 The robot must be approximately the same starting size. The robot cannot be larger than the starting size. The referee will estimate robot size, and if the referee determines the robot is likely still within size, the team may immediately restart the robot. If the referee feels the robot is not within size, the referee will quickly re-measure the robot.

## **2.3 Other**

- 2.3.1 Robots must be able to handle some field variances, such as tolerances in board length/width/height and slight waviness in the field mat. Teams should not rely on specific field attributes that can vary with tolerances (such as the amount of spacing under the north wall, the vertical angle of the field walls, etc.) when designing their robots. Teams and/or sponsors are not permitted to touch or inspect boards prior to competition.
- 2.3.2 Teams may request that any element that is not a part of their robot, not an official game piece or was not presented by the team at the start of the match be immediately and permanently removed from the field of play at any time during a match if that element resides on their half of the playing field. Such elements would be considered “debris” and could be (but are not limited to) stray parts from the opposing team’s robot and/or game pieces from the opposing side of the playing field. These elements are to be held by the referee until the end of the match.
- 2.3.3 Teams must have a properly formatted and correct Bill of Material (BOM) to be allowed to score any points as noted on the score sheet.
- 2.3.4 Team-supplied game pieces are considered part of the robot until they are removed/dropped/detached from the robot. Once a team-supplied game piece has been removed/dropped/detached, the game piece can no longer be touched/recovered by team members and may no longer be considered part of the robot for the remainder of the match. If a team member does touch a game supplied piece(s) that has been removed/dropped/detached, the referee will remove it from play.

## **Section 3 General Competition Rules**

### **3.1 Team Requirements**

For safety reasons, the number of people allowed in various locations during the contests (such as the pits) is controlled. Additionally, for fairness during the contests, communications and the amount of assistance sponsors can provide in setup/teardown is limited. Please carefully read through the rules below:

- 3.1.1 Teams are led by at least one team sponsor and are composed of at most four students.
- 3.1.2 Students are not allowed to participate on more than one team.
- 3.1.3 Teams may only compete in one division (Advanced Arena, Intermediate Arena, Advanced Inventions, or Intermediate Inventions).
- 3.1.4 The team sponsor must have an active TCEA membership for the duration of your contest season. [www.tcea.org/membership](http://www.tcea.org/membership)
- 3.1.5 All teams are required to have a team name that meets common school standards.

- 3.1.6 Only registered students are allowed to touch the robot and the computer used to program it. The only exception is when technical problems with the computer occur. Live student problem solving is part of the spirit of this competition.
- 3.1.7 Only registered students will be allowed in the team's work/competition area.
- 3.1.8 Only the robot and team provided game pieces will be allowed in the competition area. No additional parts and definitely no computers or cell phones.
- 3.1.9 Teams must designate one student member to be the Team Captain. The Team Captain is the only person from a team who can review and/or initial score sheets or dispute field setup with the referees.
- 3.1.10 Each team must have its own robot.
- 3.1.11 Each robot, for both Arena and Inventions, should be a unique design for each team.
- 3.1.12 Students in third grade and below cannot compete in TCEA contests.
- 3.1.13 Students in grades 4-5 may ONLY compete in the intermediate division.
- 3.1.14 Students in grades 6-8 may compete in either Intermediate or Advanced divisions.
- 3.1.15 Students in grades 9-12 may ONLY compete in the Advanced division.
- 3.1.16 Teams must compete in their designated Area unless there are not enough teams in that Area to hold a contest. Contact your Area Director with questions.
- 3.1.17 For the Area contests, each school may enter no more than three (3) teams per division without special permission from the Area Director. If space allows, the Area Director may allow schools to register more than three (3) teams.
- 3.1.18 A maximum of two (2) Arena and/or Inventions teams from each school per division may advance to the State Competition.
- 3.1.19 No more than three (3) wildcard teams per division from each Area can advance to the State Competition.
- 3.1.20 Wildcard teams will be selected for remaining spaces at the State Competition. Wildcard teams are selected by comparing all Area results. The top scorers who did not place first or second at the Area contests may receive invitations (depending on the number of spaces available).
- 3.1.21 If changes to the advancing team makeup need to be made due to conflicts with schedules or grades, the decision to fill the spot is up to the team sponsor and the school's principal.
- 3.1.22 NO registrations will be allowed past the deadline at the Area or State Contests.
- 3.1.23 Every effort to provide wireless Internet access will be made, but it cannot be guaranteed; please plan accordingly.
- 3.1.24 Laser pointers are NOT allowed at contests.
- 3.1.25 Sponsors/parents may help transport heavy equipment before and after each contest, but they must immediately leave the pit or contest area after delivering the items. No lingering or further assistance from the sponsors/parents will be allowed. If further help is necessary, please communicate your needs to contest personnel.
- 3.1.26 Parents, sponsors, and spectators may not be on the Arena competition floor, the pit, or the Inventions Contest location during the competition. These areas will be clearly defined at the competition.
- 3.1.27 During the competition, students may not communicate with anyone except other registered students and competition staff; all forms of communication are prohibited, including, but not limited, live and electronic communication (talking, texting, videos, etc.). Students should request assistance from competition staff if any communication with parents or sponsors is necessary.

