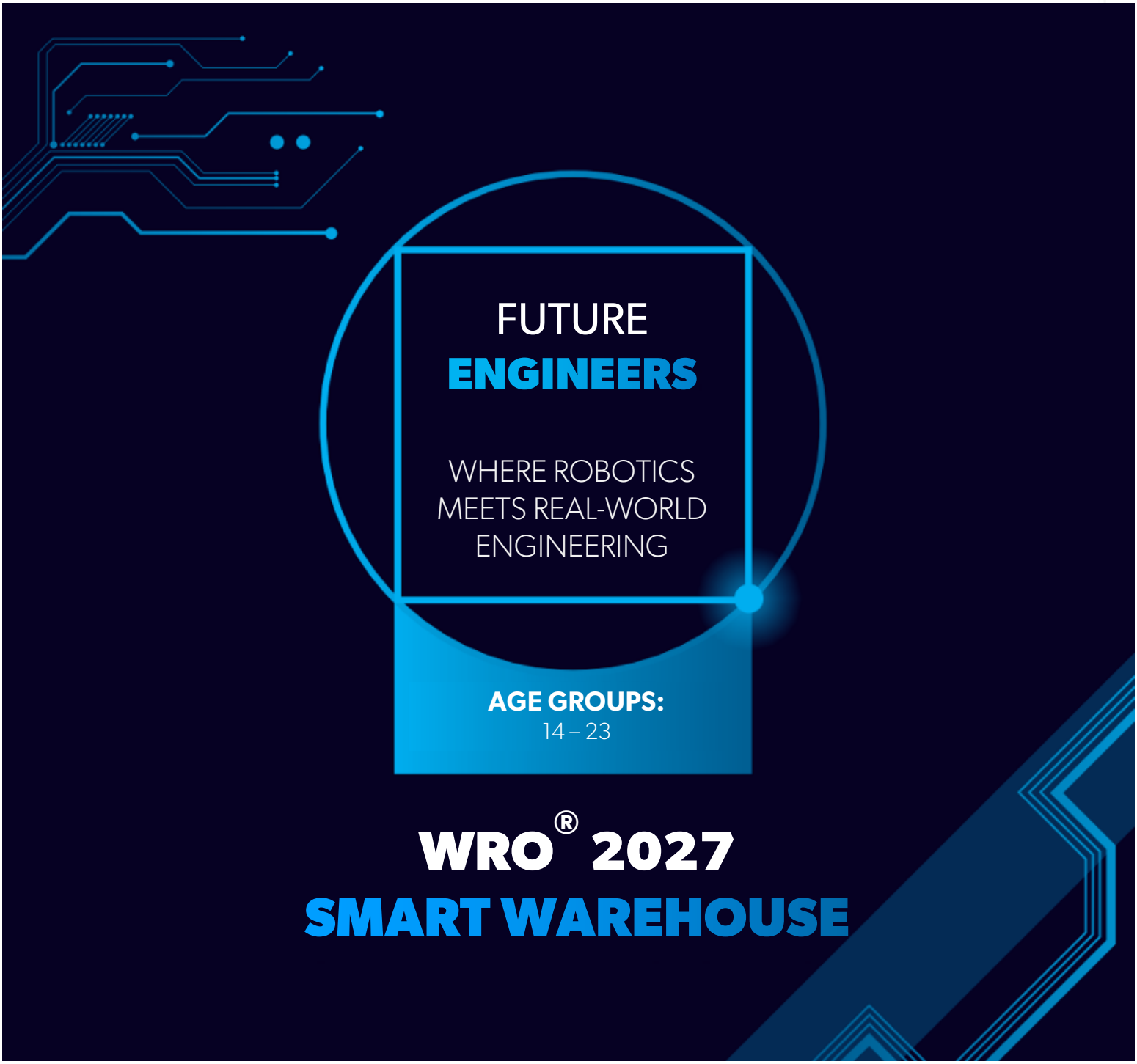
GAME RULES

VERSION: 2 November 2026

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1. Introduction

1.1. About WRO Future Engineers

WRO Future Engineers category is an open robotics competition that challenges students to design, build, program and improve autonomous robotic systems.

Teams are encouraged to make their own engineering decisions regarding the robot's mechanical structure, electronics, sensors, computing platform, software and manipulation mechanisms. The competition does not require teams to follow a predefined robot architecture or to use a specific robotics platform.

The objective is not only to complete the game missions, but also to demonstrate an understanding of autonomous robotics, engineering design, testing and continuous improvement.

1.2. The Smart Warehouse Challenge

Smart Warehouse is a robotics challenge inspired by modern warehouse operations.

Teams must develop an autonomous mobile robot capable of navigating inside a warehouse environment, locating storage positions, identifying objects, retrieving and transporting boxes, and placing them at the required destination.

All missions use the same general warehouse environment, but each introduces a different combination of navigation, perception, manipulation and decision-making challenges.

Depending on the age group and mission, the robot may be required to:

- locate and retrieve boxes from warehouse racks
- read and process an order list
- collect only the requested boxes
- detect a blocked warehouse aisle
- select an alternative route
- identify products placed inside boxes
- transport boxes to the correct storage location

All missions must be completed autonomously after the robot has been started.

1.3. Autonomous Mobile Robot Philosophy

Smart Warehouse is designed around the principles of Autonomous Mobile Robots, or AMRs.

Unlike traditional Automated Guided Vehicles (AGVs), which often follow fixed lines, magnetic strips, QR codes or predefined paths, an AMR should be able to perceive and navigate its surrounding environment.

For this reason, the Smart Warehouse field does not provide navigation lines or floor markers that indicate the route the robot should follow.

The robot should navigate using information obtained from the warehouse environment, such as:

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- rack structures
- warehouse aisles
- storage locations
- fixed landmarks
- other physical features of the field

Decorative graphics will be included on the game mat to improve its visual appearance. They are not intended to serve as navigation aids, and the robot should be designed to complete the missions without depending on them.

Teams may use any suitable combination of sensors and technologies, including cameras, distance sensors, LiDAR, inertial sensors, computer vision, mapping, localization and path-planning algorithms.

1.4. Educational and Engineering Objectives

The Smart Warehouse challenge combines several important areas of autonomous robotics and engineering.

Through the development of their robot, teams are expected to gain experience in:

- autonomous navigation
- localization and mapping
- obstacle and environment detection
- route planning and replanning
- computer vision and object recognition
- robotic manipulation and gripping
- mechanical and electronic system integration
- software development
- testing and performance evaluation
- evidence-based engineering improvement

The challenge is designed to encourage teams to develop a complete robotic system rather than solving isolated tasks.

Successful solutions will require teams to balance different engineering requirements, including robot size, mobility, turning capability, sensor placement, manipulation accuracy, processing performance and reliability.

1.5. Senior and Advanced Categories

WRO Future Engineers Category is divided into two age groups:

- Senior: ages 14 – 19 (birth years 2008–2013)
- Advanced: ages 18 – 23 (birth years 2004–2009)

Each participant may compete in only one age group during a competition season and only if they meet the stated age requirements for that group.

The two age groups use the same general warehouse environment and share the same fundamental principles of autonomous navigation and robotic manipulation. However, they include different missions and levels of technical complexity.

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2. Game Field

The Smart Warehouse game field represents a small-scale warehouse environment designed for autonomous mobile robots.

The same general field is used for both the Senior and Advanced Categories. However, the initial position of movable game objects and the specific mission setup may differ between categories and missions.

2.1. Game Field Overview

The main elements of the field are:

- three Warehouse Rack Rows
- Open Boxes that can be stored, retrieved and transported by the robot
- a Workbench used for collecting, processing or dispatching boxes
- two Charging Stations
- border walls surrounding the complete field
- additional mission-specific game objects

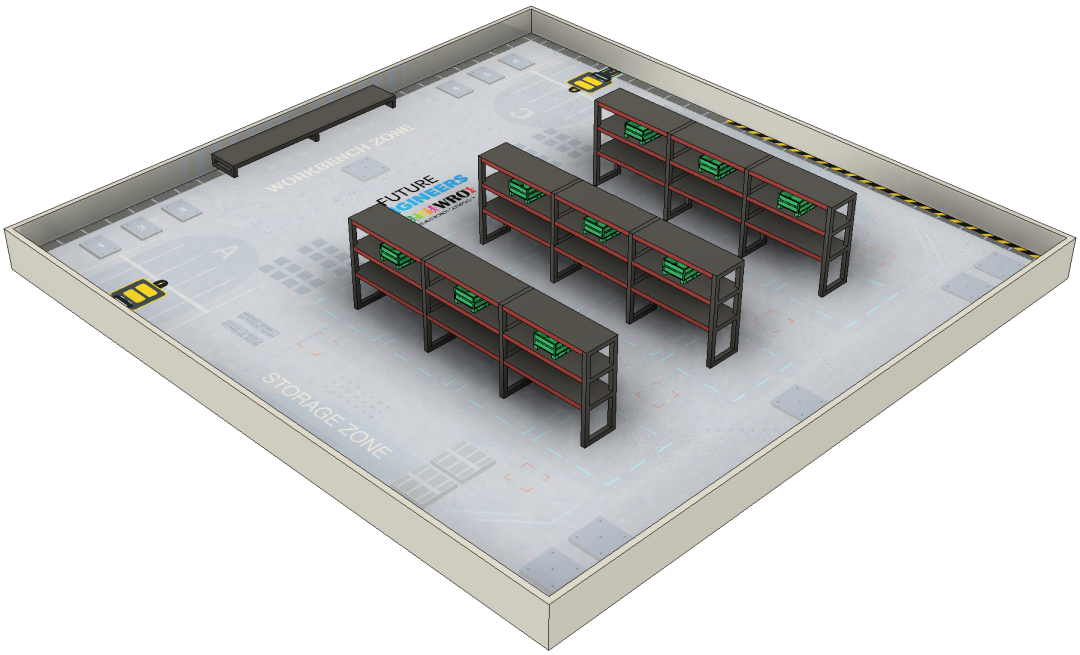


Figure 1: Smart Warehouse field overview

The Rack rows, Workbench and border walls are fixed field elements. Boxes and other mission-specific game objects are movable elements whose number, position or orientation may be randomized before a round.

All game objects may be constructed from wood or manufactured using a 3D printer, with 3D printing being the recommended method to ensure consistent dimensions and appearance. At International Events, the official 3D-printed game objects will be used. A ready-made official kit containing all game objects is available from HP Robots (see Appendix B).

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2.2. Field Dimensions

The dimensions of the Smart Warehouse game field have been selected to correspond to the combined dimensions of two standard WRO RoboMission game fields placed side by side.

