



CHALLENGE 3: UNLOCK AND STOW BOT

INSTRUCTIONS BOOKLET

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|---------------------|------------------------|
| Revision 1.0 | Initial Release |
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1 IMPORTANT NOTES

For World Robotics League®, the constitution and Manifesto which describes the acceptable behavior of help from Parents, Coaches and Mentors is present [here](#).

In addition to the drawings and figures, the challenge field computer model is provided in eASM format. You can look at multiple views, rotate, look at details and measure using eASM files. We strongly recommend you to install free eDrawing and eAsm viewer provided by Dassult/solidworks, from following site: http://www.solidworks.com/sw/support/edrawings/e2_downloadcheck.htm

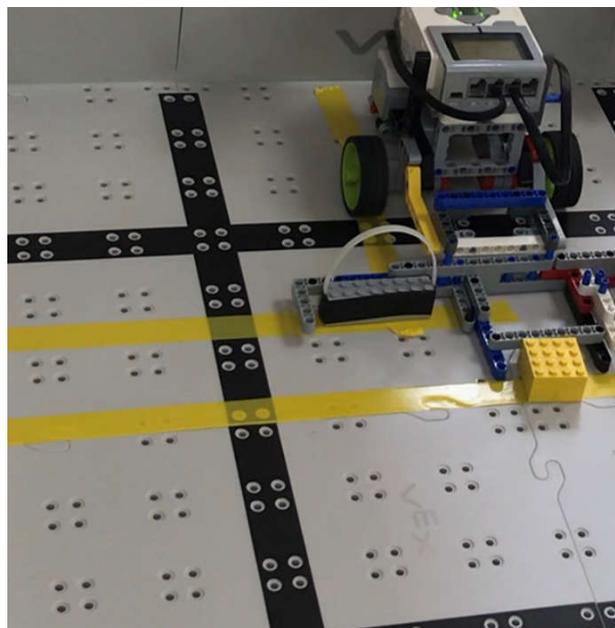


Figure 1 : An example of how tape is used to mark regions.

As described in Figure 1 different regions of the field can be marked using masking tape or electrical tape. Avoid using thick fabric-based tape or tapes that may spill glue since this may alter behavior of the robot. For marking purposes, you may use tape of any color.

For the Boundary of the competition area, you may use a piece of wood obtained at many hardware stores in dimensions of 2 inches x 3 inches and 8 foot length (Actual dimension 1.5 in x 2.5 in x 8ft). If you don't have this available, alternatively, you may use tape to represent the wall. If you are using tape to represent wall and when recording the video for competition, please record at an angle that it is obvious beyond doubt that robot does not overlap in the walled area. In case the robot's mode of engagement with wall is not clear, Referees decision will be final.

This challenge is suited for RoboNINJA™ Craftsman Bronze skill level ONLY. For explanation of the levels, see the **Levels and Progression** page on the World Robotics League website.

The challenge is offered in two categories, Teleoperated and Autonomous. Please specify if you are attempting teleoperated mode or Autonomous mode. In teleoperated mode you have not more than 1 minutes (60 seconds) to attempt the challenge. In autonomous mode, the total time to attempt the challenge is 2 minutes and 30 seconds

Note that in the rest of the document, all units are specified in inches unless otherwise specified.

The Blocks are built using 4 blocks of 2x4 LEGO bricks as shown in Figure 2. Alternatively, you may arrange other smaller LEGO bricks to build the block as shown in Figure 3. If you don't have LEGO blocks available, you may use cardboard boxes or wooden boxes that mimic the same size. Figure 4 describes dimensions and folding pattern for approximately 1mm thick cardboard to build the block that mimics the LEGO blocks. The friction and total weight of cardboard and wooden box may differ from Lego brick-based block. However, this is acceptable as long as the actual dimensions match those of the LEGO blocks.

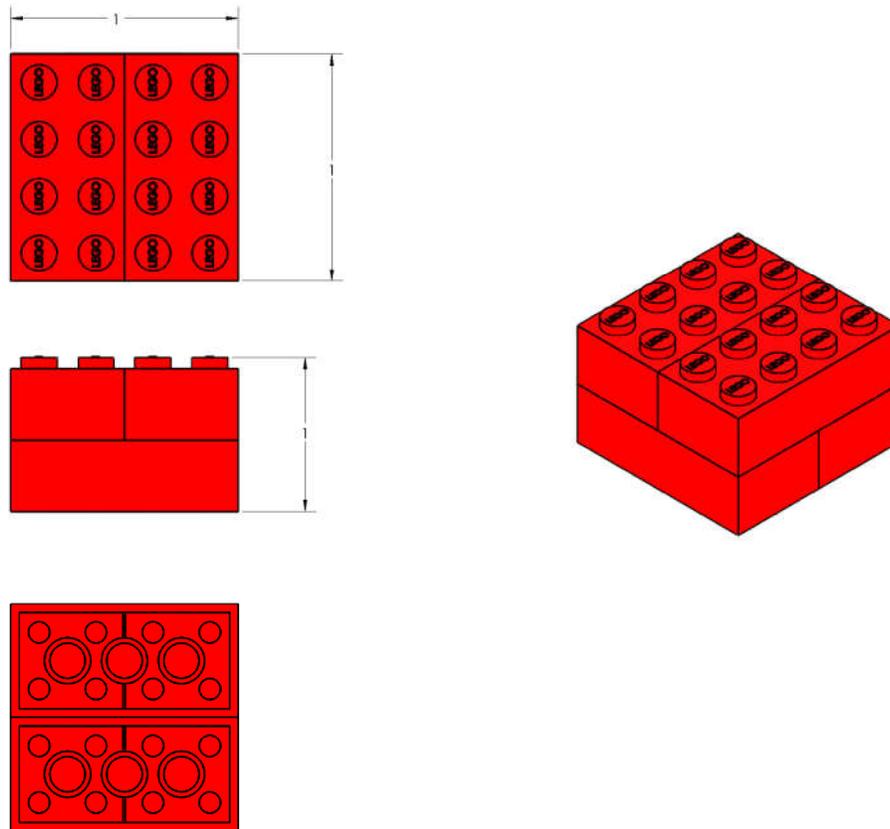


Figure 2 Details of a block (Units in Inch)

