



Game Rules – WRO College Category 2014

1. Game Story

Your robot has landed on Mars to represent your country in the lucrative trade of delivering materials to the colonies spread across the planet. Each colony needs certain materials more than others. Your robot's job is to maximize the time it has in a single battery charge by delivering goods for maximum profit. Buy low and sell high is your mission. You will receive an extra bonus for precious metal (i.e. gold) that you place in the company return vehicle (4th Waypoint). Hurry back to the recharge station before your 5 minute battery charge run's out. Happy roving.

2. Game Description

- 2.1. The objective is to get the highest score possible in the shortest amount of time.
- 2.2. A match round is 5 minutes long.
- 2.3. Two opposing robots compete on the field in opposite directions to harvest and deliver different colored LEGO Technic Balls (52mm) that represent delivering minerals to factories on the surface of Mars. The optional 4th Waypoint can be completed for an additional bonus.
- 2.4. Points are awarded for deliveries made, modified by the time to complete the course and the shared waypoint bonus.
- 2.5. The robot contestant starts in the green start zone and ends in the red end zone.

3. Competition Schedule

- 3.1. The tournament will generally follow this agenda:
 - Team Check-in
 - Robot Hardware and Software Inspection
 - Qualification Matches
 - Elimination Matches
 - Awards



4. Materials Allowed

The only parts and materials allowed in the construction the Robot are listed below. No other parts and materials are permitted.

- 4.1. Any part from the LEGO®, MATRIX™ or TETRIX™ system with the following constraints:
 - 4.1.1. No more than eight (8) DC drive Motors.
 - 4.1.2. No more than eight (8) Servos.
 - 4.1.3. No more than two (2) Rechargeable Battery Packs, which are identical to those supplied in the kit of parts.
 - 4.1.4. You may modify metal parts to any size.
- 4.2. Any LEGO building element with the following constraints:
 - 4.2.1. Exactly one (1) **NXT/EV3** Brick may be used as controller.
 - 4.2.2. The **NXT/EV3** controller must be powered either by the NXT rechargeable AC battery, NXT DC Battery, **EV3 DC Battery** or six (6) AA (rechargeable) batteries.
 - 4.2.3. LEGO Motors may be used with the following constraints (per **NXT/EV3** motor port, and the 4th motor port is not allowed with EV3):
 - One (1) **EV3 Large Servo Motor**
 - One (1) **EV3 Medium Motor**
 - One (1) NXT Interactive Servo Motor
 - One (1) XL Power Function Motor
 - Two (2) E Power Function Motors
 - Two (2) M Power Function Motors
 - One (1) E Motor and one (1) M Motor
 - You are allowed to use any number of NXT conversion cables to connect the Power Function Motors with the **NXT or EV3** Brick
 - You are NOT allowed to use any of the Power Function Battery Packs
 - 4.2.4. LEGO pneumatic elements are allowed. Teams may not modify LEGO pneumatic elements or attempt to change the working pressure limits of the elements.
 - 4.2.5. Any LEGO certified **NXT/EV3** sensor (as indicated by the LEGO MINDSTORMS Certified – Hardware label) is allowed.
 - 4.2.6. Any **NXT/EV3** compatible sensor from HiTechnic, including the NXT Touch Sensor Multiplexer, NXT Sensor Multiplexer and the NXT prototype boards (both solderable and solderless) is allowed.
 - 4.2.7. The HiTechnic 9-volt Battery Box that is sold as part of the NXT Sensor Multiplexer set may be used in conjunction with each NXT Multiplexer (i.e. one Battery Box per Sensor Multiplexer). It may be used only in conjunction with and to power the NXT Sensor Multiplexer(s).