This approach gives teams and National Organizers two possible options for constructing the field:

- construct a new Smart Warehouse field, or
- reuse existing tables built according to the standard RoboMission field dimensions and connect them to create the required playing area.

The complete Smart Warehouse field has the following dimensions:

- Length: 2362 mm
- Width: 2286 mm
- Border wall height: 100 mm
- Border wall colour: White

Detailed instructions for adapting and connecting existing RoboMission tables are provided in Appendix A.

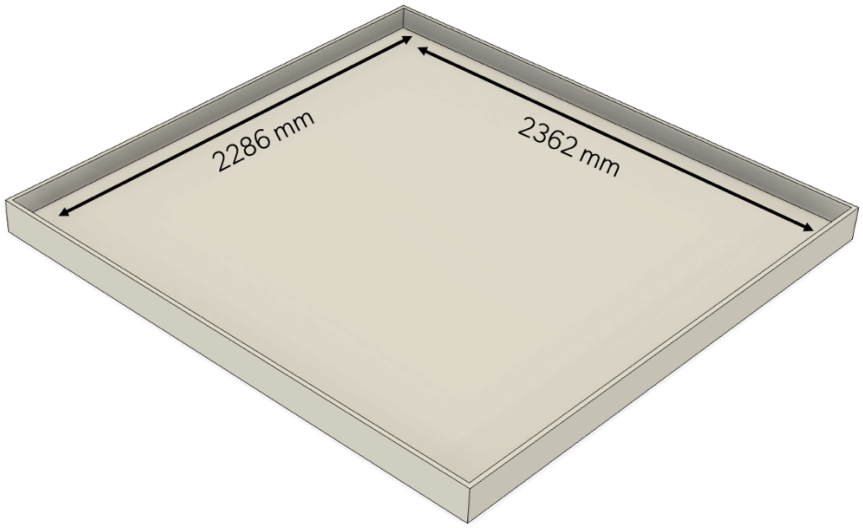


Figure 2: Main field dimensions

2.3. Warehouse Layout

The Smart Warehouse field is organized as a small warehouse environment with three parallel Rack Rows, a Workbench and two Charging Stations.

The Rack Rows are positioned to create a network of Warehouse aisles through which the robot can move and access the storage positions. The distances between the fixed field elements are designed to provide sufficient space for navigation, turning and alignment with the Racks, while still requiring accurate localization and motion planning.

The Workbench is located outside the main Storage Zone and is used as a collection, dispatch or processing station, depending on the mission.

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Two Charging Stations are located at different positions on the field. Depending on the mission, one of them may be used as the robot's starting or finishing area.

The same fixed layout is used for both the Senior and Advanced Categories. The positions of boxes and other movable game objects may vary according to the mission and the randomization procedure.

The exact position, orientation and distances between all fixed field elements are shown in Figure 3.

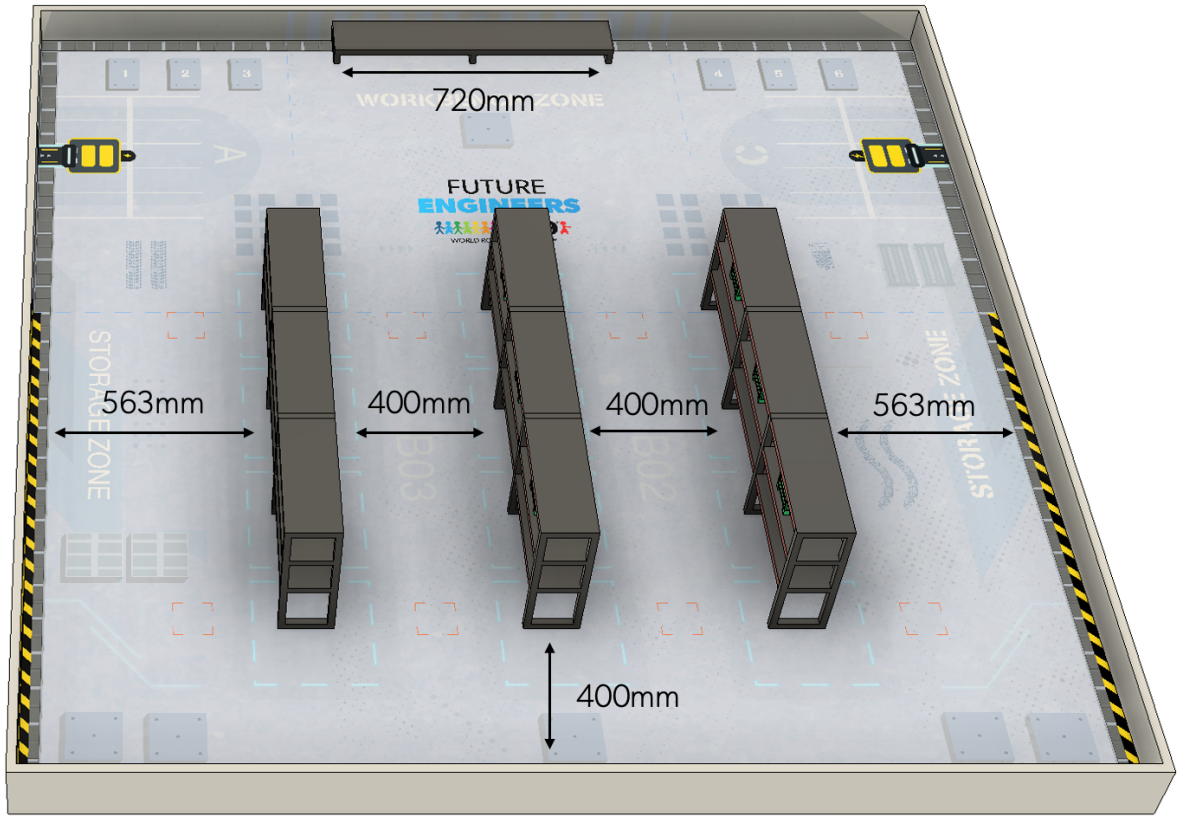


Figure 3: Smart Warehouse field layout

2.4. Rack Units

The basic storage element of the Smart Warehouse field is the Rack unit.

Each Rack unit consists of a vertical structure containing three horizontal Rack levels. Depending on the mission, an open box may be placed on one of these levels.

For the purposes of these rules:

- a **Rack unit** is one individual vertical storage module
- a **Rack row** consists of three Rack units placed side by side
- a **Rack level** is one horizontal storage surface within a Rack unit
- a **storage location** is a specific Rack level within a specific Rack unit.

The exact Rack level used and the initial position of each box are defined in the corresponding mission description.

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The Rack units are black, while their front and back sides are red to provide visual contrast and facilitate camera-based detection by the robot. They are also secured to the game field surface using double-sided tape and must remain in their official positions throughout the round. The robot may approach them and interact with boxes placed on them, but it must not intentionally move, rotate, lift or damage the Rack structure.

The official dimensions and details of a Rack unit are shown in Figure 4.

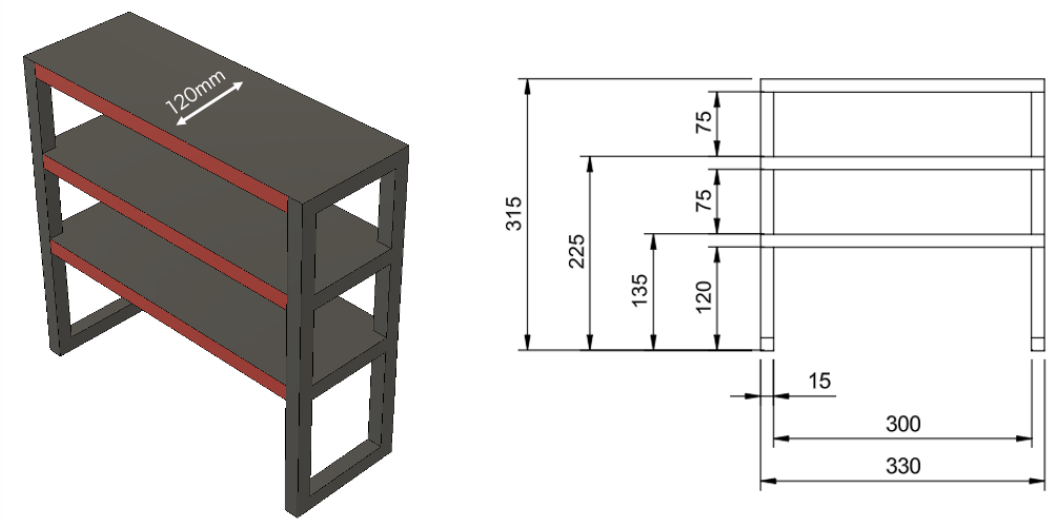


Figure 4: Individual Rack unit and rack levels

2.5. Rack Rows

The Smart Warehouse field contains three identical Rack rows.

Each Rack row consists of three Rack units placed side by side. Adjacent Rack units share common vertical uprights, reducing the number of required components and creating a simpler and more stable structure.

The three Rack rows are positioned parallel to each other and form the main storage area of the warehouse. The spaces between and around the Rack rows create Aisles that allow the robot to navigate and approach the Rack units.

All Rack rows are fixed field elements and must remain in their official positions throughout a competition round.

The shape and total length of a Rack row are shown in Figure 5.



Figure 5: Complete Rack row

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The Rack rows may be constructed from wood or manufactured using a 3D printer. Regardless of the construction method, the official dimensions and colours must be maintained.

The Rack units are black (HEX #000000), with red front and back sides (HEX #CE4A4A). For details on the official 3D-printing files, see Appendix B. At all WRO International Events, all parts will be 3D printed using HP Robots FastPLA filament. National Organizers may use equivalent filament for their own events.

2.6. Workbench

The Workbench represents a packing, collection and processing station within the Smart Warehouse environment.

Depending on the mission, the Workbench may be used:

- as the destination for Boxes retrieved from the Warehouse Racks
- as the initial position of Boxes that must be transported to the storage area, or
- for the placement of mission-specific objects

The Workbench is a fixed field element and remains in the same position and orientation throughout a competition round.

The Workbench has the following dimensions:

- Length: 720 mm
- Depth: 120 mm
- Height: 45 mm

The upper surface of the Workbench is used for placing game objects. The number, position and orientation of these objects are defined separately in the corresponding mission description.

The exact dimensions of the Workbench are shown in Figure 6.