- 3.1.28 Any filming of the competition must be done from the designated spectator area (Arena) or by a team member who is in the competition area (Arena/Inventions). Students are allowed to videotape with a video camera but not with an Internet or Bluetooth accessible device. (i.e. cell phone, tablet)
- 3.1.29 Violations of these rules may result in the team's disqualification and ejection from the competition. A point deduction may be taken in circumstances where the team is not eliminated for the violation.

### **3.2 Competition Format**

The "Bees, Bots and Beyond!" game is a head-to-head challenge where two teams are separately competing on identical physically adjacent competition areas. Teams work to complete their tasks as efficiently and effectively as possible.

### **3.3 Tournament Scheduling and Scoring**

Each tournament will attempt to keep to the same scheduling for consistency between tournaments. Depending upon the number of teams, the time allotted for the tournament, and/or the number of playing fields available, the actual tournament schedule may vary from tournament to tournament.

A typical tournament is scheduled in rounds; in the first round, all teams play one match versus another randomly selected team. Once all teams have played at least one match, the round is over and the tournament typically takes a short break. In the second round, all teams play another match against different teams, until all teams have played at least twice. The same goes for the third round, where all teams play against a different opponent than previously played, until all teams have played at least three times. The tournament should attempt to maintain a minimum amount of time between matches to allow teams time to tweak their robots and programs.

- 3.3.1 Teams have three (3) attempts, or rounds, in which to play and earn points.
- 3.3.2 Each match can last up to 2 minutes (120 seconds) in duration.
- 3.3.3 Rounds never occur in immediate succession for any team.
- 3.3.4 When practical, no two teams play across from each other twice. Surrogate teams may be used to fill holes in the schedule.
- 3.3.5 If any teams play more than three rounds, as in the case of surrogates, only the team's first match in each round is for points.

### **3.4 Match Procedures**

- 3.4.1 Prior to each match, the referees or table-reset crew will place game pieces on the field according to the rules.
- 3.4.2 Teams must inspect the field and ensure that all game pieces are correctly placed.
- 3.4.3 Team members **ARE NOT** allowed to move game pieces themselves; if the team wishes to contest the placement of game pieces prior to the end of their setup time, the team must request the referee to correct the placement.
- 3.4.4 Teams may begin to set up their robots on the table when instructed by the referees.
- 3.4.5 Teams have a minimum of one minute to set up their robots prior to the start of the match.