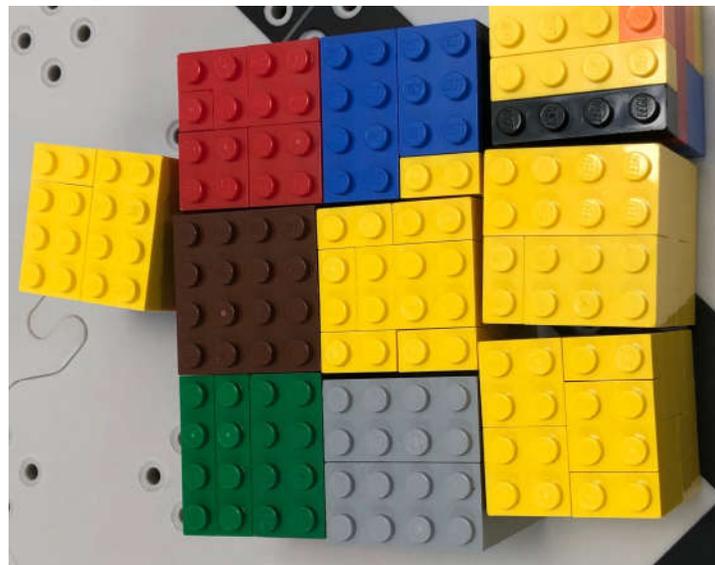


Figure 3 : Example to show how different sizes of bricks can be stacked to build similar block size

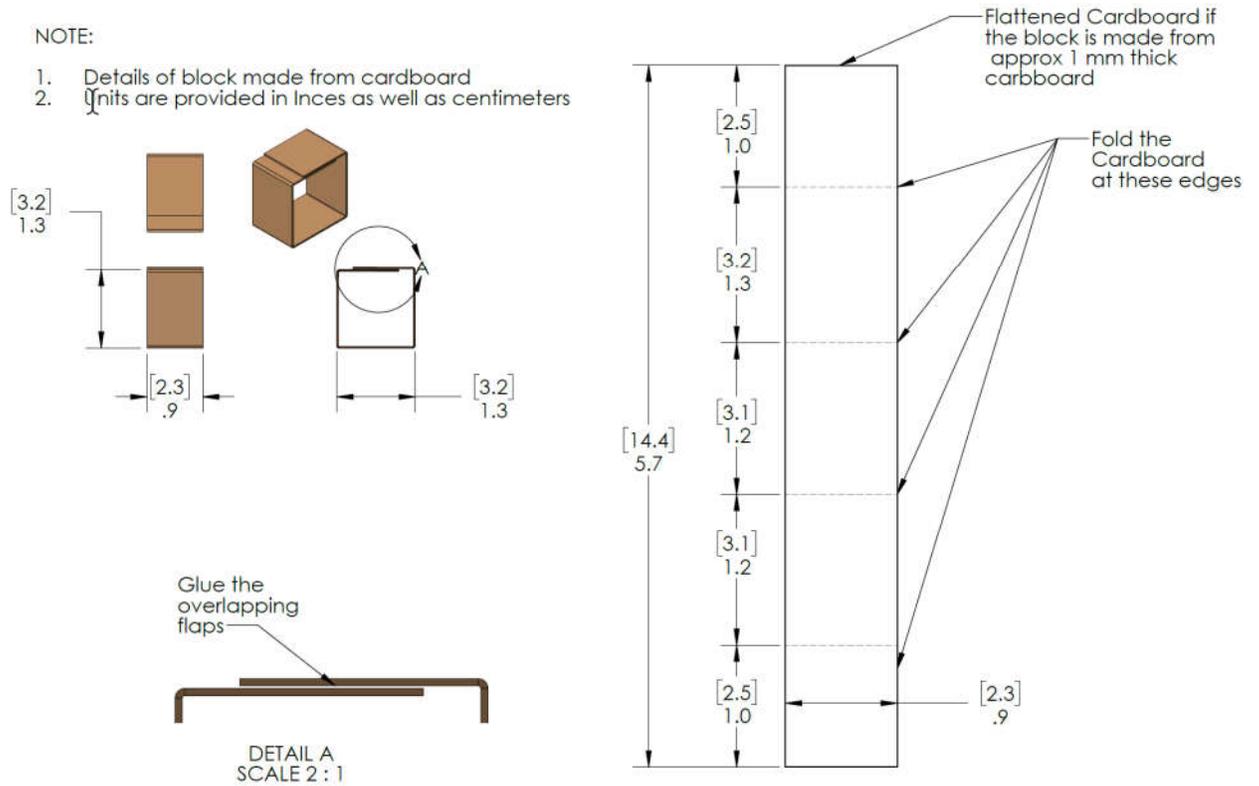


Figure 4: Scheme for building the LEGO blocks with cardboard in case participant doesn't have enough LEGO bricks

To understand the rest of the challenge, refer to Figure 5 which showcases the challenge field in detail. For this challenge, you will need to create fixed walls and gates that may be moved by sliding them.

For the fixed walls as well as the sliding gates, Lego bricks 2X4 or any other Lego block combination can be used(Figure 5, Figure 6). Alternatively, if participant doesn't have access to Lego bricks, carboard can be used for building the walls. Figure 7 describes dimensions and folding pattern for approximately 1mm thick cardboard to build the walls in case you do not have sufficient cardboard.