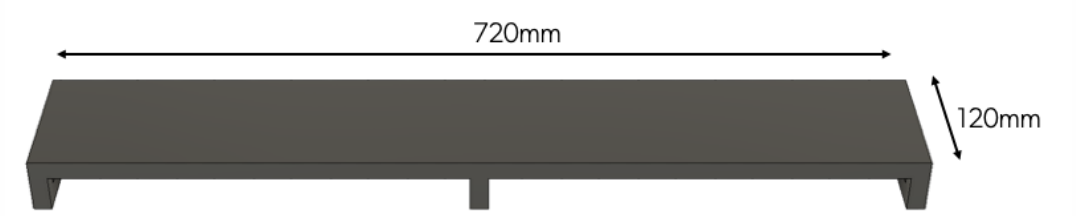


Figure 6: Workbench dimensions

The Workbench may be constructed from wood or manufactured using a 3D printer. Regardless of the construction method, the official dimensions and colours must be maintained. The Workbench is black (HEX #000000). At International Events, 3D-printed Workbenches will be manufactured using HP Robots FastPLA filament. For details on the official 3D-printing files, see Appendix B.

2.7. Open Boxes

Open boxes are the main movable game objects used in the Smart Warehouse missions.

Depending on the mission, the boxes may initially be placed on the Warehouse Racks or on the Workbench. The number of boxes and their exact initial positions are defined separately in each mission description. No more than nine boxes are used in any mission.

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Each box is open at the top and has the following external dimensions:

- Length: 100 mm
- Depth: 80 mm
- Height: 50 mm

The box design includes openings, recessed areas and external protrusions. These features are intentionally included to provide teams with different options for grasping, lifting, pushing or otherwise transporting the box.

Teams may design any suitable manipulation mechanism, including grippers, robotic arms, lifting mechanisms or other solutions, provided that the robot and its operation comply with the technical rules.

All boxes used during a competition must follow the same official design and dimensions. Minor differences in surface finish or appearance are permitted, provided that they do not significantly affect the difficulty of detecting or manipulating the box.

The number, content, orientation and exact initial position of the boxes are defined in the corresponding mission setup.

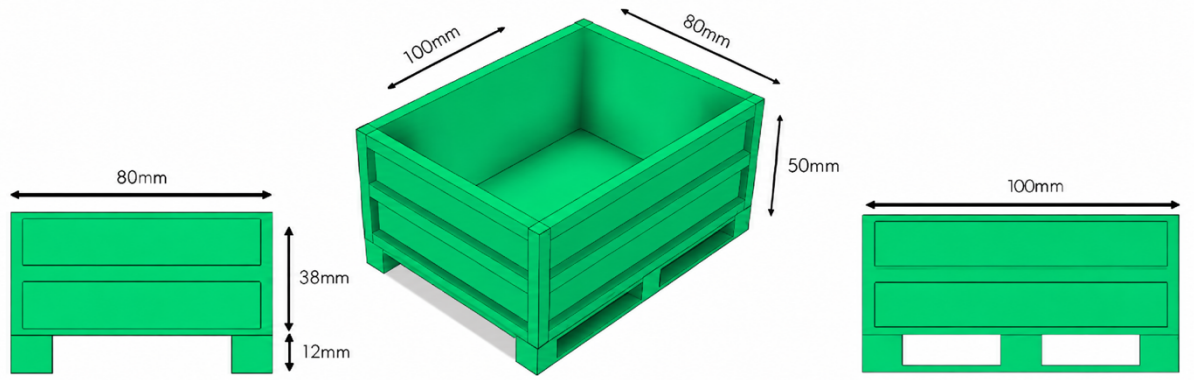


Figure 7: Open box design and external dimensions

The boxes must be manufactured using a 3D printer to ensure consistent dimensions, weight and colour. For details on the official 3D-printing files, see Appendix B. All boxes are green (HEX #00D072). At all International Events, the boxes will be 3D printed using HP Robots FastPLA filament. National Organizers may use equivalent filament for their own events, but the colour should be as close as reasonably possible to the official reference colour. National Organizers must inform teams in advance which filament and colour will be used at their competition.

2.7.1. Standard Placement on a Rack Level

When a box is initially placed on a Rack level, it must be positioned upright, with its open side facing upward, and centred on the Rack level as shown in Figure 8. A 10 mm gap must be maintained between the box and both the front and rear edges of the Rack level. No part of the box may extend beyond the edges of the Rack level.

The exact Rack unit and Rack level on which each box is placed are defined in the corresponding mission setup.

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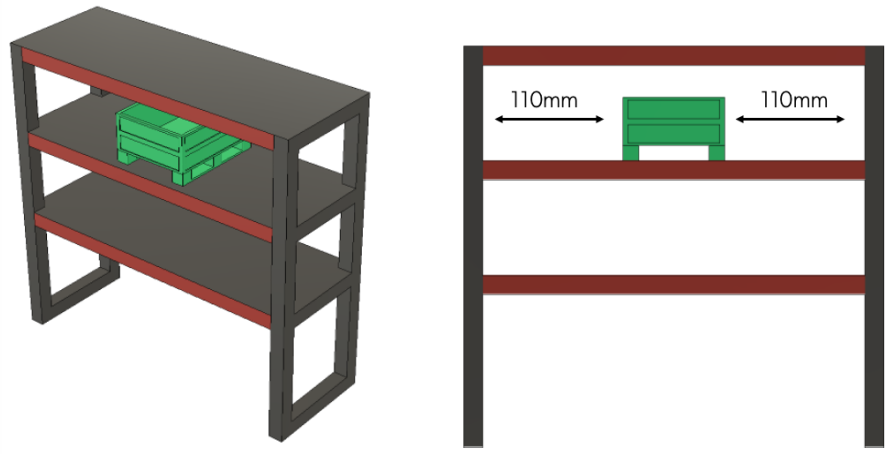


Figure 8: Standard box placement on a Rack level

2.8. Charging Stations

The Smart Warehouse field contains two Charging Stations, marked as flat graphics on the playing surface. They represent the locations where the robot may start and finish a mission. The Charging Stations have no physical height and do not contain functional charging equipment.

The dimensions and positions of the Charging Stations are shown in Figure 9.

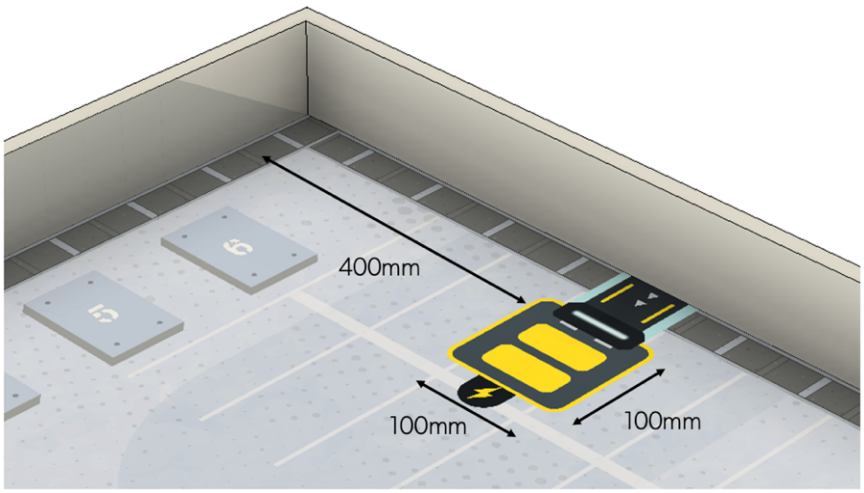


Figure 9: Dimensions and positioning of the Charging Stations

Starting Position

Before the start of a round, the robot must be placed at the assigned Charging Station. The robot must be positioned so that its vertical projection covers as much of the yellow area as its dimensions allow. If the robot is large enough to cover the entire yellow area, it must do so. Smaller robots are not required to cover the entire yellow area.

Finishing Position

At the end of a round, the robot is considered successfully parked at a Charging Station if it has stopped and any part of its vertical projection overlaps the yellow area of the Charging Station. Full coverage of

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the yellow area is not required. If there is no overlap between the robot's vertical projection and the yellow area, the robot is not considered parked correctly at the Charging Station.

Figure 10 illustrates the robot positioning requirements at a Charging Station. The left example shows the correct starting position, where the robot covers as much of the yellow area as its dimensions allow. The middle example shows successful parking, where the robot's vertical projection partially overlaps the yellow area. The right example shows unsuccessful parking, where there is no overlap between the robot's vertical projection and the yellow area.

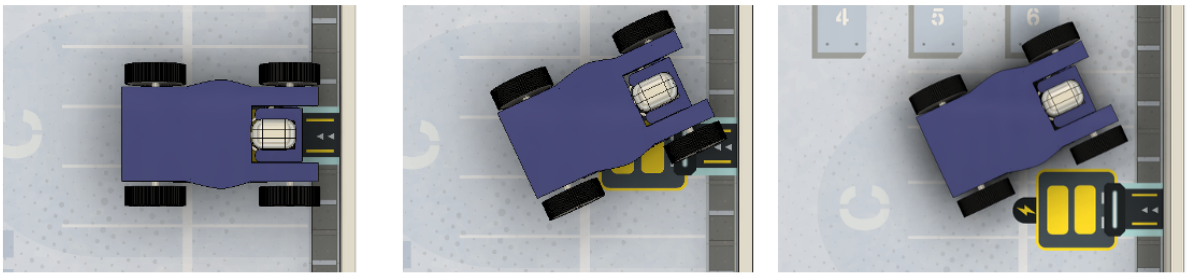


Figure 10: Correct starting position (left), successful parking (middle), and unsuccessful parking (right).

The relevant mission rules define which Charging Station is used at the start and whether the robot may finish at either Charging Station.

2.9. Workbench Zone

The Workbench Zone is the area surrounding the Workbench, marked by a dashed blue line on the game mat. The boundaries of the Workbench Zone are illustrated in Figure 11.



Figure 11: Workbench Zone boundaries, indicated by the dashed blue line surrounding the Workbench

Depending on the mission, teams may earn points by successfully transporting at least one box into the Workbench Zone. This scoring condition is separate from any points awarded for placing boxes on the Workbench. The applicable scoring conditions and point values are defined in the corresponding mission scoring table.

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2.10. Storage Zone

The Storage Zone is the main storage area containing the Rack rows. It is separated from the rest of the warehouse environment by a dashed blue horizontal line, visible in the upper part of Figure 12. This line should not be confused with the other light-blue decorative markings on the game mat.

Depending on the mission, teams may earn points by successfully transporting at least one box into the Storage Zone.