- 3.4.6 After one minute of setup time has elapsed, if referees have determined that both robots are legal and meet all robot requirements, referees may start the match whether the teams are ready or not. **Teams MUST be able to set their robots up quickly.**
- 3.4.7 If a referee determines that a robot is not legal, the team must bring the robot into compliance before starting; if a team cannot bring their robot into compliance with all robot rules, the team may be disqualified.
- 3.4.8 Each match begins when indicated by the tournament host, head referee, or individual field referee; this may be done with any means indicated to teams prior to the beginning of the tournament.
- 3.4.9 Once the match begins, teams are allowed to initiate action to start their robots (starting their programs, pressing a touch sensor, waving hands across an ultrasonic sensor, etc....).
- 3.4.10 Robots must begin the match in accordance to all rules, including but not limited to robot size, robot location, and any other rules defined. Once the match starts, robots may exceed any robot size limitation for the duration of any fully-autonomous play.
- 3.4.11 While the match is in play, robots are fully autonomous unless specified by the specific game rules. Robots may not be controlled or influenced by outside interaction.
- 3.4.12 The match continues until the match timer expires or the referee (or another designated official) calls the end to the match.
- 3.4.13 The match timer NEVER pauses.
- 3.4.14 Once the match ends, teams must turn off their robots. Teams MAY NOT remove their robot from the field of play, nor move their robot from its final condition, until instructed or allowed by the referee.
- 3.4.15 The referee will complete a score sheet indicating the condition of the field (and the robot) at the moment the game ended.
- 3.4.16 Any action taken by the robot after time expires is not valid, and any such action will be reversed by the referee to restore the field state to the condition present at the end of the match.
- 3.4.17 The score sheet indicates the number of points a team has accumulated during a match and may or may not be calculated for teams before leaving the playing field. The completed score sheet must be initialed by the referees AND the team captain prior to leaving the field. The score sheet is then the ONLY and FINAL indicator of the results of the match and CAN NOT be contested EXCEPT when the score sheet itself is in clear violation of the game rules (i.e. the score sheet indicates a score that is impossible). In NO SITUATION will external review be admitted or allowed, especially video replay.

### **3.5 Team Ranking**

Teams are ranked based on their performance in the game. Eligibility for awards and advancement is based on a team's *ranking score* and any tie breakers (if necessary).

- 3.5.1 At area competition, the team's average of three (3) scores becomes their *ranking score*.
- 3.5.2 In the event that two or more teams have the same ranking score at the end of the tournament, the team's last score will be used as an initial tie breaker; the highest score in the third round wins.
- 3.5.3 In the event that two or more teams are still tied in ranking score after an initial tiebreaker, the lowest score of an individual round for each team will be used as a secondary tiebreaker; the team with the highest of the tied teams lowest scores wins.
- 3.5.4 After both tie breakers have been evaluated, for teams still tied for first, second, third,

fourth or fifth places ONLY, the team who scored the highest score first wins. This is determined by the round where the highest score was earned; a team scoring their highest score in the first round of play beats a team who scored their highest score in the second round, and so on.

- 3.5.5 If any teams in first, second, third, fourth or fifth places ONLY are still tied, tournament directors will determine how to break ties. This may involve, but is not limited to, limited time playoff matches (an additional round that ends after 45 seconds on the clock have elapsed), first-to-score match (an additional round that when one team scores the match is over and the scoring team wins), or a smallest-robot-volume-wins determination.

## Section 4 General Robot Rules

The robot is the cornerstone of the competition. Teams are given the game rules in advance of the tournament then design, prototype, build, program, and test their robots prior to arriving for the tournament. These rules provide the general framework for standardizing robots and keeping the game fair.

### 4.1 Robot Composition

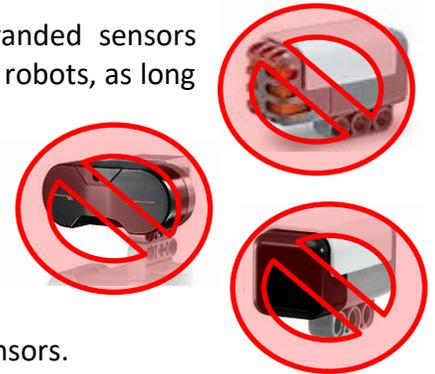
- 4.1.1 This competition is a LEGO Mindstorms competition, so all robots must use the LEGO Mindstorms product to build and execute their robot design.

- 4.1.2 Teams are allowed to use exactly one LEGO programmable processing unit; this could be a SPIKE Prime, EV3, NXT, or RCX controller. “Slave” devices are not allowed. Teams should not have anything plugged into the USB Host port on their programmable processing unit at any time during the competition.