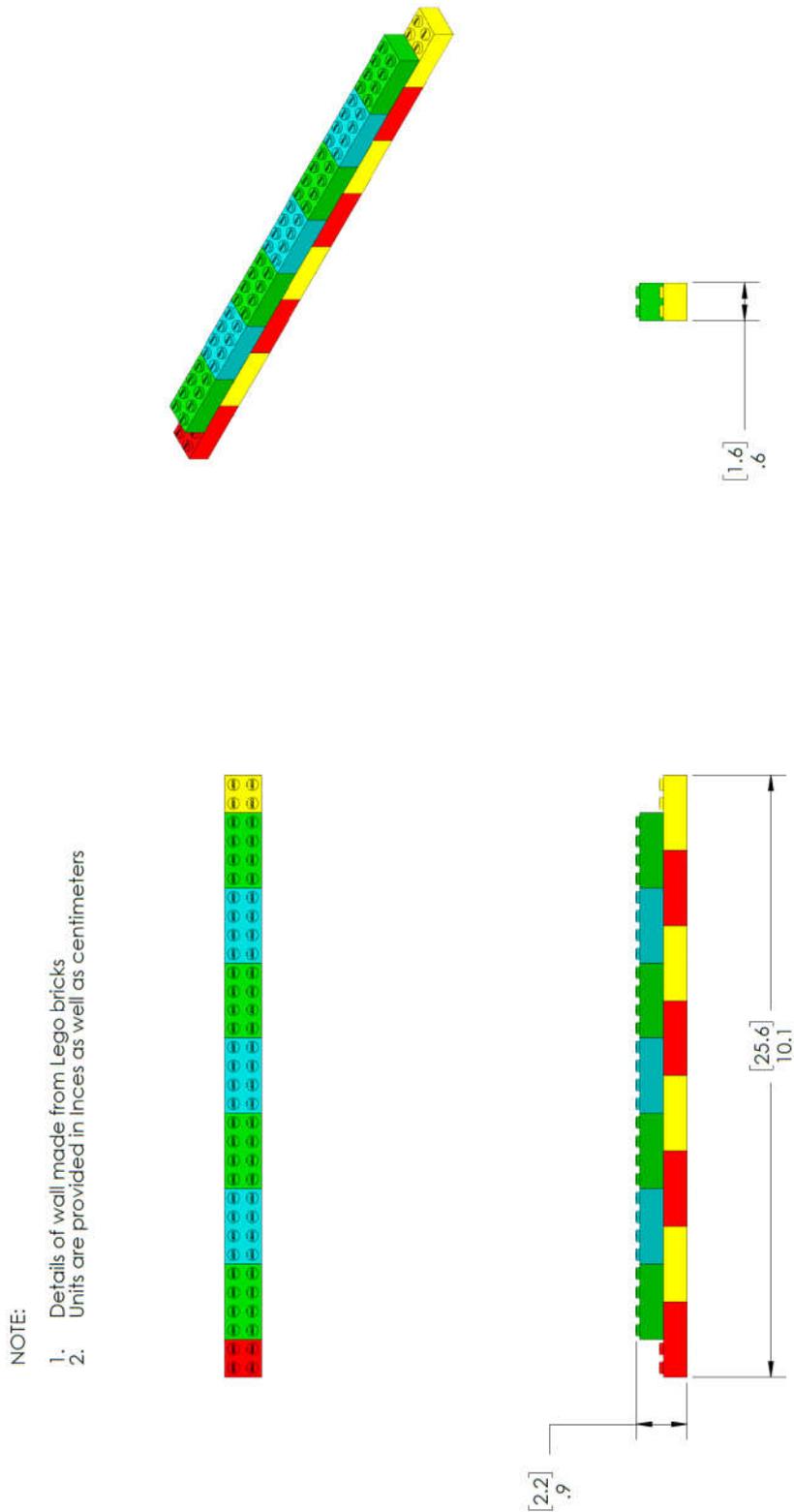


Figure 5: fixed walls and sliding gates built using 2X4 Lego blocks

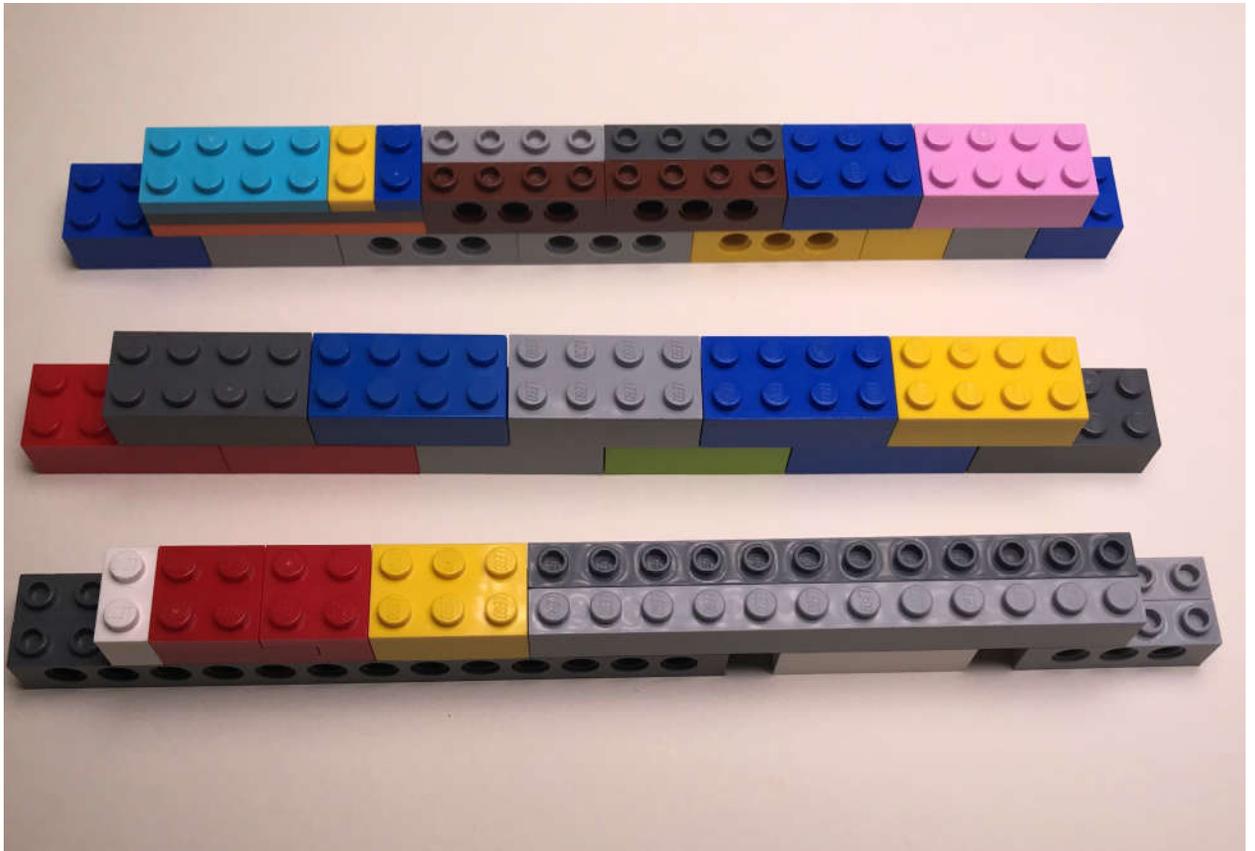


Figure 6 : Wall made using different combination of Lego bricks