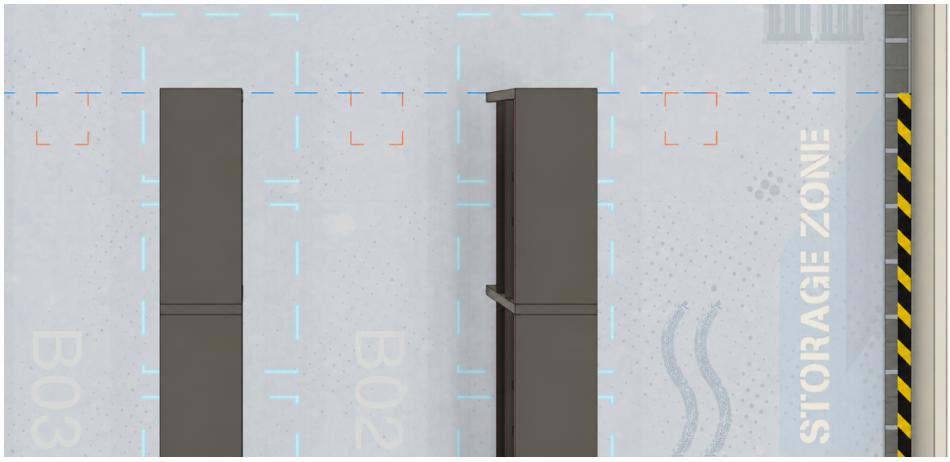


Figure 12: Storage Zone boundary, indicated by the dashed blue horizontal line

The applicable scoring conditions and point values are defined in the corresponding mission scoring table.

2.11. Order List Areas

The game mat contains six numbered rectangular areas, each measuring 120 × 80 mm, which may be used to place cards containing order list information during certain missions.

As shown in Figure 13, the areas are numbered from 1 to 6, with three located to the left of the Workbench and three to the right.

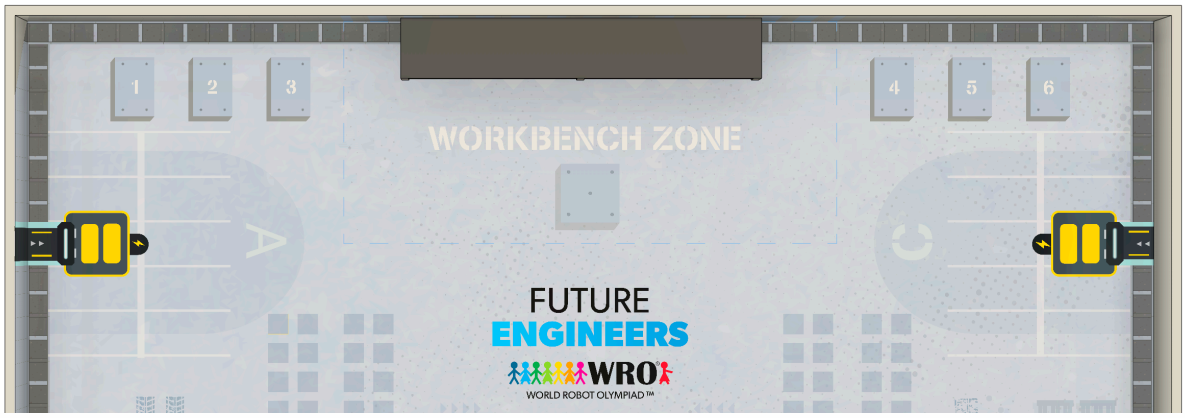


Figure 13: The six numbered Order List Areas (1–6), located to the left and right of the Workbench

The use of these areas and the placement of the order list cards are defined in the corresponding mission rules.

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3. Senior Category Missions

3.1. Senior Mission 1 – Rack Clearance

In this mission, five empty open boxes are placed at randomly selected storage locations. The robot must autonomously locate the boxes, retrieve them from the Racks and deliver them to the Workbench.

3.1.1. Field Setup and Randomization

Before each competition round, five of the nine Rack units are randomly selected. One open box is placed on the middle level of each selected Rack unit, according to the standard placement described in Section 2.7.1.

The nine dot cards described in Senior Mission 2 – Order Picking may be used for this randomization.

The remaining four Rack units and the Workbench are left empty. Figure 14 shows the numbering of the Rack units and an example setup in which Rack units 2, 3, 4, 7 and 9 have been selected.

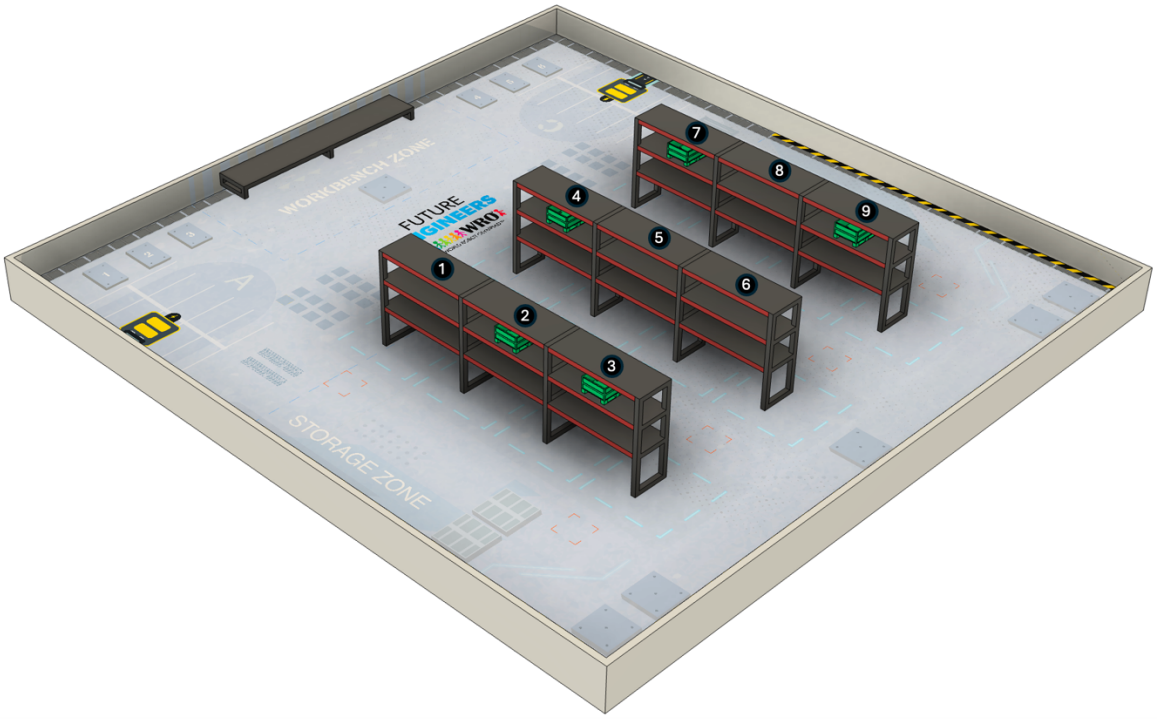


Figure 14: Rack unit numbering and example randomized setup

The same randomized setup is used for all teams competing in the same round. Before each run, the judges must verify that the boxes are placed in the correct Rack units and in the correct orientation.

3.1.2. Mission Tasks

Before the start of the round, the team may choose either Charging Station as the robot's starting position. The robot must be positioned according to the requirements defined in Section 2.8.

After the robot has been started, it must autonomously:

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- navigate through the Smart Warehouse field
- locate the five boxes
- remove them from the Racks
- transport them to the Workbench
- place them on the upper surface of the Workbench
- return to either Charging Station

The robot may retrieve and transport the boxes in any order. The Charging Station used at the end of the round does not need to be the same as the starting Charging Station.

Teams are free to determine their own navigation, manipulation and delivery strategy, provided that the robot complies with all general and mission-specific rules.

3.1.3. Scoring

Scoring Table - Senior Mission 1	Point value	Total available
Robot completely leaves the starting Charging Station	5	5
Box removed from a Rack	3	15
Workbench and Storage Zones		
At least one box is completely inside the Workbench Zone (even if the box is not upright).	10	10
At least one box is completely outside the Storage Zone (even if the box is not upright).	10	10
Box Delivery		
Box completely placed on the Workbench	10	50
Box partially placed on the Workbench	5	25
Box placed upright anywhere on the game mat	2	10
Finishing Position (points are awarded if at least one point is scored in the mission tasks above)		
Robot successfully parked at a Charging Station	10	10
Surprise Rule		
Total points available from the Surprise Rule	50	50
The team performed repairing actions by taking the robot out of the field even if the actions were not successful.	Total round divided by factor 2	
Maximum Score	150	

Box Placement Scoring Conditions

The following conditions apply when evaluating box placement:

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- **Completely placed on the Workbench:** The box must be upright, with its entire base resting directly on the upper surface of the Workbench (10 points).
- **Partially placed on the Workbench:** The box must be upright, with part of its base resting directly on the upper surface of the Workbench and the remaining part extending beyond its edge (5 points).
- **Placed upright on the floor:** The box must be upright, with its base resting on the game mat (2 points).

To receive placement points, a box must be fully released by the robot and remain in position without any support or stabilization from the robot.

Boxes that are tilted, lying on their side or upside down do not receive any placement points, regardless of whether they are placed on the Workbench or on the floor. If boxes are stacked, only a box resting directly on the Workbench may receive points. Any box resting on top of another box receives no placement points.

Figure 15 illustrates the different scoring conditions for the boxes. Boxes 1 and 3, marked with dark green circles, are completely placed on the Workbench and score **10 points each**. Boxes 2 and 4, marked with light green circles, are partially placed on the Workbench and score **5 points each**. Box 5, marked with an orange circle, is placed upright on the floor and scores **2 points**. Boxes 6 and 7, marked with red circles, do not satisfy any scoring condition and score **0 points**.

