World Robot Olympiad 2018

Advanced Robotics Category

Game Description, Rules and Scoring

DO NOT PUBLISH BEFORE JANUARY 15TH 2018

Version: Final Version January 15th

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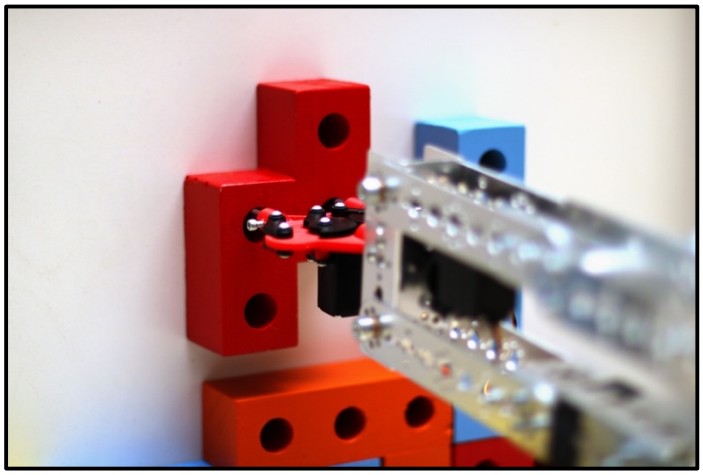
Introduction

The challenge is to make a robot that can score as many points as possible in a robot version of the Tetris® game called Tetrastack. The robot will locate, identify, and stack interlocking colored shapes called tetracubes within the Stacking Form – a rectangular upright box.



Important changes for Tetrastack 2018

Rule Number	Section 2. Game Rules
1.	Match Timing: Robot Setup Time is increased to 90 seconds.
3.	Starting Configuration: New ways of setting up the field are introduced.
3.a.	The first 2 randomly selected pieces may be placed on the robot and/or on a short supply line.
3.b.	The next 3 randomly selected pieces must be placed in the large open spaces.
3.c.	The 6th randomly selected piece will be placed on the Stacking Form by the judge.
7.	Added that robot should still fit inside robot base when Tetracubes are placed on it.
	Section 5. Game Object Specifications
Packaged Delivery Cube:	Prepackaged Cube: The cube packing has been modified.

1. Game Description

Tetrastack is a robotic construction challenge. The mission is to gather tetracubes from sources in the Construction Zone and place them into the Stacking Form to complete as many interlocking rows as possible.

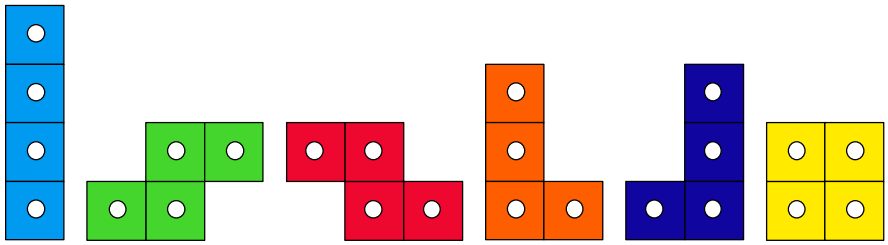
At the beginning of a match, each of the following conditions must be met:

- The robot is parked in the Robot Base
- There is one tetracube in the Stacking Form, placed by the judge
- Tetracubes are available at the source locations

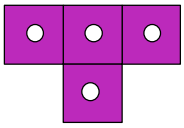
There are two types of matches: qualifying matches and final matches.