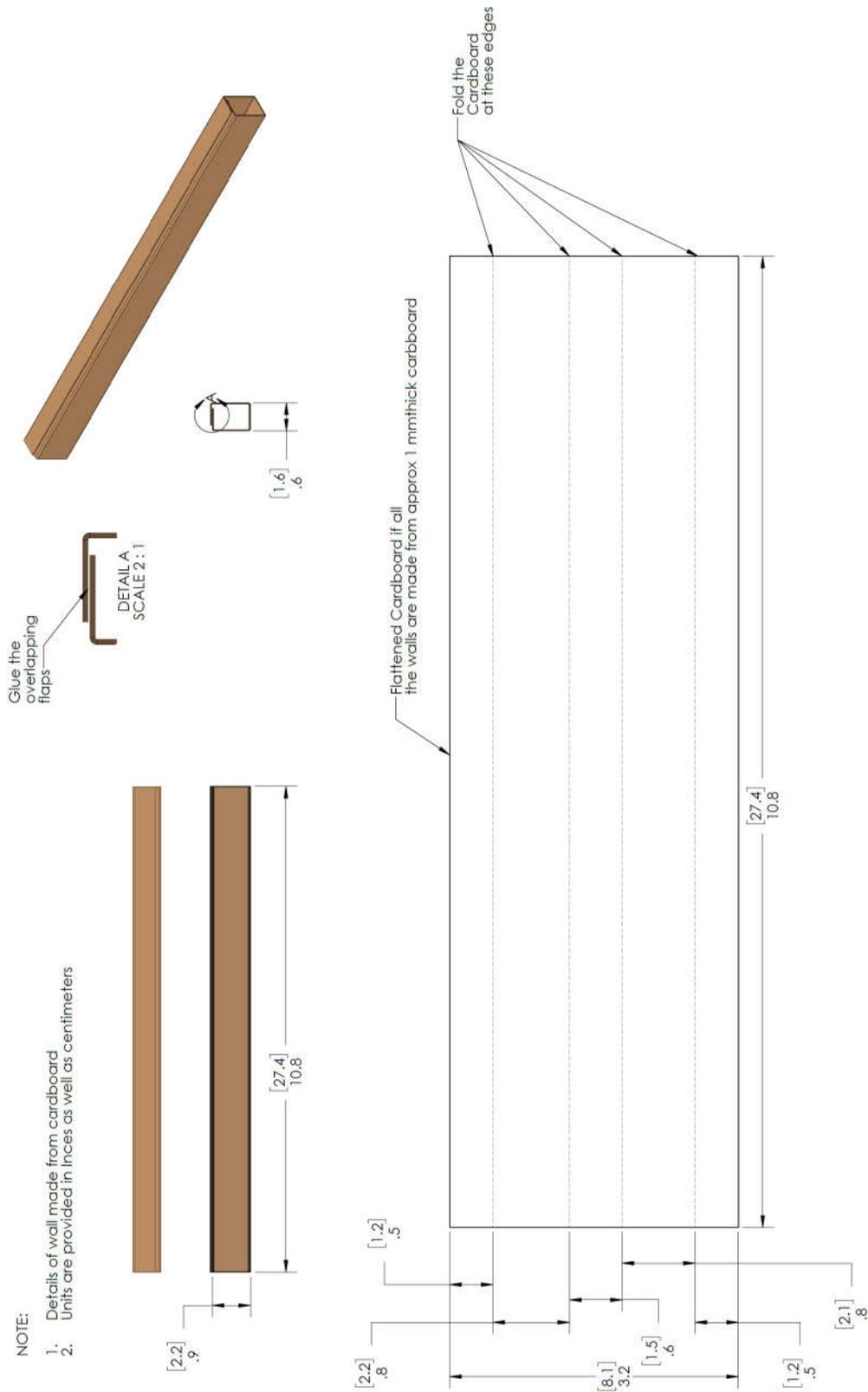


Figure 7 : Scheme for building fixed walls and sliding gates using cardboard, in case participant doesn't have enough LEGO bricks