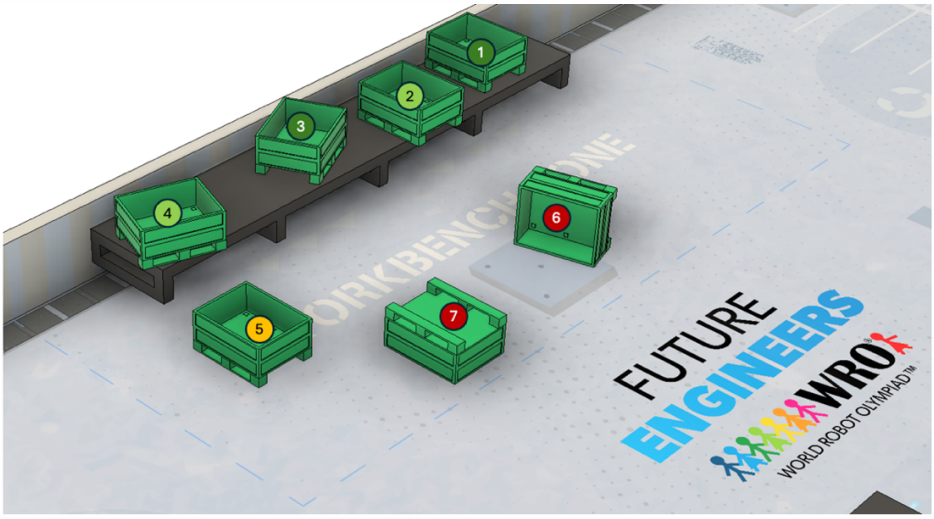


Figure 15: Examples of box positions and the corresponding scores

3.2. Senior Mission 2 – Order Picking

In this mission, one empty open box is placed on the middle Rack level of each of the nine Rack units. Five cards containing order list information are placed in the designated Order List Areas on the game mat, indicating which five boxes must be collected. The robot must first read the order list cards and then autonomously retrieve only the boxes from the five selected Rack units and deliver them to the Workbench.

3.2.1. Field Setup and Randomization

Before each competition round, one open box is placed on the middle Rack level of each of the nine Rack units. Each box is positioned according to the standard placement described in Section 2.7.1.

The five boxes to be collected are selected using the following randomization procedure:

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1. Nine dot cards representing Rack units 1 to 9 are shuffled and placed face down.
2. One judge randomly draws five cards without replacement.
3. The five selected cards are placed face up in the first five designated Order List Areas (1–5), with one card in each area (Area 6 remains empty).
4. The dot patterns shown on the cards correspond to the Rack unit numbering shown in Figure 14.
5. The boxes located in the five selected Rack units, form the order that the robot must collect.

The remaining four boxes must remain on their original Rack units.

The same randomized order list is used for all teams competing in the same round. Before each run, the judges must verify that:

- one box is correctly placed on the middle level of every Rack unit
- all boxes are positioned correctly according to Section 2.7.1
- the five selected Dot Cards are correctly placed face up in Order List Areas 1–5

Figure 16 shows the complete set of nine dot cards used for randomization and order generation. Each card measures 120 mm × 80 mm. For details on the official print-ready Dot Card files, see Appendix B.

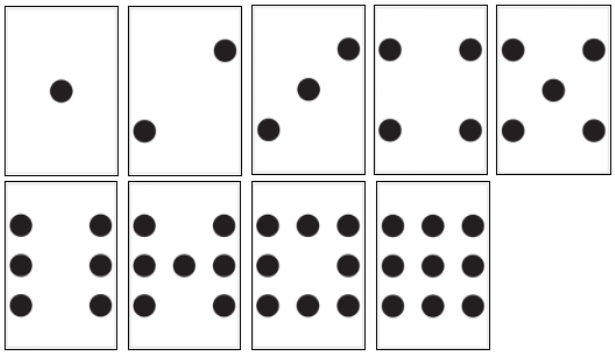


Figure 16: Complete Set of Dot Cards

Figure 17 shows an example order list created by randomly drawing dot cards 7, 6, 4, 8 and 2. The figure also illustrates their placement in Order List Areas 1–5, next to the Workbench. Order List Area 6 always remains empty in this mission.

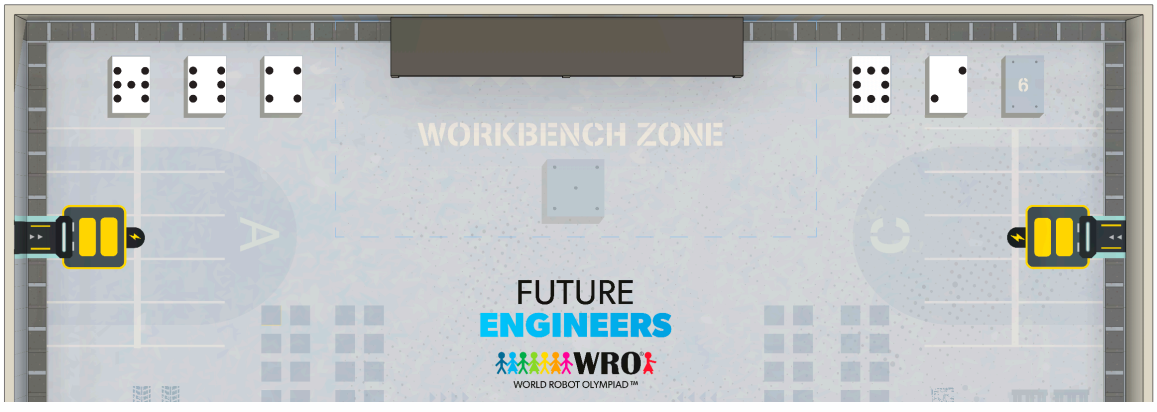


Figure 17: Example Order List and Dot Card Placement

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Based on the dot cards drawn in the example shown in Figure 17, Figure 18 illustrates the corresponding mission setup. The boxes that the robot must retrieve from the Rack units and transport to the Workbench are marked with green circles.

The remaining boxes, marked with black circles, must stay in their original positions on the Racks.

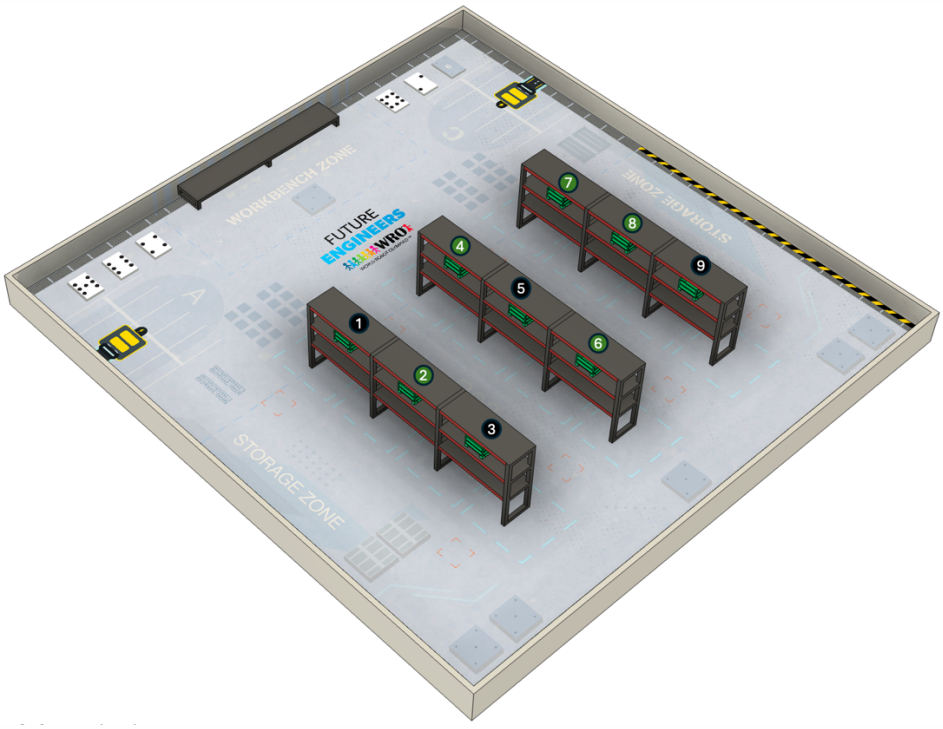


Figure 18: Example of the mission setup.
The boxes to be retrieved and transported to the Workbench are marked with green circles.

3.2.2. Mission Tasks

Before the start of the round, the team may choose either Charging Station as the robot's starting position. The robot must be positioned according to the requirements defined in Section 2.8.

After the robot has been started, it must autonomously:

- navigate to the Order List Areas
- read the order list
- identify the five requested rack units
- navigate through the Smart Warehouse field
- retrieve only the requested boxes from the racks
- transport them to the Workbench
- place them on the upper surface of the Workbench
- return to either Charging Station

The robot may retrieve and transport the requested boxes in any order. The Charging Station used at the end of the round does not need to be the same as the Charging Station at the start.

Teams are not allowed to manually enter the selected rack unit numbers or any information from the order list into the robot after the randomization procedure has been completed.

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3.2.3. Scoring

Scoring Table - Senior Mission 2	Point value	Total available
Robot completely leaves the starting Charging Station	1	1
Requested box removed from a Rack	3	15
Unrequested box remains in its original position on the Rack*	1	4
Workbench and Storage Zones		
At least one requested box is completely inside the Workbench Zone (even if the box is not upright).	10	10
At least one requested box is completely outside the Storage Zone (even if the box is not upright).	10	10
Requested Box Delivery		
Requested Box completely placed on the Workbench	10	50
Requested Box partially placed on the Workbench	5	25
Requested Box placed upright anywhere on the game mat	2	10
Finishing Position (points are awarded if at least one point is scored in the mission tasks above)		
Robot successfully parked at a Charging Station	10	10
Surprise Rule		
Total points available from the Surprise Rule	50	50
The team performed repairing actions by taking the robot out of the field even if the actions were not successful.	Total round divided by factor 2	
Maximum Score	150	

** Points are awarded only if the robot has removed at least one requested box from a Rack.*

3.3. Senior Age Group – Overall Scoring

The following table summarizes the maximum points available in the Senior age group:

Competition Component	Maximum Points	Percentage
Senior Mission 1 – Rack Clearance	150	30%
Senior Mission 2 – Order Picking	150	30%
Secret Mission	100	20%
Engineering Documentation	100	20%
Total	**500**	**100%**

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4. Advanced Category Missions

4.1. Advanced Mission 1 – Route Replanning

This mission builds on Senior Mission 2 – Order Picking, with one additional challenge. Two warehouse aisles are temporarily closed using Maintenance Cones. The robot must autonomously detect the blocked aisles, select an alternative route and complete the order-picking task.

4.1.1. Field Setup and Randomization

The field setup and order list randomization described in Section 3.2.1 (Senior Mission 2 – Order Picking) also apply to this mission.

In addition, before each competition round, two warehouse aisles are randomly selected and closed using maintenance cones.

Figure 19 shows the numbering of the warehouse aisles used for the randomization procedure.