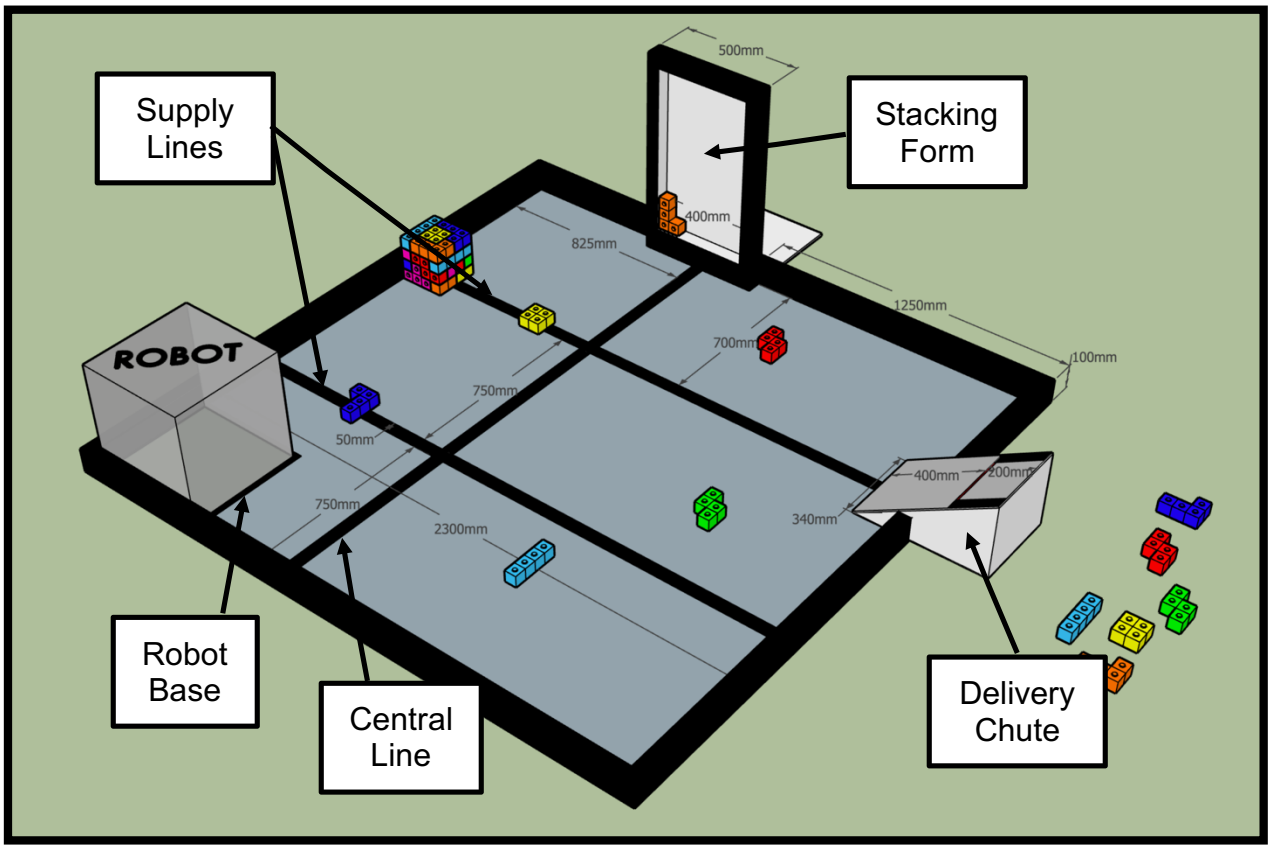
During **qualifying matches**, the robot has 3 minutes to gather up to 12 tetracubes and place them into the Stacking Form.
During **final matches**, the robot has a total of 5 minutes and 28 tetracubes.

In the qualifying matches, the robot has access to 2 sets of 6 tetracube shapes. The shapes are:



In the final matches, the robot has access to 4 sets of 7 tetracube shapes – adding the shape below to the set:





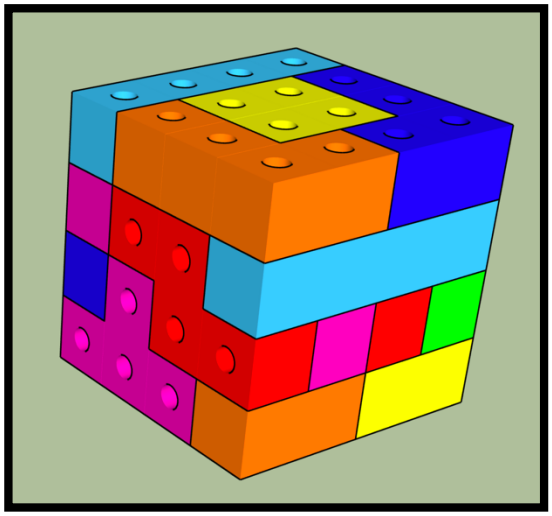
The playing field is referred to as the **Construction Zone.** It is the 2.3 m x 2.3 m floor space inside the four border walls where the robot maneuvers and manipulates tetracubes.

The robot will have access to tetracubes from three distinct sources:

- **Prepared Layout** (both types of matches):
  Before the match begins, team members will place tetracubes on the field or the robot as described in the Starting Configuration section of this document.

- **Dynamic Delivery** (both types of matches):
  After the match begins, team members may enter 6 tetracubes into the Construction Zone by sliding them down the Delivery Chute.