- 4.2.9. The HiTechnic 9-volt Battery Box that is sold as part of the NXT Sensor Multiplexer set may be used in conjunction with each NXT Multiplexer (i.e. one Battery Box per Sensor Multiplexer). It may be used only in conjunction with and to power the NXT Sensor Multiplexer(s).
 - 4.2.10. Custom NXT/EV3 extension cables are allowed, as long as it looks like approved one.
 - 4.2.11. Non-NXT/EV3 electrical elements not specified above are not allowed, with the exception of RCX sensors.
 - 4.2.12. LEGO Duplo products are not allowed.
 - 4.2.13. At the time of writing these rules the compatibility of TETRIS/MATRIX and EV3 controller was inconsistent. Teams use EV3 and/or its components at their own risk
- 4.3. Plastic-coated wire rope with a bare wire diameter of 0.03125" (0.08cm) or smaller. Compatible compression sleeves, clamps and hardware may also be used only in conjunction with the plastic-coated wire rope.
 - 4.4. All mechanical fasteners (nuts, bolts, screws, etc.) of any length, any thread type, up to 3.5. 0.375" (0.9525cm) diameter. The intent of this rule is to allow teams to use fasteners from any supplier that are substantially the same as MATRIX/TETRIS fasteners. Compatible fasteners are characterized by using the same thread characteristics as MATRIX/TETRIS fasteners. For example, for MATRIX standard metric (M3, M4) screws are an acceptable substitute. For TETRIS 6-32 thread, 1/2" length socket head cap screw is a 6-32 thread, 3/4" length, button head cap screw purchased at a local hardware store. Any other non-metal parts are allowed with maximum thickness 0.2cm.
 - 4.5. No additional components may be used, however functionless components used only for decoration and are easily removable as wanted are allowed.
 - 4.6. Teams should prepare and bring all the equipment, software and portable computers they need during the tournament.
 - 4.7. Contestants may write their program beforehand.
 - 4.8. Control software must be either NXT® Software, EV3 Software or LabVIEW (any version). SD card is not allowed on EV3 robot.

5. Robot Design

- 5.1. The maximum dimensions of the robot before it starts the "mission" must be within 30cm x 30cm. After the robot starts, the dimensions of the robot are not restricted. There is no height limitation.
- 5.2. Teams are allowed to use only one NXT or EV3 Brick as controller.
- 5.3. Any actions or movements by the participants are not allowed to interfere or assist the robot while it is running (performing the "mission"). Teams that violate this rule will be disqualified for that round.



- 5.4. A robot must be autonomous and finish the “missions” by itself controlled only by its program. Any radio communication, remote control and wired control systems are not allowed while the robot is running. Teams in violation of this rule will be disqualified for the duration of the competition.
- 5.5. The **NXT/EV3** Brick’s Bluetooth & Wi-Fi functions must be switched off. Downloading programs must be done through USB cable.

6. Rules & Regulations

- 6.1. At the beginning of a Match, each Robot must not exceed a volume of 30 cm wide by 30 cm long. An offending Robot will be removed from the Match at the Head Referee’s discretion.
- 6.2. Contestants are required to program a 5 second timer at the beginning of their program. This allows the contestant to start the program and get out of the way. The official clock will start at the end of the wait period.
- 6.3. It is up to the referee(s) to determine whether or not there has been a false start (one robot starting before the other) to the round. It is up to their discretion to restart the round in the event that this happens.
- 6.4. Contestants are prohibited from making contact with the robot, the playing field or any game or field object. Any instance of a team member or coach touching the playing field or robot during a round will result in their immediate disqualification for that round.
- 6.5. Robots may not deliberately detach parts, or leave mechanisms on the playing field during a match. In the case where this does happen it is up to the discretion of the referee to determine if it was deliberate or accidental. If deliberate or seen as trying to inhibit their opponent, the team will be disqualified for the round or possibly even the game in a severe case. Play nice. If deemed accidental the part will be removed and game play will continue.
- 6.6. Unexpected Robot behavior in and of itself will not result in a Match replay. Team induced failures, such as low battery conditions, processor sleep timeouts, mechanical/electrical/software failures, etc. are NOT valid justifications for a rematch.
- 6.7. A team may never enter (touch) their opponent’s side of the field.
- 6.8. Robots may only carry/hold/control up to 3 balls at any one time, **or get punishment (-30 points) every time when the 4th ball is touched by the robot.**
- 6.9. A robot is considered finished with its round when it is completely in the red “finish zone” square and at a complete stop. The time bonus will be calculated from this point. A robot must acquire at least one ball during a round to have a qualifying score. **The score you got from the mission is also your maximum time bonus.** Traveling directly from the green square to the red square for maximum time bonus is not a good idea.

7. Scoring

The Following scores are recorded by the Referees at the end of the game.

7.1. Each waypoint will award different points for each colored ball as follows:

- **Waypoint 1**

- Buys- Red Balls: 40 points, Blue Balls: 20 points
- Supplies: Red Balls x 2, Blue Balls x 4 (in random order)

- **Waypoint 2**

- Buys - Red Balls: 20 points, Blue Balls: 40 points
- Supplies - Red Balls x 4, Blue Balls x 2 (in random order)

- **Waypoint 3**

- Buys - Red Balls: 10 points, Blue Balls: 10 points
- Supplies - Red Balls x 3, Blue Balls x 3, Yellow Ball x 1 (in random order)

- **Waypoint 4** = 100 points with the Yellow Ball placed successfully in the basket at the end of the round

7.2. Travel time bonus = **Minimum** {[300 less time to complete, in seconds (round up to nearest integer)], [Score from Waypoints]} , if the robot stop in the red zone completely.