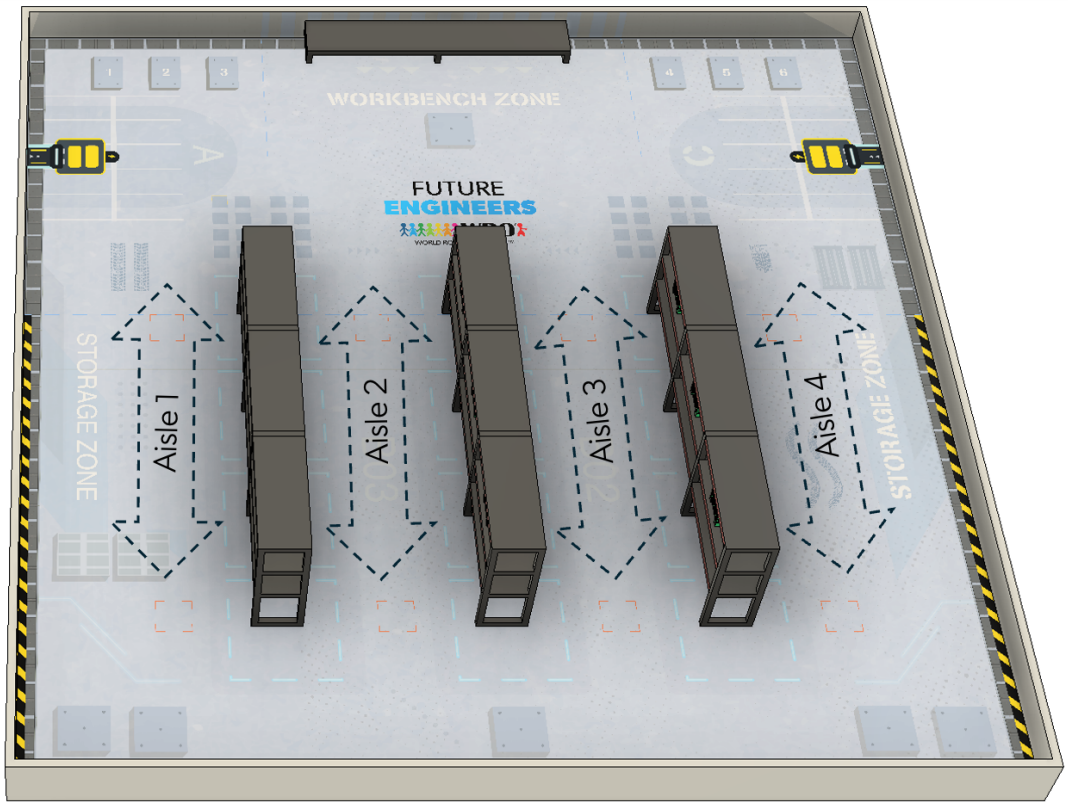


Figure 19: Warehouse Aisle Numbering

Maintenance Cones

Each Maintenance Cone has an overall height of 120 mm and base dimensions of 85 × 85 mm, as shown in Figure 20. For details on the official 3D-printing files, see Appendix B.

The Maintenance Cones are orange (HEX #FFBD3B) with two white stripes. At all International Events, the orange parts will be 3D printed using HP Robots FastPLA filament. National Organizers may use

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equivalent filament for their own events, but the orange color should be as close as reasonably possible to the official reference color.

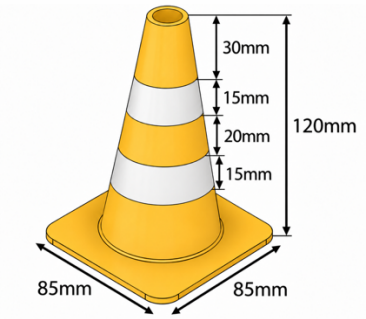


Figure 20: Dimensions of the Maintenance Cone

Blocked Aisle Randomization

Before each round, either Aisle 2 or Aisle 3 is randomly selected as the first blocked aisle. The second blocked aisle is then determined so that every Rack row remains accessible from at least one side:

- if Aisle 2 is selected, Aisle 4 is also blocked
- if Aisle 3 is selected, Aisle 1 is also blocked.

In the example shown in Figure 21, Aisle 3 was randomly selected. Therefore, Aisle 1 is also blocked. Two Maintenance Cones are placed in each blocked aisle, within the dashed orange squares marked on the game mat, resulting in a total of four cones. This arrangement keeps all three Rack rows accessible from at least one side.

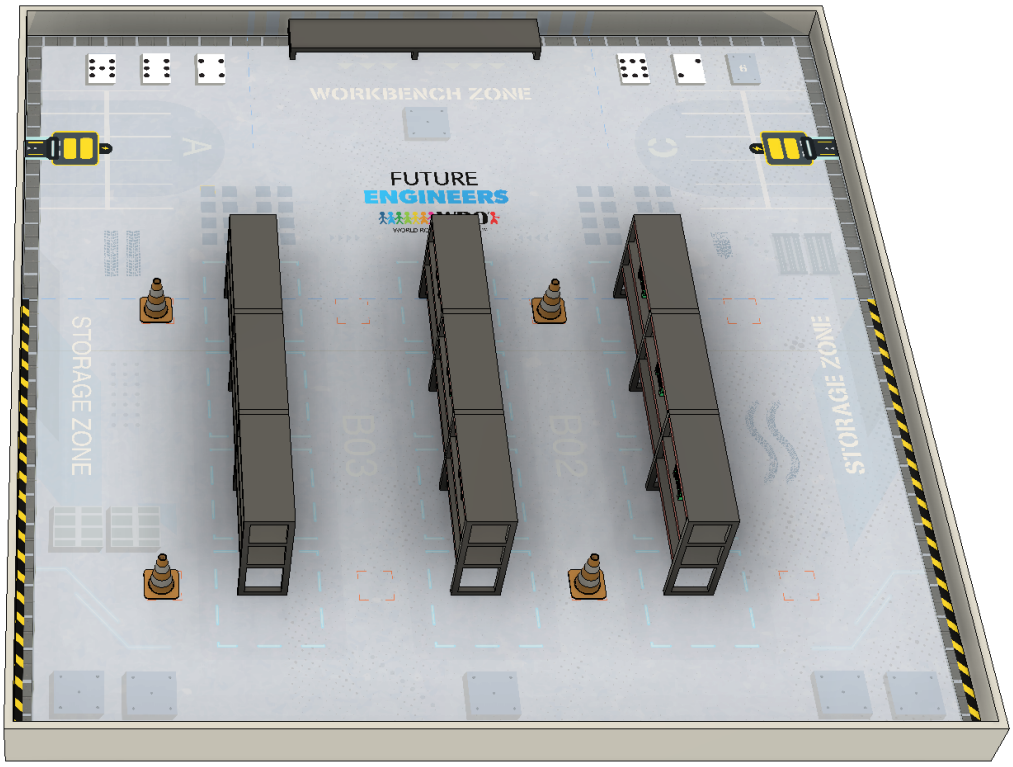


Figure 21: Example of blocked aisle randomization

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Starting Charging Station Randomization

Before each round, either the left or the right Charging Station is randomly selected as the robot's starting position. The robot must start from the selected Charging Station.

4.1.2. Mission Tasks

Before the start of the round, the robot is placed at the Charging Station selected through the randomization procedure. The robot must be positioned according to the requirements defined in Section 2.8.

After the robot has been started, it must autonomously:

- navigate to the Order List Areas
- read the order list
- identify the five requested Rack units
- detect the two blocked warehouse aisles
- select an alternative route
- navigate through the Smart Warehouse field
- retrieve only the requested boxes from the Racks
- transport them to the Workbench
- place them on the upper surface of the Workbench
- return to either Charging Station

The robot is not allowed to pass through a blocked aisle or interact with Rack units from the blocked side. This restriction also applies to Aisles 1 and 4, even if there appears to be enough space for the robot to pass without touching the Maintenance Cones. The robot is also not allowed to pass over the cones or intentionally move them.

The robot may touch a Maintenance Cone without ending the run, provided that the cone remains upright and at least part of it remains within or touching its designated dashed orange square on the game mat.

The judge stops the run immediately if the robot enters a blocked aisle, passes over a Maintenance Cone, knocks over a cone, or moves a cone completely outside its designated square. A fallen cone ends the run even if it remains within or touching its designated square. The score is calculated based on the positions of the robot and game objects at that moment.

The robot may retrieve and transport the requested boxes in any order. The Charging Station used at the end of the round does not need to be the same as the starting Charging Station.

Teams are free to determine their own navigation, manipulation and delivery strategy, provided that the robot complies with all general and mission-specific rules.

Teams are not allowed to manually enter the selected order list or the blocked aisle configuration into the robot after the randomization procedure has been completed. All information required to complete the mission must be obtained autonomously by the robot during the round.

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4.1.3. Scoring

Scoring Table - Advanced Mission 1	Point value	Total available
Robot completely leaves the starting Charging Station	1	1
Requested box removed from a Rack	3	15
Unrequested box remains in its original position on the Rack*	1	4
Workbench and Storage Zones		
At least one requested box is completely inside the Workbench Zone (even if the box is not upright).	10	10
At least one requested box is completely outside the Storage Zone (even if the box is not upright).	10	10
Requested Box Delivery		
Requested Box completely placed on the Workbench	10	50
Requested Box partially placed on the Workbench	5	25
Requested Box placed upright anywhere on the game mat	2	10
Finishing Position (points are awarded if at least one point is scored in the mission tasks above)		
Robot successfully parked at a Charging Station	10	10
Surprise Rule		
Total points available from the Surprise Rule	50	50
The team performed repairing actions by taking the robot out of the field even if the actions were not successful.	Total round divided by factor 2	
Maximum Score	150	

** Points are awarded only if the robot has removed at least one requested box from a Rack.*

The box placement scoring conditions described in Section 3.1.3 also apply to this mission.

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4.2. Advanced Mission 2 – Product Classification

In this mission, four non-empty boxes are placed on the Workbench. Each box contains a product of a specific type. The robot must autonomously identify the product inside each box and transport the boxes to the correct Rack units while avoiding the maintenance cones blocking the warehouse aisles.

4.2.1. Field Setup and Randomization

Workbench Setup

Before each competition round, four empty boxes are placed upright on the upper surface of the Workbench, with their open sides facing upward. The boxes are arranged in a single row, with a distance of 80 mm between adjacent boxes and a clearance of 10 mm from both the front and rear edges of the Workbench, as shown in Figure 22. The boxes are identified as Box 1 to Box 4, from left to right.