- **Packaged Delivery** (final matches only):
  16 tetracubes are packed into a cube called the Package Cube. Before the match begins, team members place the Package Cube on the short segment of the Supply Line closest to the Stacking Form.



The mission may end early if the robot returns to the Robot Base, and the projection of the robot is completely within the Robot Base (cables are allowed to be outside of the Robot Base).

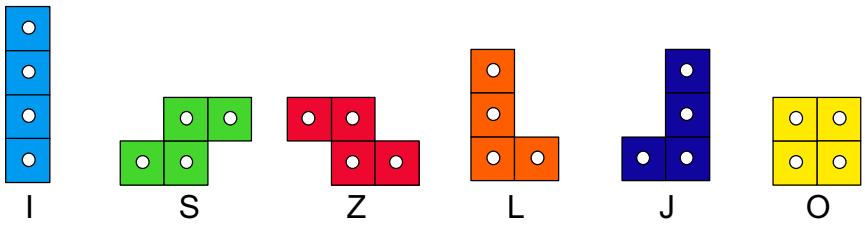
2. Game Rules

Match Timing:

1. A qualifying Tetrastack match is three minutes in length. Final matches are five minutes in length. Ninety seconds of setup time is provided for team members to place the tetracubes and the robot.

Starting Configuration:

2. Before each round of play, cards with the 12 tetracubes printed on them are placed in an opaque box. Six cards, drawn randomly from the box, determine the tetracubes for the Prepared Layout. The remaining six tetracubes will be used for Dynamic Delivery. (Printable cards are provided in the addendum.)
3. During the setup time before each match, team members have ninety seconds to place the tetracubes to be used in the Prepared Layout as described below.
   a. Each of the first two randomly selected tetracubes may be placed either within the robot or on the short segment of a Supply Line (one per line). If placed on the line, it must touch the line, but it must not touch the Central Line, the exterior wall, or the Packaged Cube.
   b. The next three randomly selected tetracubes must be placed in the large open spaces of the construction zone. Any orientation of a tetracube may be used, and team members determine the placement of each piece, but they must be at least 100mm away from all borders. Walls, the central line, the long portion of the supply lines and the ramp define the borders of the space. No measurement tools are allowed.
   c. The final randomly selected tetracube will be placed on the stacking form by the judge. The orientation of the pieces will be as shown below. Most shapes will be placed in the left corner of the stacking form, but the shapes named J and Z will be placed in the right corner -- this prevents trapping an empty space.



4. During the setup time of each final match, team members will also place the Packaged Delivery cube on the short segment of the Supply Line nearest to the Stacking Form. The way to assemble the package cube is described in Section 5 of this document. Any orientation of a package cube is allowed. The cube must touch the short segment of the Supply Line. It cannot touch the Central Line, but it can touch the exterior wall if desired. No measurement tools are allowed.
5. Team members are expected to wear safety glasses when appropriate, and shoes may not be worn if it is necessary to walk in the Construction Zone.

Match Start:

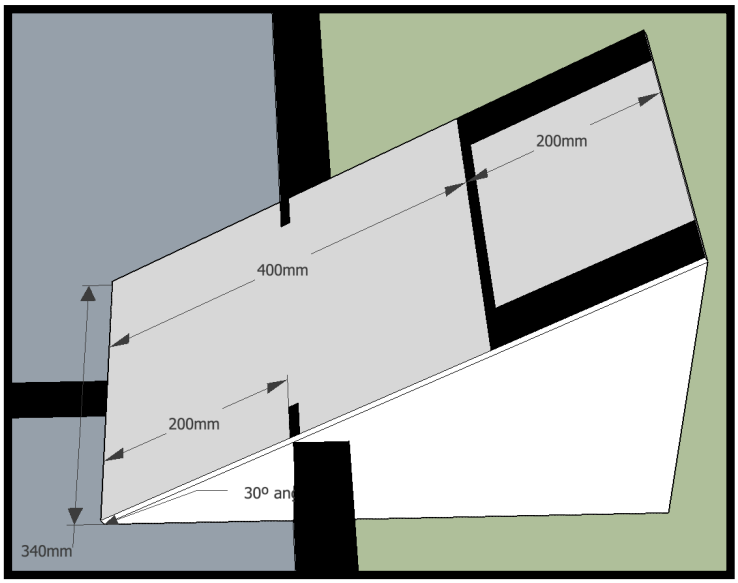
6. At the beginning of a match, each of the following conditions must be met:
   a. The robot is parked in the Robot Base
   b. The Stacking Form contains only the element (see 3.c.) that was placed by the judge.
   c. Tetracubes are available at the source locations
7. The robot starts from within the Robot Base, a square of 450 mm x 450 mm marked with a thin black line. The robot height must not exceed 450 mm and the projection of the robot must be completely within the Robot Base (cables are allowed to be outside of the Robot Base). If randomly selected pieces (see 3.a) are placed within the robot, the robot including the Tetracubes must still fit within the Robot Base. The black lines are not included in the Robot Base. Once the match begins, the size of the robot is not restricted except by the borders of the Construction Zone.
8. During inspection time / reviewing, the robot may not include tetracubes or elements that resemble tetracubes as part of its construction.
9. The match timer starts when the judge gives the signal to start.