- 4.1.3 Teams are allowed to use any number of LEGO-branded sensors (regardless of the actual vendor of the sensor) on their robots, as long as they DO NOT belong to one of these standard class

- Sound Sensor
- Infrared Sensor
- Magnetic / Compass Sensor

Teams are NOT allowed to use sensor multiplexing devices. Teams may use as many unmodified LEGO wires and/or converter cables as necessary for their sensors.



- 4.1.4 Teams are allowed to use any number of LEGO-branded motors on their robots. Motor signals and power MUST originate from motor ports on the programmable processing unit; robots with motors using sensor ports will not be allowed to compete. Teams are NOT allowed to use motor multiplexing devices. Teams may use as many unmodified LEGO wires and/or converter cables as necessary for their motors.

These electrical part limitations of LEGO-branded devices are important – ONLY LEGO-branded devices outside the disallowed classes are allowed to be used.

- 4.1.5 There are no restrictions on the quantities or sources of non-electric LEGO elements,

except that factory-made wind-up/pull-back “motors” are not allowed. Pneumatics ARE allowed.

- 4.1.6 Teams are not allowed to melt, deform, cut, bend, glue, solder, or otherwise alter LEGO elements (plastic and electrical) for use in their robots – the only exceptions are that LEGO tubing or LEGO string may be bent and/or cut to length.
- 4.1.7 Teams are allowed to incorporate non-electrical, non-LEGO parts on their robots to enhance functionality or as decorations, but there is no requirement to do so; **ALL TEAMS** are **REQUIRED** to have a Bill Of Materials (BOM), whether or not they are using non-LEGO parts on their robots. The total retail value of all non-LEGO parts may not exceed \$5, and all teams that incorporate non-LEGO parts must specify the quantity and cost of each of the items in use – scrap or surplus items with less than one cent per square foot retail value may be specified as having zero cost. The BOM must be in the following format:

Description	Cost	Quantity	Total
LEGO Plastic & Electronic Parts	--	Unlimited	--
Popsicle sticks	\$2.50	10	\$2.50
Bubble Gum	\$1.00	1	\$1.00
Plutonium Rods	\$0.25	2	\$0.50
Stopwatch	\$0.25	2	\$0.50
Cardboard, Scrap	\$0.00	Unlimited	\$0.00
String	\$0.00	Unlimited	\$0.00
<b>TOTAL</b>			<b>\$4.75</b>

Extra items may not be used to enhance the structural stability of your robot, only the functionality or aesthetics. Extra items (such as string, etc.) cannot be used to reinforce the LEGO structure — they may ONLY be used to attach other objects; glue or any permanent (or chemically altering) adhesive is NEVER allowed to be used on LEGO parts for any reason. **Tape is not allowed for any reason other than labeling parts.**

## 4.2 Robot Etiquette

At the competition, there are a number of things that teams should not do with their robots.

- 4.2.1 All teams using NXT, EV3, and SPIKE Prime systems must disable Bluetooth on the device in the arena. Bluetooth may be used to program in the pit only.
- 4.2.2 All teams using RCX systems must be mindful of other RCX robots when downloading programs. Use only the lowest power setting, and please shield your robot/tower when downloading programs.
- 4.2.3 No computers are allowed in the competition area within 10 feet of any robot or programmable controller. Teams are strictly forbidden from bringing any computers into the competition area at all – with the only exception of security reasons, and in those situations the computer must be OFF at all times when in the competition area.
- 4.2.4 Light detecting, color detecting, and Ultrasonic sensors are allowed but realize that no

consideration will be made for ANY interference to them.

Ultrasonic interference at the competition must be expected. Please consider carefully your choice to use an ultrasonic sensor, as your opponent's ultrasonic sensor will most likely cause your ultrasonic sensor to incorrectly function (and vice versa). However, please observe professionalism in this matter; if it is determined by any referees or competition staff that your robot is using an ultrasonic sensor in a way specifically designed to subvert the use of an ultrasonic sensor by your opponent, the competition staff may ask that you remove the sensor from your robot.