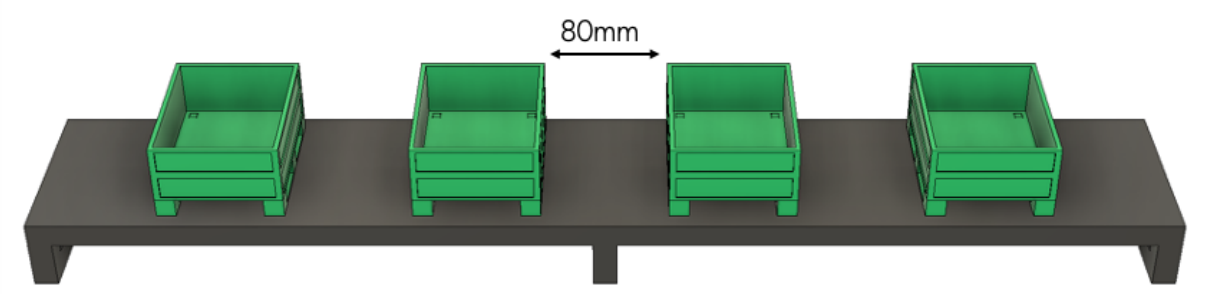


Figure 22: Initial placement of boxes on the Workbench

Product Objects

Three different types of 3D-printed product objects are used in this mission:

1. **Cylinder:** 2 cylindrical objects.
2. **Pyramid:** 2 pyramid-shaped objects.
3. **Rectangular block:** 2 rectangular blocks.

Two identical objects of each product type are available for the randomization, resulting in a total of six product objects. The three product types are shown in Figure 23.

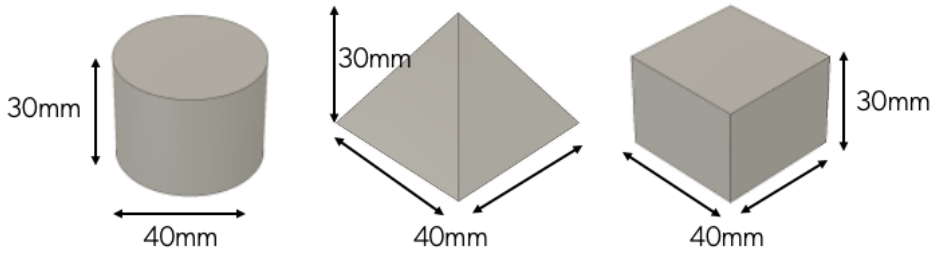


Figure 23: Product objects used in Advanced Mission 2 – Product Classification

All product objects are silver (HEX #E6E6E6). At all International Events, the product objects will be 3D printed using HP Robots FastPLA filament. National Organizers may use equivalent filament for their own events, but the color should be as close as reasonably possible to the official reference color.

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Product Placement Randomization

Before each round, the product objects placed in Boxes 1 to 4 on the Workbench are randomized. Six product objects are available:

- two cylinders
- two pyramids
- two rectangular blocks

Four of these objects are selected, and one object is placed inside each box. The randomization determines both the four objects used and the box assigned to each object. As a result, each product type may appear zero, one or two times.

Figure 24 shows one possible result of the product placement randomization. In this example, the four selected product objects are two pyramids, one cylinder and one rectangular block. From left to right, Box 1 contains a pyramid, Box 2 contains a cylinder, Box 3 contains a pyramid, and Box 4 contains a rectangular block.

Each product object is placed approximately at the centre of its box, with an orientation similar to that shown in Figure 24. Each product object must rest completely on the bottom surface of the box.

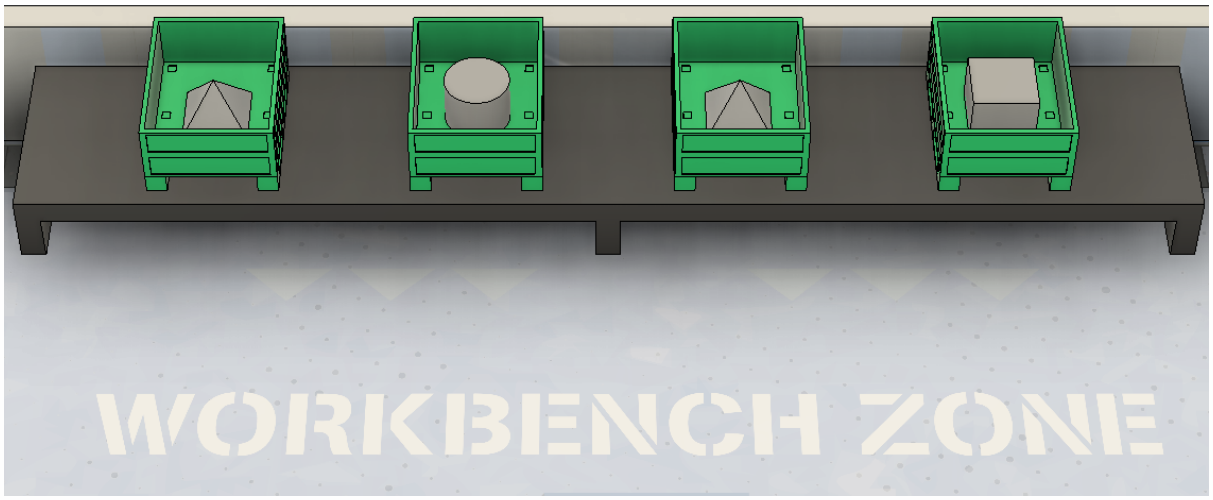


Figure 24: Example of product placement after randomization

Empty Box Placement Randomization

Before each round, three empty boxes are randomly placed on the middle levels of the Rack units. One box is placed in each Rack row:

- one in Rack units 1 to 3
- one in Rack units 4 to 6
- one in Rack units 7 to 9

The randomization determines the Rack unit used within each row. Each box is positioned according to the standard placement described in Section 2.7.1. All other Rack units remain empty.

Figure 25 shows an example setup with three empty boxes placed in Rack units 2, 6 and 7.

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4.2.2. Mission Tasks

Before the start of the round, the two blocked aisles and the robot's starting Charging Station are selected using the same randomization procedures described in Section 4.1.1. Maintenance cones are placed in the selected aisles. The robot must be placed at the selected Charging Station and positioned according to the requirements defined in Section 2.8.

In this Mission, the robot must place the four boxes located on the Workbench in the correct Rack units according to the following rules:

- Boxes containing a **rectangular block** must be placed on the unoccupied middle level of one of Rack units 1 to 3.
- Boxes containing a **cylinder** must be placed on the unoccupied middle level of one of Rack units 4 to 6.
- Boxes containing a **pyramid** must be placed on the unoccupied middle level of one of Rack units 7 to 9.

Figure 25 illustrates an example of the initial placement of all game objects before the mission begins. Note the labels identifying the three Rack rows according to the product types they are intended to store.

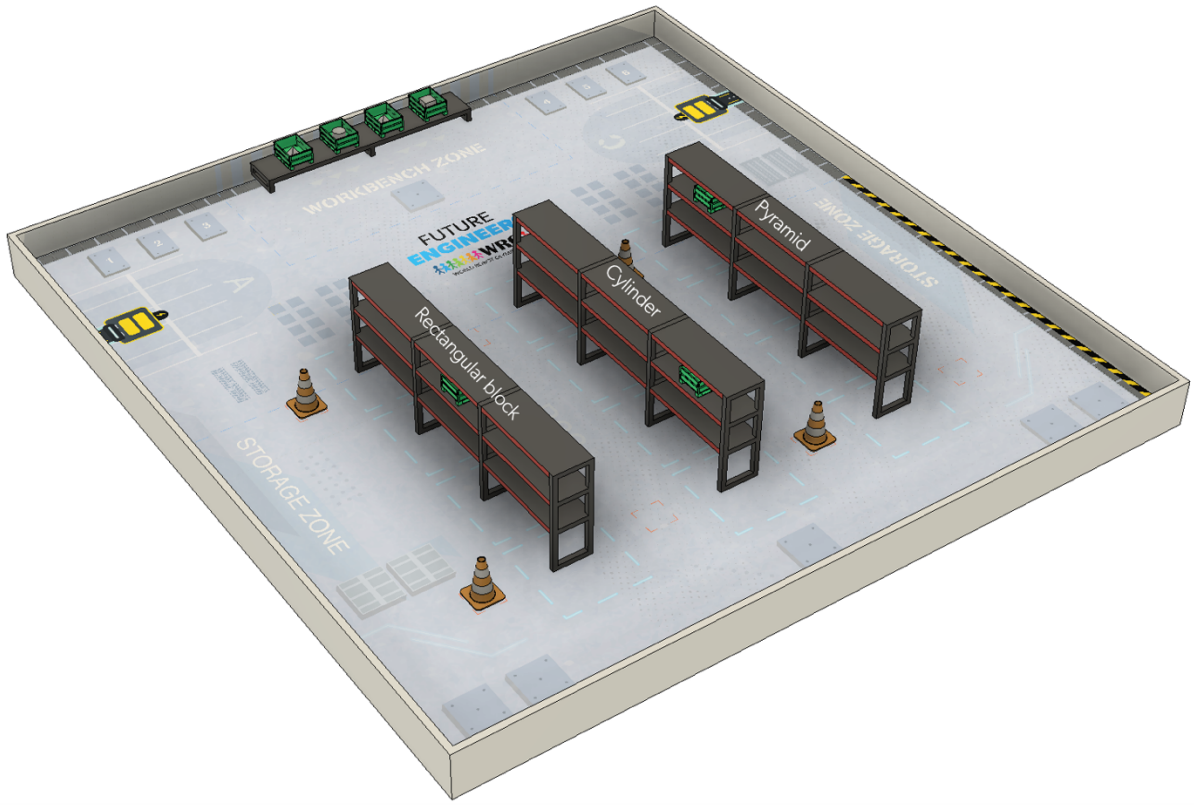


Figure 25: Example of the initial game field setup for Advanced Mission 2 – Product Classification, showing the placement of all game objects and the designated Rack rows for each product type.

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After the robot has been started, it must autonomously:

- navigate to the Workbench
- identify the product object contained in each box
- remove the boxes from the Workbench
- detect the blocked warehouse aisles
- select an alternative route
- transport each box to the corresponding Rack row
- place each box on the middle level of an unoccupied Rack unit in the correct Rack row
- leave the three boxes initially placed on the racks in their original positions
- avoid moving the maintenance cones
- return to either Charging Station.

The blocked aisle rules defined in Section 4.1.2 also apply to this mission.

The robot may identify, retrieve, transport and place the boxes in any order. When two boxes contain the same product type, both boxes must be placed in the two available Rack units of the corresponding Rack row.

For Rack placement scoring, a box must be upright, fully released by the robot, and resting directly on the correct Rack level, with its product remaining inside. A box is considered completely placed when its entire base is supported by the Rack level and partially placed when only part of its base is supported.

The Charging Station used at the end of the round does not need to be the same as the starting Charging Station.