Additional Pieces:

10. The robot may introduce additional pieces and/or constructions to temporarily aid in the collection or stacking of tetracubes. The additional pieces must meet the following conditions:
    a. They are considered part of the robot
    b. They are required to be inside the Robot Base at the start of the match
    c. They are constructed using only the Tetrix and/or Matrix building system
11. The robot may leave the additional pieces in the Construction Zone when returning to the Robot Base at the end of the match.

Field Interaction:

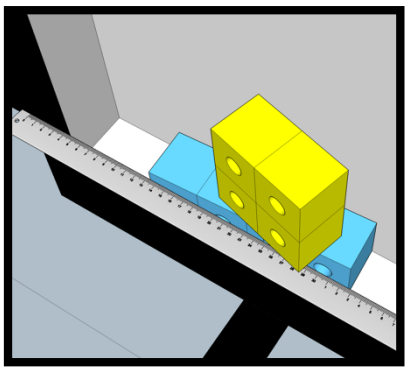
12. During the match, one team member may enter the 6 Dynamic Delivery tetracubes into the Construction Zone using the Delivery Chute. The team member may place the tetracube on the ramp only in the Release Area: the upper portion of the Delivery Chute surrounded by the black lines. (The Release area does not include the lines.) The team member may then release or push the tetracube, allowing it to slide into the Construction Zone. (Two black lines mark the point where the ramp crosses the border of the field and the Construction Zone begins.) It is expected to slide down the ramp and not be thrown onto the field.



13. The tetracubes may be entered in any order and at any point during the match.
14. The team member may only interact with tetracubes entirely outside of the Construction Zone. For Dynamic Delivery, the team member may only interact with tetracubes entirely within the Release Area of the Chute. The robot may only interact with pieces that are at least partly within the Construction Zone.

Score:

15. Tetracubes placed in the Stacking Form are considered valid and will be included in the official score at the end of the match if both of the following conditions are met:
    a. The four cubes of the tetracube are completely inside the Stacking Form. The judge may use a ruler for validation.
    b. The tetracube is not touching the robot or any mechanism that is considered part of the robot. A valid tetracube can only touch other tetracubes and the Stacking Form.



The light blue tetracube is completely inside the Scoring Frame. It is valid for the Piece Score - one point. The yellow tetracube will touch the ruler and is invalid, no Piece Score.

16. **Piece Score**: For each valid tetracube in the Stacking Form, a Piece Score is awarded. Valid tetracubes are allowed to touch and be supported by invalid tetracubes. The tetracube that was placed by the judge (see 3.c.) will only be awarded a point if the team has been awarded other points for stacking tetracubes.
17. **Row Score**: For each horizontal row of eight cubes belonging to validly stacked tetracubes a Row Score is awarded.
18. **Parking Bonus**: If the projection of the robot is completely within the Robot Base at the completion of the match, a Parking Bonus is awarded (cables are allowed to be outside of the Robot Base). The Parking Bonus will be awarded only if points were also awarded for stacking tetracubes.

Match end:

19. A match ends and time is stopped if any of the following conditions occur:
    a. The match timer expires
    b. Any team member touches the robot or other Field Interaction rules are violated
    c. Any team member touches tetracubes in the Construction Zone or the Stacking Form
    d. The robot places a tetracube outside of the Construction Zone or drives outside of the Construction Zone
    e. The robot or team member damages the field – Delivery Chute, the Stacking Form, Flooring, or the Border
    f. The projection of the robot is completely in the Robot Base

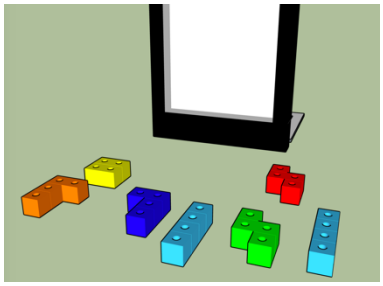
3. Scoring

The official score will be calculated at the end of each match. The maximum score is 100 points. If teams have the same score, ranking is determined by the Row Score and then by the shortest match time.