2 THE CHALLENGE

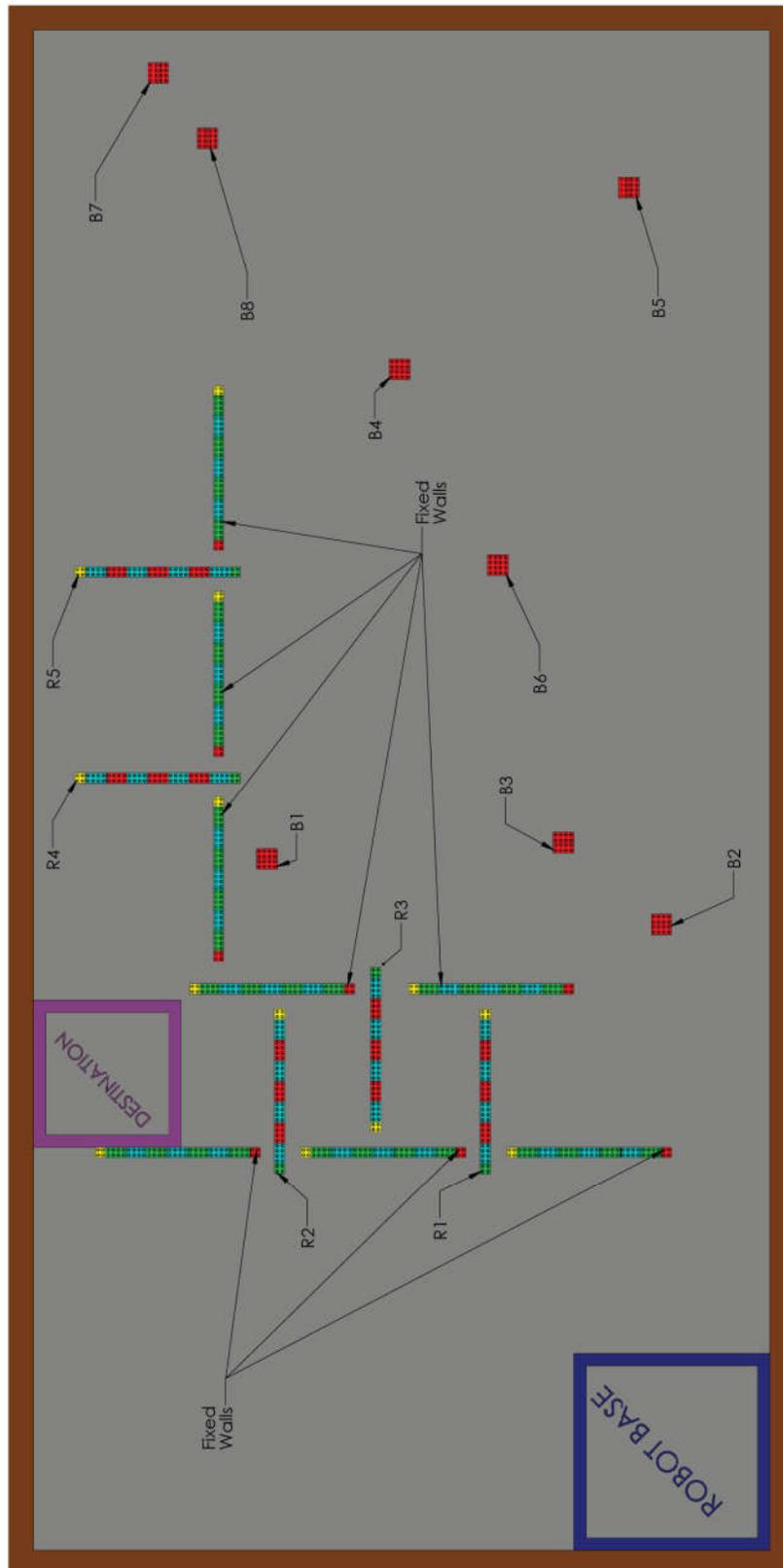
Robots are extensively used in material handling application. Use of Robots become especially relevant if the material to be handled is toxic or radioactive in nature.

As a Mobile Robotic expert, you have been requested to design a robot, its attachment and come up with a strategy to clear a nuclear reactor site. Your task is to design a novel mobile robot and its attachment to clean up contaminated nuclear waste and move it to a safe location.

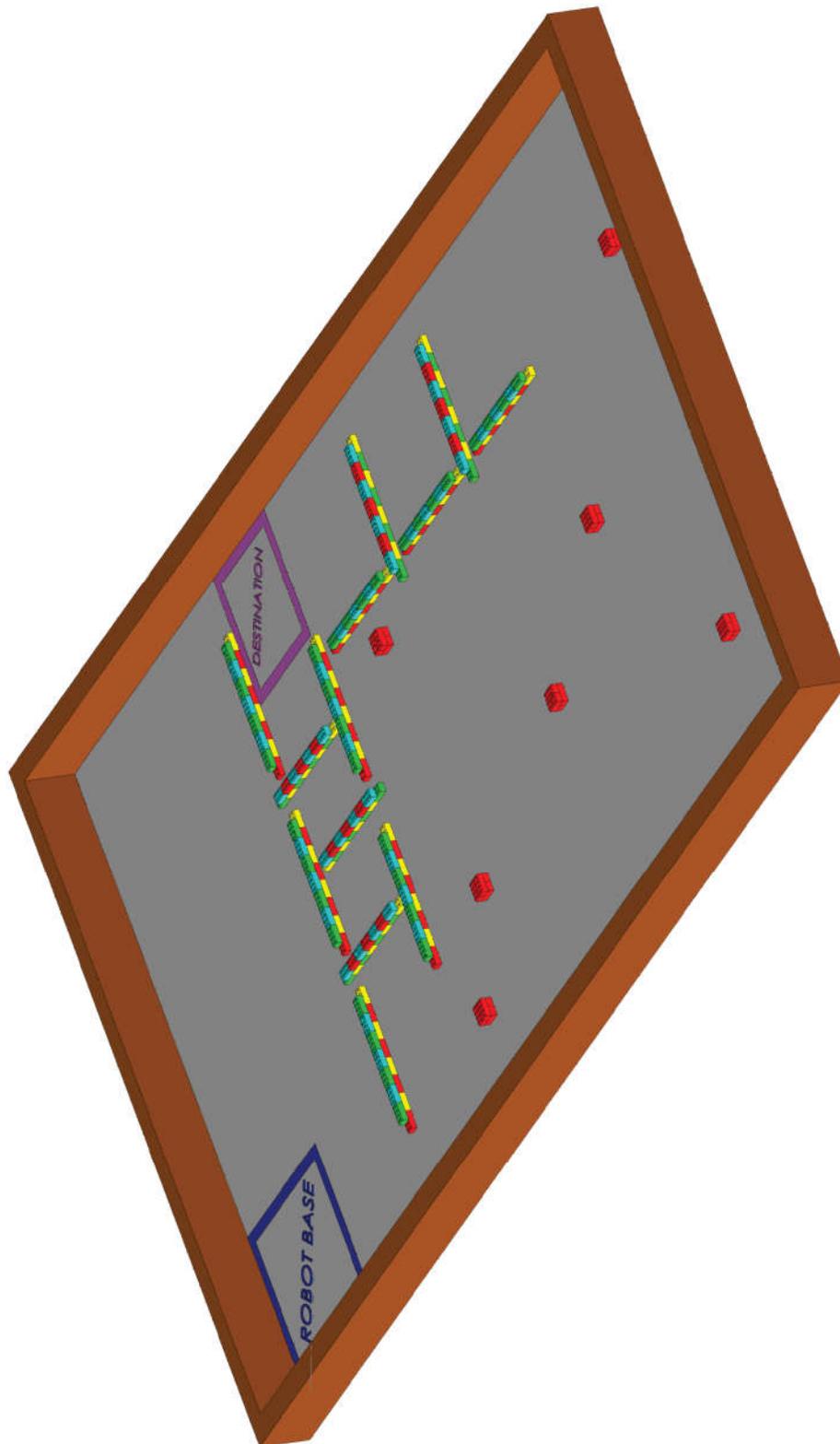
Due to safety concerns, the electric power to nuclear reactor is shut down causing all the safety doors to automatically lock. Therefore, before you may move the material, all the safety doors need to be opened using a robot. The nuclear waste is scattered across the nuclear reactor. The safe storage location is behind multiple doors. The doors must be opened with the help of the robot and then the nuclear waste should be pushed to the storage area. The Robots needed for the task i.e. the robot that you will be designing starts at the *base*. The base is the area where the Robot is parked, maintained, and tuned and therefore direct human engagement between the Robot and humans happens at Robot base and is acceptable. The Robot can visit the Robot Base multiple times during the operation for any modifications and may be handled by the operator there; however, nuclear waste cannot be brought to the Robot base as it will contaminate the base.