- 4.2.5 Teams should make every effort to minimize the likelihood and impact of physically contacting or interfering with an opposing team's robot and will not be deemed "interference." However, if a robot's actions or design are deemed deliberately malicious to the opposing team (either intentionally by design or by lack of prevention), that robot may be disqualified for the round at the discretion of the Head Referee.
- 4.2.6 At the conclusion of each match, teams should inspect their robot and ensure that all pieces are accounted for. Robot parts left at the table are not guaranteed to be returned, even though all reasonable efforts will be made to do so.

## Section 5 State Championship Variations

It has become tradition to have a variant or two to the rules for the State Championship. This gives teams an extra "something" to strive for, and if known in advance teams can design for it in the beginning.

*Honey bees will cap certain cells in the hive with wax. When the eggs are laid by the queen it takes about 10 days until the worker bees cap the cell with wax. When nectar has been turned to honey and dried to about 18% water the bees cap the honey cells.*

### 5.1 State Championship - Intermediate competition

Provide team-provided game pieces to act as wax cappings for the nectar (red checkers) in the hive honey frames. These cappings need to cover approximately ½ of the nectar cell (red checker).

### 5.2 State Championship - Advanced competition

- Provide team-provided game pieces to act as wax cappings for the brood (PVC couplers) or the nectar (red checkers) in the hive honey frames. These cappings need to cover approximately ½ of the nectar cell (red checker) or brood (PVC couplers).
- Additional points will be awarded to teams that do not recover their robots during competition play (use no touch penalties).

## Section 6 Game Intent FAQ

In this section, the game designer answers some of the most frequently asked questions about the *Bees, Bots and Beyond!* competition. This is designed to help teams and referees understand the task rules, scoring methods,

and anything else related to the game and its mechanics.

**6.1 Can we use tape if it is nonstructural?**

No. One of the changes made to competition two years ago is that absolutely no tape can be used during competition. The only exception is to use tape for labeling of wires and such.

**6.2 What is a Bill of Materials and why do you require it?**

TCEA allows you to add non-LEGO items, but you have a spending limit in order to keep things fair, and a requirement to track this. Even if you do not use non-LEGO items, the Bill of Materials (BOM) is required. Please review section 4.1.7 to see the correct format for a BOM. The BOM also needs to have materials specifically called out for the team supplied game pieces so the referee is absolutely clear about what the team supplied game pieces are made of.

Another great reason to require a BOM is that engineers create/use them for their designs and projects all the time; it is a concise way of communicating your design intent.

**6.3 Is there a place where I can ask questions if this FAQ isn't enough?**

Every sponsor must join the Robotics Contest Group in the TCEA Community.

**6.4 Is there any expectation that the fields will be level?**

No, there is no expectation that the fields will be level. The expectation is that your robot will be able to handle variations in the field. Please see section 2.3 for specific examples.

**6.5 I understand that the rules start off as DRAFT and can be changed until they are finalized. When will the rules be finalized?**

The rules are generally finalized towards the middle of October. If you find rules that don't make sense after that point, the rules will be followed to the letter of the rule as written. It's in everyone's best interest to make sure the rules are bullet-proof by then. Please help us vet the rules and make suggestions/corrections/questions in the robotics contest community. The final rules will be marked as such on the title page and have a history which includes the final rules changes. The FINAL rules are the only ones that will be accepted/referenced at competition. BE SURE to bring a copy of the final rules to the competition with you.

**6.6 Is there any situation that will allow the team to grab the robot and reset it without penalty?**

There's no situation that allows a team to touch the robot without a penalty once the robot starts moving in the match.

## Revision History

- 6/6/2019 (Draft Version 1)
1. Original release of Game Manual
- 6/24/2019 (Draft Version 2)
1. Made adjustments as requested.
- 7/6/2019 (Draft Version 3)
1. Made adjustments as requested.
- 7/23/2019 (Final Version, Rev 1)
1. Included final name, "Bees, Bots and Beyond!"
  2. Clarified sections 1.1.1 and 1.4.1 – concerning replacement of nectar and pollen once the honey bee robot is out of the feeding station and added graphic.
  3. Clarified section 2.1.2 – measuring of the robot based on coach feedback.
  4. Section 1.5.4 - Added pollution of water hole.
  5. Section 4.1.3 - Added pictures of sensors that are not allowed.
  6. Made grammar corrections as requested.
  7. Clarified FAQs, section 6.