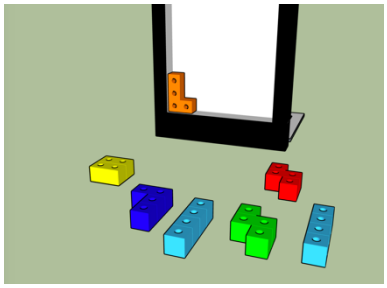
Scoring Table:

Requirements	Point Value	Total Available
Piece Score: A tetracube is placed into the Stacking Form such that all four cubes are contained within the interior of the Stacking Form.	1	28
Row Score: A completed row contains eight cubes from tetracubes that qualify for a piece score.	5	70
Parking Bonus: Final robot position is completely within the Robot Base. (The bonus is awarded only if other points were scored.)		2
Maximum Points		**100**

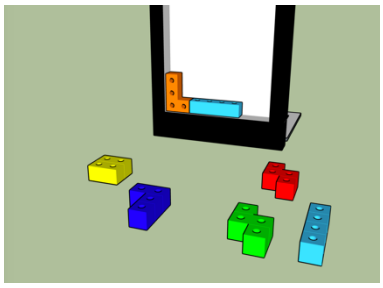
Scoring Examples:



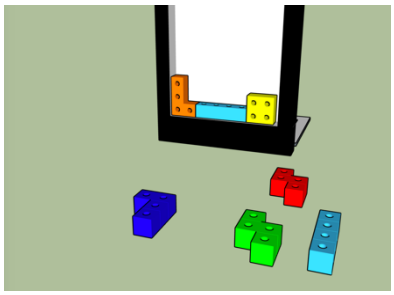
0 points: 0 pieces



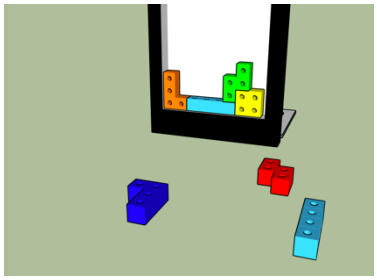
0 points: 1 piece preplaced by judge



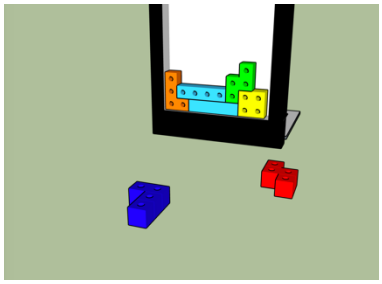