With the above context, as described in the Figure 8 (a), (b) and Figure 10, the game board represents the nuclear reactor. Blocks B1 - B8 represent contaminated nuclear waste scattered across the reactor. The fixed walls are shown in the Figures as marked. Elements R1-R5 are the retractable doors that your robot will have to move by sliding or other manner without destroying them. The region marked "DESTINATION" is the safe area where nuclear waste should be deposited. At the start of the challenge, the Robot is at the base and the doors are closed. In order to move the blocks to the destination, the robot needs to slide the moving doors to open the access paths as shown in Figure 9. The doors cannot hinge, the doors must be pushed out as described in Figure 9 to open the access path. You may choose a strategy as it fits you. That is, you may slide out R1, R2 and R3 to just open one access path or you may open the second access path by sliding R4 and R5 or you may slide out all the doors R1, R2, R3, R4 and R5 to open both access doors. Once the door(s) are open you can start moving the blocks (B1-B8) to destination.

Please note that the Robot cannot bring any of the blocks (B1-B8) to robot Base.



(a) Initial Configuration



(b) Final Configuration

Figure 8: Challenge Filed -isometric View, Initial configuration

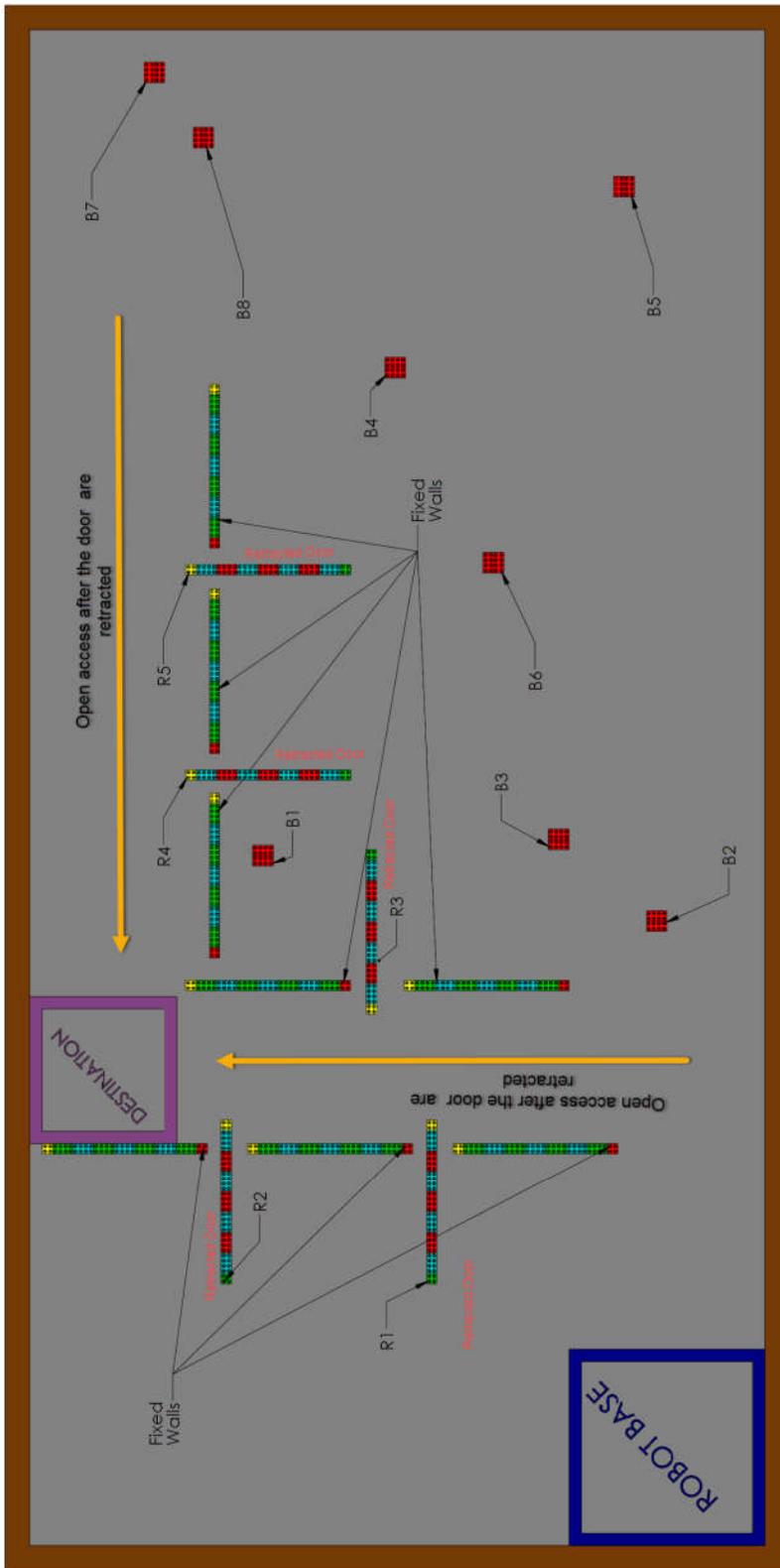


Figure 9: Access to the destination by retracting the retraction doors

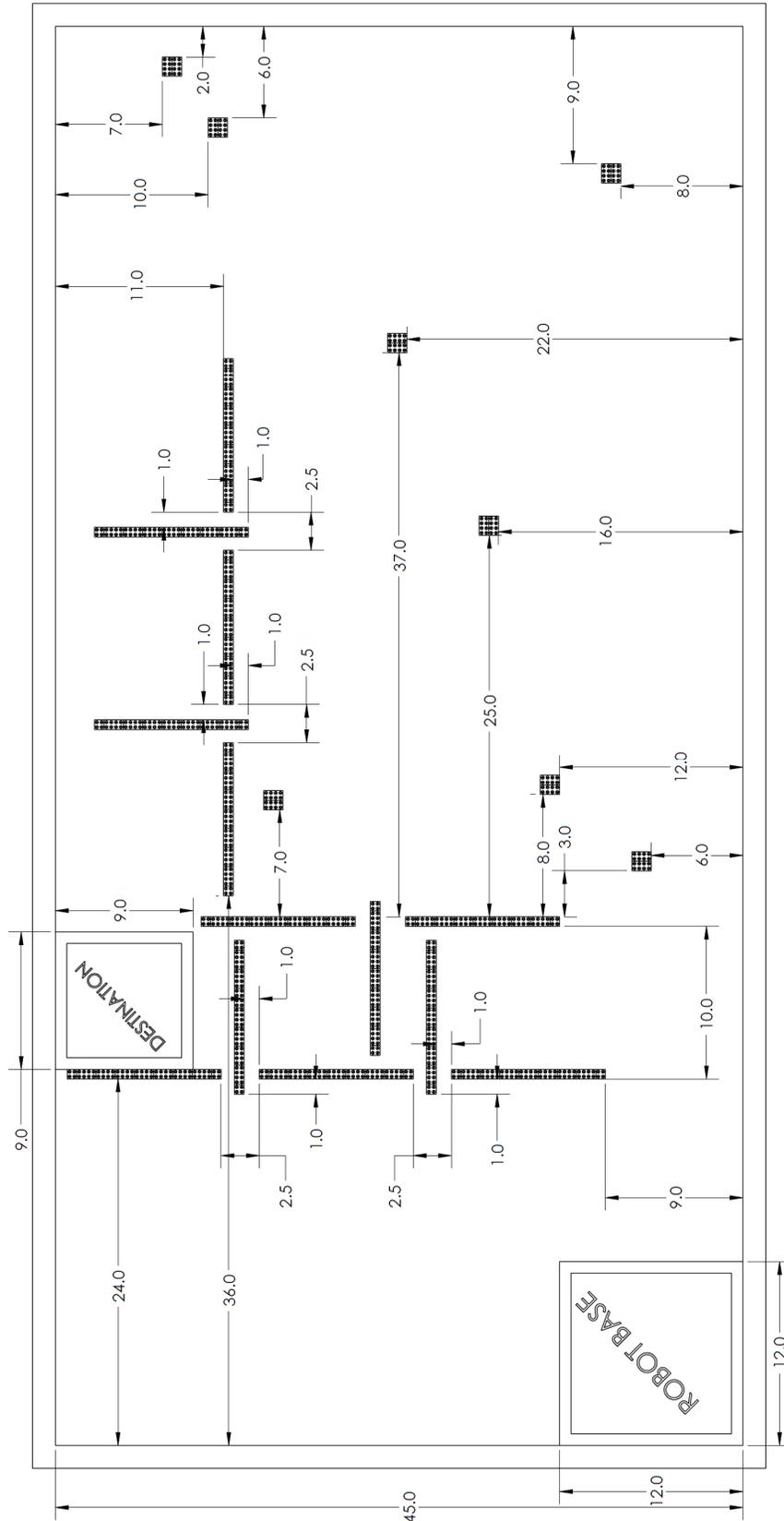


Figure 10 : Detailed Top view of field (Initial Configuration)

3 CHALLENGE CONDITIONS AND RULES

- All challenge field units are specified in inches. *NOTE: In case you are building the walls and the blocks using cardboard, the dimensions of the cardboard flat pattern and folded is also provided in **centimeters** for your convenience. Make sure you are reading the units correctly*
- Size of the Robot shall not exceed 12in X 12in X 12 in. The robot base is marked as a 12in x 12in rectangle on the field that you should mark using tape on your field. If you are submitting your challenge via video, the team shall include a top view of Robot area in their videos before the start of the challenge to confirm that no part of robot exceeds the specified boundary.