Teams are not allowed to manually enter the product configuration, rack box positions, blocked aisle configuration or starting Charging Station into the robot after the randomization procedure has been completed. All information required to complete the mission must be obtained autonomously by the robot during the round.

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4.2.3. Scoring

Scoring Table - Advanced Mission 2	Point value	Total available
Robot completely leaves the starting Charging Station	1	1
Empty box remains in its original position on the Rack*	3	9
Workbench and Storage Zones		
At least one box containing a product is completely outside the Workbench Zone (with the product remaining inside the box).	10	10
At least one box containing a product is completely inside the Storage Zone (with the product remaining inside the box).	10	10
Requested Box Delivery (the product must remain inside the box in all cases)		
Box completely placed on the correct Rack row and level	15	60
Box partially placed on the correct Rack row and level	10	40
Box placed upright anywhere on the game mat	5	20
Finishing Position (points are awarded if at least one point is scored in the mission tasks above)		
Robot successfully parked at a Charging Station	10	10
Surprise Rule		
Total points available from the Surprise Rule	50	50
The team performed repairing actions by taking the robot out of the field even if the actions were not successful.	Total round divided by factor 2	
Maximum Score	150	

** Points are awarded only if the robot has placed at least one box containing a product at least partially on the correct Rack row and level.*

4.3. Advanced Age Group – Overall Scoring

The following table summarizes the maximum points available in the Advanced age group:

Competition Component	Maximum Points	Percentage
Advanced Mission 1 – Route Replanning	150	30%
Advanced Mission 2 – Product Classification	150	30%
Secret Mission	100	20%
Engineering Documentation	100	20%
Total	**500**	**100%**

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Appendix A – Adapting Two RoboMission Tables

The Smart Warehouse field can be constructed by reusing two standard WRO RoboMission tables. The tables do not need to be permanently modified, and their existing border walls do not need to be removed.

Step 1: Position the Two RoboMission Tables

Place two standard RoboMission tables side by side, with their long sides aligned. Each table has an internal playing area of approximately 2362 mm × 1143 mm.

Together, the two tables provide the dimensions required for the Smart Warehouse playing area:

- Length: 2362 mm
- Width: 2286 mm

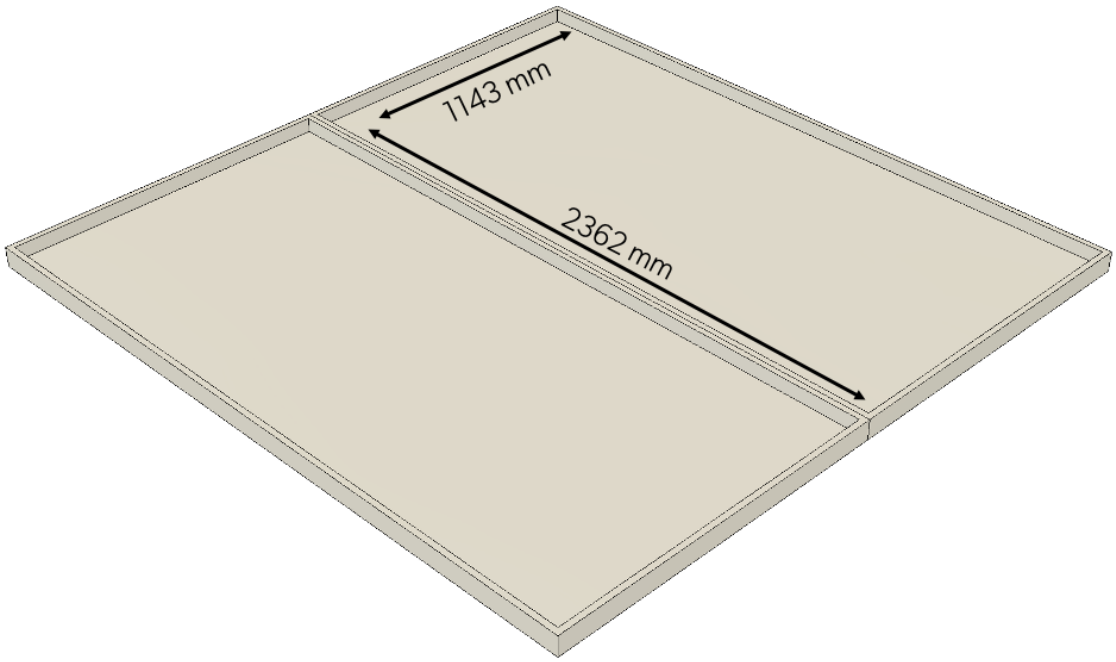


Figure 26: Two standard RoboMission tables placed side by side

Step 2: Turn Over and Connect the Tables

Turn both tables upside down so that their existing border walls face downward. The reverse sides of the tables form the supporting surface for the Smart Warehouse field.

Place the inverted tables directly next to each other and align all outer edges. Securely connect or fix the tables so that they cannot separate or move during a round.

The surfaces must be level and must form one continuous supporting area. The connection between the tables must not create a significant gap, ridge or difference in height.

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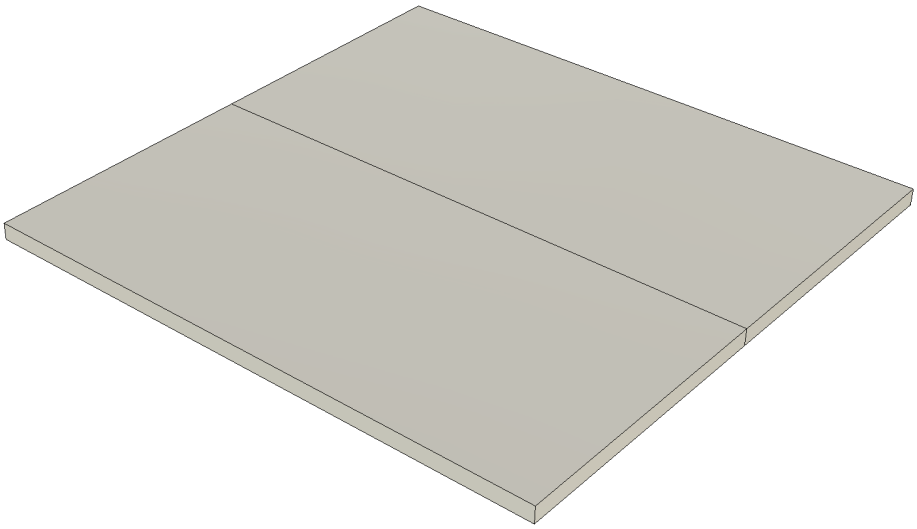


Figure 27: The two RoboMission tables turned upside down and connected to form the supporting surface of the Smart Warehouse field

Step 3: Install the New Border Wall

Construct a new border frame and place it around the two inverted tables.

The frame must provide a clear internal playing area of 2362 mm × 2286 mm. The walls must extend 100 mm above the playing surface.

The external dimensions of the new frame may be smaller than the overall outer dimensions of the two inverted tables, depending on the thickness of their original border walls. In this case, a small part of the supporting table surface may remain outside the new wall. This is acceptable, provided that:

- the clear internal playing area is exactly 2362 mm × 2286 mm
- the perimeter walls do not extend into the required playing area
- the frame is stable and cannot move during a round
- the complete game mat is flat and fully supported

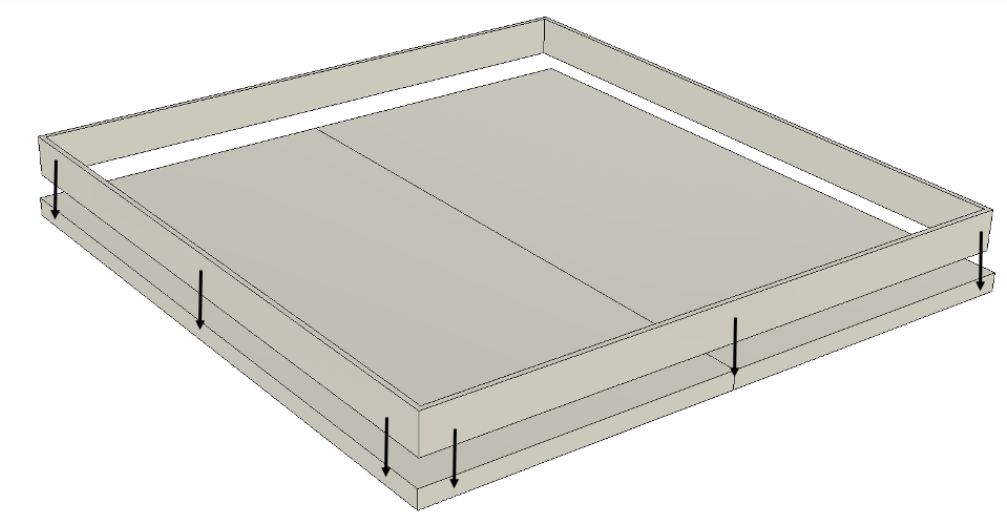


Figure 28: Installation of the new border wall around the two inverted RoboMission tables

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Appendix B – Game Materials and Resources

The Smart Warehouse rules are accompanied by external files for constructing and preparing the official game field and game objects.

The latest versions of all downloadable game materials will be available on the official WRO website, on the Future Engineers – Smart Warehouse page.

Game Field Files

- Smart Warehouse Game Mat
- Dot Cards: The cards can be printed on thick white A4 cardstock (recommended weight: 200–250 gsm) and cut out individually.

3D-Printed Game Objects

Object	Weight (approx.)	Colors	Quantity	Age group
Rack Row	No restriction	Black and Red (#CE4A4A)	3	Senior / Advanced
Workbench	No restriction	Black	1	Senior / Advanced
Open Box	~63 gr	Green (#00D072)	9	Senior / Advanced
Maintenance Cone	~47 gr	Orange (#FFBD3B) and White	4	Advanced
Cylinder	~13 gr	Silver (#E6E6E6)	2	Advanced
Pyramid	~8 gr	Silver (#E6E6E6)	2	Advanced
Rectangular block	~16 gr	Silver (#E6E6E6)	2	Advanced

Some 3D-printed game objects are divided into multiple parts, depending on their size, to allow printing with standard 3D printers. Assembly instructions for these objects are available at the following link: https://link.wro-association.org/future-engineers-box

At International Events, all 3D-printed game objects will be manufactured using HP Robots FastPLA filament.

Official Smart Warehouse Box – HP Robots

Teams wishing to purchase the **official Smart Warehouse Box**, containing all required 3D-printed game objects, can place an order directly with HP Robots. The ordering link is available on the official WRO website, on the Future Engineers – Smart Warehouse page.

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