2 points: 2 pieces



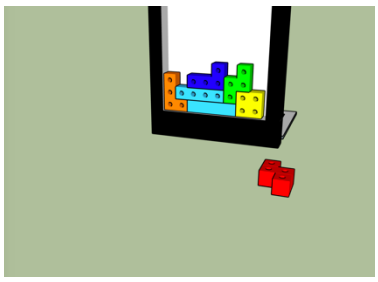
8 points: 3 pieces and 1 row



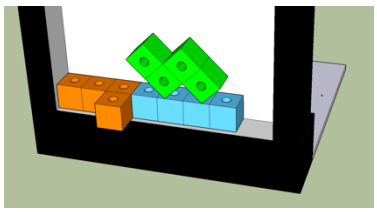
9 points: 4 pieces and 1 row



15 points: 5 pieces and 2 rows

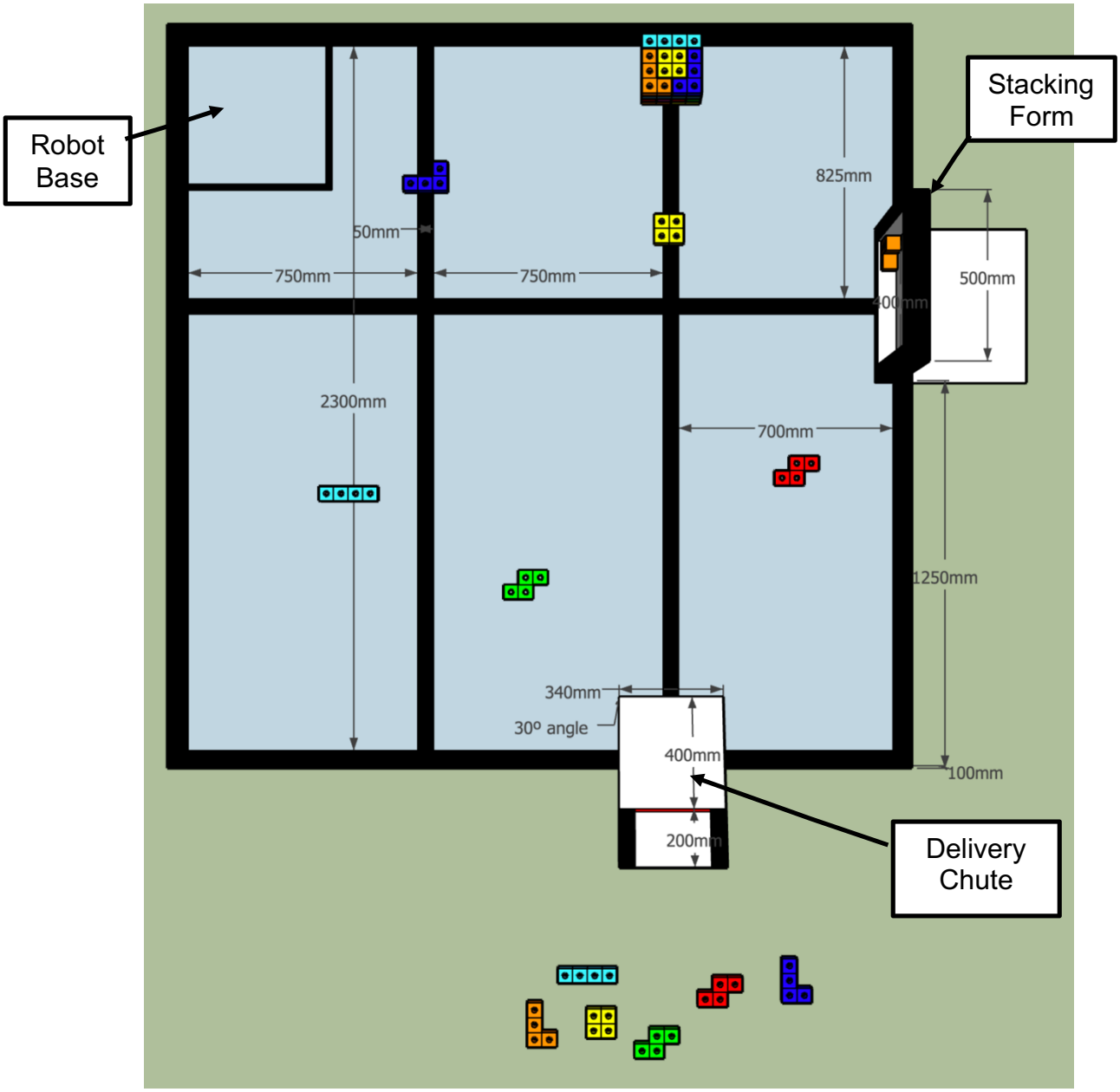


16 points: 6 pieces and 2 rows



2 points: Light blue and green each score 1 point. The orange piece has only three cubes inside the stacking form.

4. Field Specifications



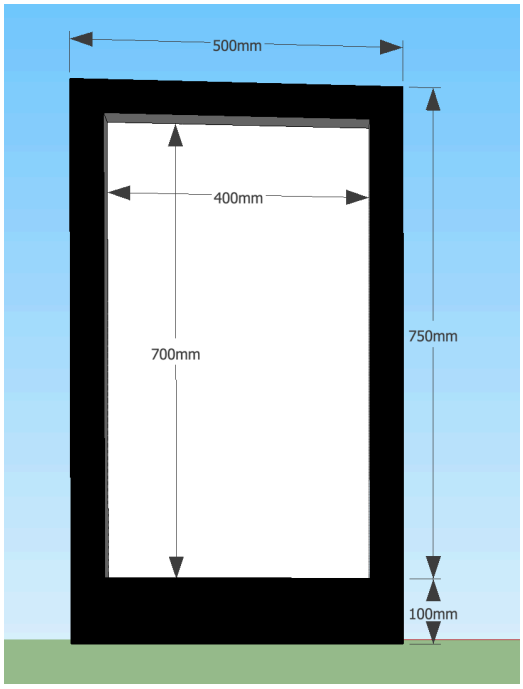
Construction Zone:

The Construction Zone is the 2.3 m x 2.3 m floor space where the robot maneuvers and stacks. The floor of the Construction Zone is white or light in color with black 50 mm lines, as shown above. The Construction Zone is surrounded by a border 70 mm (+/- 20mm) high.