- Each challenge may be attempted in Autonomous mode or Teleoperated League. Awarding for the Autonomous or Teleoperated will be in different categories.
- For the teams competing in Autonomous mode league, Robot shall navigate and completes task without human intervention. Robot can be modified, realigned and alternate program may be run only when robot is in Robot area. Once the robot leaves the robot area, any intervention, and touching will incur penalty. Total time to complete the Autonomous mode Challenge is 2-1/2 minutes (150-seconds). The 2-1/2 minute clock will not stop when the robot is modified or reoriented in the Robot base.
- Clarification on the above: Your robot *MAY* use multiple programs to perform different tasks. However, your robot *MUST* come back to the base before you may select and run a second program. The challenge timer, once started does not stop for any reason including changing and running different programs.
- In Teleoperated mode robot shall navigate and complete tasks with the help of a remote-control device. Robot cannot be modified or realigned once the Robot leaves the Robot area. Total time to complete the Autonomous mode Challenge is 2 minute 30 seconds.
- When multiple teams are competing at a common venue, each team will be given two opportunities and the Maximum of the two runs will be considered as the actual team score. For the submission by video, only one video per team is allowed.
- For this challenge, if your robot misbehaves, you may pick up the robot and restart the robot. There is a 5-point penalty for picking up the robot.
- The Robot may move the blocks to respective final position in any order.
- To satisfy the requirement that a block has reached the destination, the blocks should be visibly inside destination boundaries at the completion of the challenge.
- You may choose to move one block or multiple blocks at a time.
- You may use up to 4 motors total on the mechanism of any kind.
- You may use up to 4 sensors of any kind in this challenge.

4 SCORING

Points are scored when Robot Completely opens the access path, touches a block and moves the block. The points are assigned per follows:

Table 1 Score details

| Task number | Detail | Score |
|--------------------|--|--------------|
| 1 | Slide out first door (along any access path) | 20 |
| 2 | Slide out second door (along any access path) | 20 |
| 3 | Completely open first access path (Not in any specific order) | 25 |
| 4 | Completely open second access path (Not in any specific order) | 10 |
| 5 | Touch Block B1 | 7 |
| 6 | Touch Block B2 | 2 |
| 7 | Touch Block B3 | 2 |
| 8 | Touch Block B4 | 7 |
| 9 | Touch Block B5 | 5 |
| 10 | Touch Block B6 | 5 |
| 11 | Touch Block B7 | 10 |
| 12 | Touch Block B8 | 10 |
| 13 | Move Block B1 to any of the access path | 15 |
| 14 | Move Block B2 to any of the access path | 5 |
| 15 | Move Block B3 to any of the access path | 5 |
| 16 | Move Block B4 to any of the access path | 15 |
| 17 | Move Block B5 to any of the access path | 10 |
| 18 | Move Block B6 to any of the access path | 10 |
| 19 | Move Block B7 to any of the access path | 5 |
| 20 | Move Block B8 to any of the access path | 5 |
| 21 | Move Block B1 to the Destination | 10 |

| | | |
|----|----------------------------------|----|
| 22 | Move Block B2 to the Destination | 10 |
| 23 | Move Block B3 to the Destination | 10 |
| 24 | Move Block B4 to the Destination | 10 |
| 25 | Move Block B5 to the Destination | 10 |
| 26 | Move Block B6 to the Destination | 10 |
| 27 | Move Block B7 to the Destination | 10 |
| 28 | Move Block B8 to the Destination | 10 |

5 TEAM REGULATIONS

1. Teams may be 1 person individually and at most 2 people.
2. At most two of the team members may be at the table before starting the run; they will be designated as “Robot Drivers”.
3. Everyone else must stand back at least 12 inches from the table.

6 AWARDS

- Highest score Award: 3 awards for the top three scores.
- Repeatability: (Applies to the challenges attempted at by multiple teams at a common venue) The robot with most repeatable runs. We want to ensure that the skill of the kids is the largest part of the robot run. The robot that produces the highest scores in a consistent manner will get this award.
- Referees choice (flexible criteria): If a design, program or teams’ approach is found to be exceptional in any manner; Referees may recognize the team.
- One team may win multiple awards.

7 ROBOT RUN RULES

1. One team can use ONLY one robot during the entire challenge. They must finish with the exact same robot that they started with.
2. If you are submitting video entry:
 - a. Your video must describe the team name/number, Season (WRL 2020), Challenge Number and Category (Bronze 3, Teleoperated or Autonomous) on a A4 size paper.
 - b. At the start of the video, you must show a top view to ensure that the robot is within the specified size and no part of the robot is extending beyond 12in. Additionally, the height of the Robot shall be confirmed by placing a ruler next to the Robot. It is participants responsibility to submit the evidences for Robot size in a manner that ascertains robot size beyond doubt. Should there be any doubt, referee’s decision will be final.
 - c. The video must be one continuous unedited video through the Robot run duration.

- d. The angle of video recording must ensure beyond doubt that robot does not interfere with the walls. Should there be any doubt, referee's decision will be final.
3. For the teams competing in Autonomous mode league, Robot shall navigate and completes task without human intervention. Robot can be modified, realigned and alternate program may be run only when robot is in Robot area. Once the robot leaves the robot area, any intervention, and touching will incur penalty. Total time to complete the Autonomous mode Challenge is 2-1/2 minutes (150 seconds). 2-1/2 minutes clock will not stop when the robot is modified or reoriented in Robot base.
4. In Teleoperated mode robot shall navigates and completes task with the help of a remote-control device. Robot cannot be modified or realigned once the Robot leaves the Robot area. Total time to complete the Autonomous mode Challenge is 2-1/2 minutes.
5. If a robot misbehaves and needs human intervention, a Robot Driver may intervene. Touching the robot disqualifies the run i.e. score from any previous runs will be discarded unless the game specific rules say otherwise.
6. *If a robot or mechanism created by the participating team starts destroying any fragile mechanisms, the referees will stop your mechanism. You may reattempt the challenge if the rules allow and if you are still within the allotted time.
7. The robot runs can be attempted indefinite number of times within the allotted time frame. *The referee will stop the run if the robot is not finished by the end of the allotted time.
8. *There will be two referees on either side of the table, and their combined decision will be final.
9. *There will be 2 rounds for each team. Each team will get 1 run in each round. There will be at least 5-minute break between rounds for kids to tweak their programs or robots.
10. Adult help should be limited to non-competitive elements. Adults may help with video recording and time keeping, laying out team details on A4 page as specified in previous sections. We want kids to do the work themselves demonstrably.
11. Referees and Judges may ask the participants to explain their programs and design before the run to ensure that they have done original work by themselves. Each member of the team must be able to answer questions about the program and design. If a team member cannot answer questions satisfactorily, that team will not be eligible for any awards no matter their score.
 - * Should there be any doubt, referee's decision will be final.