7.3. Example Game Scenario:

The robot leaves base and goes to Waypoint 1 and draws 3 balls - Red, Blue and Blue. It inserts the Red Ball into the hopper of Waypoint 1 for 40 points. The robot draws one more ball - Blue. A minute and half has passed and it moves to Waypoint 2 to deposit 3 Blue Balls for 40 points each, bringing the total score to 160 points. Arriving at Waypoint 2 the robot gets both Blue Balls available and deposits them back in for a total of 240 points. With half of the round time gone the robot fills up with 3 balls, all blue, and heads for Waypoint 3 to find the Yellow Ball so it can get the Waypoint 4 bonus. After arriving at Waypoint 3 the robot drops its 3 balls for 10 points each. With a total score of 270 and only 2 minutes left it draws 3 balls hoping for the yellow ball. Sadly it draws 2 Blues and a Red. With only 2 minutes left the robot thinks it might not have time to deliver them back to the more lucrative Waypoints 1 & 2 so it deposits them back for 10 points each bringing the score to 300. The robot draws one ball and it's yellow! It turns and dashes for Waypoint #4 and places the Yellow Ball there for the 100 point bonus. With just under 1 minute left it decides to head back to the finish for the remaining time bonus. Crossing into the red square ends the round at 4 minutes 10 seconds receiving an additional 50 points, one point for each second under the maximum allotted 5-minute time.

Waypoint 1: 1 x Red Ball (40 pts. ea.) = 40 points

Waypoint 2: 5 x Blue Balls (40 pts. ea.) = 200 points

Waypoint 3: 5 x Blue Balls (10 pts. ea.), 1 x Red Ball (10 pts. ea.) = 60 points

Waypoint 4 = 100 Points

Time Bonus = **Min** [(300 seconds - 250 seconds), 400] = 50 points

Final Score = 450

8. Waypoints

Each Waypoint will consist of a Ball Dispenser and Hopper for ball deposit.

- 8.1. All dispensers and hoppers will be in the exact same spot on the waypoint mat making their location predictable.
- 8.2. Each dispensing mechanism will have a piece of color contrasting tape that leads to dispense mechanism.
- 8.3. Each dispenser will have a different mechanism for that will require different actions to activate it. **Robot must use these mechanisms to get the ball, or get punishment (-30 points) every time when a ball is captured through other way.**
- 8.4. Each Hopper will be of a different size and height.
- 8.5. All waypoints will deposit balls at the exact same height.
- 8.6. Balls are placed in random order in the dispenser before the start of the round.
- 8.7. Waypoint attributes are as follows:
 - **Waypoint 1 (Difficulty: Hard)**
 - Mechanism: Crank
 - Buys - Red Balls: 40 points, Blue Balls: 20 points
 - Supplies: Red Balls x 2, Blue Balls x 4 (in random order)
 - **Waypoint 2 (Difficulty Medium)**
 - Dispense Mechanism: Pull
 - Buys - Red Balls: 20 points, Blue Balls: 40 points
 - Supplies - Red Balls x 4, Blue Balls x 2 (in random order)
 - **Waypoint 3 (Difficulty Easy)**
 - Dispense Mechanism: Push
 - Buys - Red Balls: 10 points, Blue Balls: 10 points
 - Supplies - Red Balls x 3, Blue Balls x 3, Yellow Ball x 1 (in random order)
 - **Waypoint 4**
 - +100 points for placing the Yellow Ball in the waypoint.
 - +50 points to both teams if both teams accomplish the task.

9. Playing Field

- 9.1. The field consists of two halves, side by side, 18 pcs. 2' x 2' foam floor tiles in a 3 x 6 configuration. If foam floor tiles cannot be acquired any material with enough color contrast to be detected by a light sensor can be used - colored paper, painted wood, etc.
- 9.2. Black tiles consist of open field. Colored tiles will host waypoints for scoring points.
- 9.3. A white foam border surrounding the field will act as a virtual border.
- 9.4. The two sides of the field are separated by a **1~2" (thickness) x 6~8" (tall) wall (depends on organizer)** to keep robots from wandering onto the other playing field.