Stacking Form:

The Stacking Form is centered on the central line located on the wall opposite the Robot Base. The interior is 60 mm (+/- 2 mm) deep, 400 mm (+/- 5 mm) wide, and 700 mm (+/- 5 mm) tall. It holds 8 cubes in width and 14 cubes in height + 2 mm tolerance for per cube in each direction.
The edge border is painted black 50 mm +/- 5 mm in size except for the lower border which is 100 mm +/- 5 mm. The backing surface is solid and painted white. The form will tilt backwards at approx. 85-degree angle from the floor. This will result in the top edge of the form being approx. 7 cm behind the bottom edge.

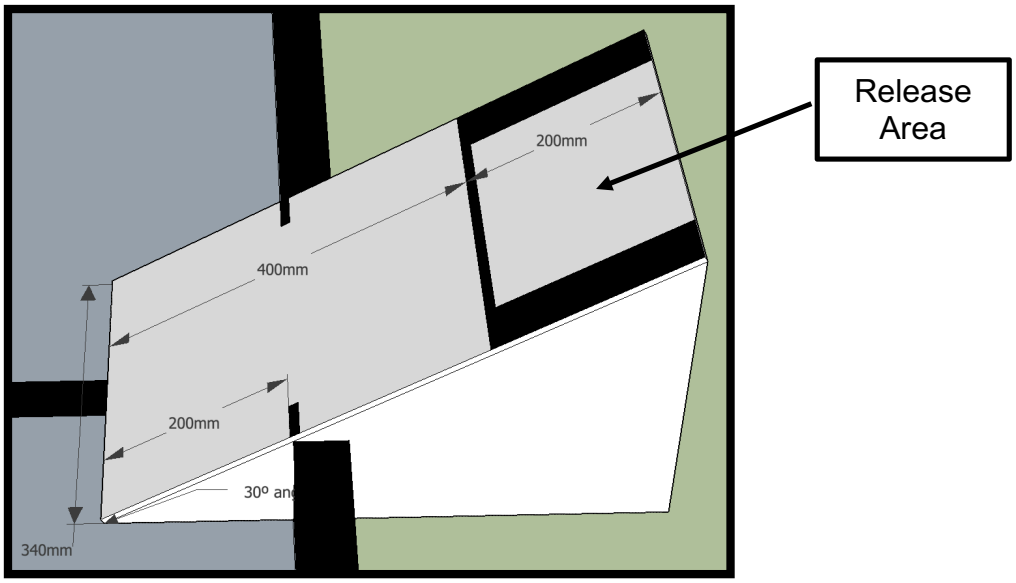
(these pictures do not meet the standard and are for illustrative purposes only)



Delivery Chute:

The Delivery Chute is a ramp 340 mm wide by 600 mm long set at a 30-degree angle from the floor. The ramp surface will be constructed of a smooth and low-friction material such as is used to construct white-boards. One third of the ramp protrudes into the Construction Zone. The edges of the upper third of the ramp are 50 mm +/- 2 mm wide areas colored black using tape or marker. A line is drawn on the surface using a marker. The line helps define the Release Area without affecting how a tetracube slides down the ramp. Two 50 mm +/- 2 mm drawn lines at the lower third of the ramp help define the end of the Construction Zone.

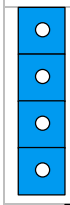
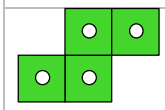
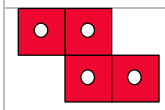
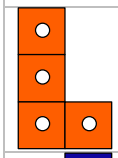
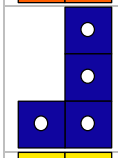
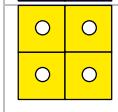
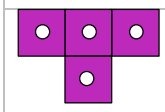
Tetracubes are expected to slide from the top to the bottom of the ramp in less than one second. Therefore the ramp should not contain rough areas or pits that could cause a tetracube to stop before the bottom of the ramp.



5. Game Object Specifications

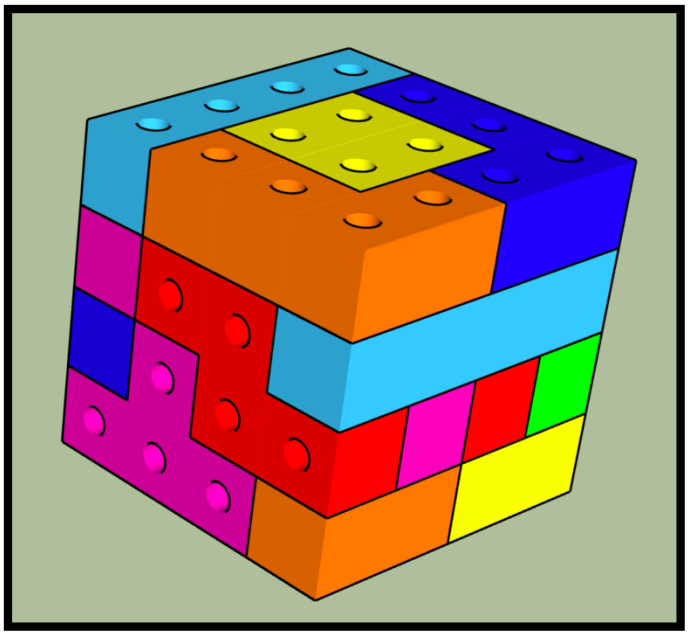
Tetracubes:

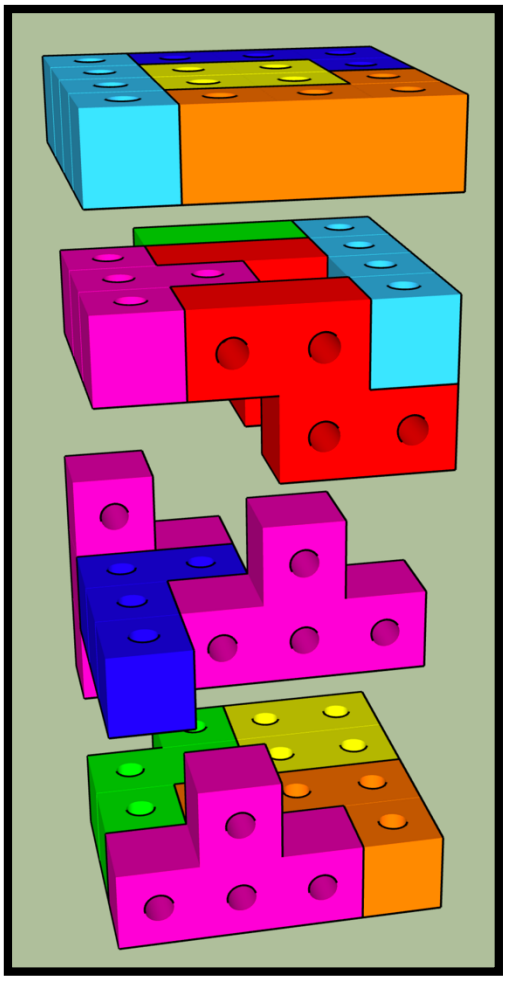
The construction piece is composed of 4 cubes, 48 mm ± 1 mm on edge. Each tetracube will have a 15 mm ± 1 mm diameter hole centered in each primary cube face. They may be constructed of solid wood, or products such as plywood or high-density-fiberboard. CAD files are available to support automated construction methods. A completed piece will weigh approximately 200 g to 230 g and will be colored using paint or other commonly available materials.
PANTONE colors should be the better standard for paint matching. RGB lookup is dependent on color profile of monitor and provided primarily for image processing reference.

Planar Shape	Name	Color Specification
	I	Light Blue or Cyan PANTONE 801 C RGB 0, 154, 206
	S	Green PANTONE 802 C RGB 68, 214, 44
	Z	Red PANTONE 1795 C RGB 238, 39, 55
	L	Orange PANTONE Bright Orange C RGB 254, 94, 0
	J	Blue PANTONE Blue 072 C RGB 16, 6, 159
	O	Yellow PANTONE 803 C RGB 254, 233, 0
	T	Purple PANTONE Purple C RGB 187, 41, 187

Packaged Delivery Cube:

The Package Delivery Cube is built using 16 tetracubes – 2 base sets plus 4 purple T shaped tetracubes. There are many possible constructions of the cube, but the following images illustrate the one teams must use for Tetrastack:





Addendum:

Cards used for random drawing of six (6) Tetracubes used for the Prepared Layout: