

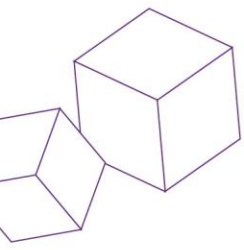
TEST PROJECT MOBILE ROBOTICS

WSA2022_TP23 EN

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Submitted by: James Taylor
Member Country or Region: Canada



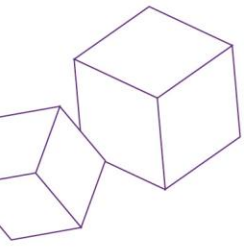


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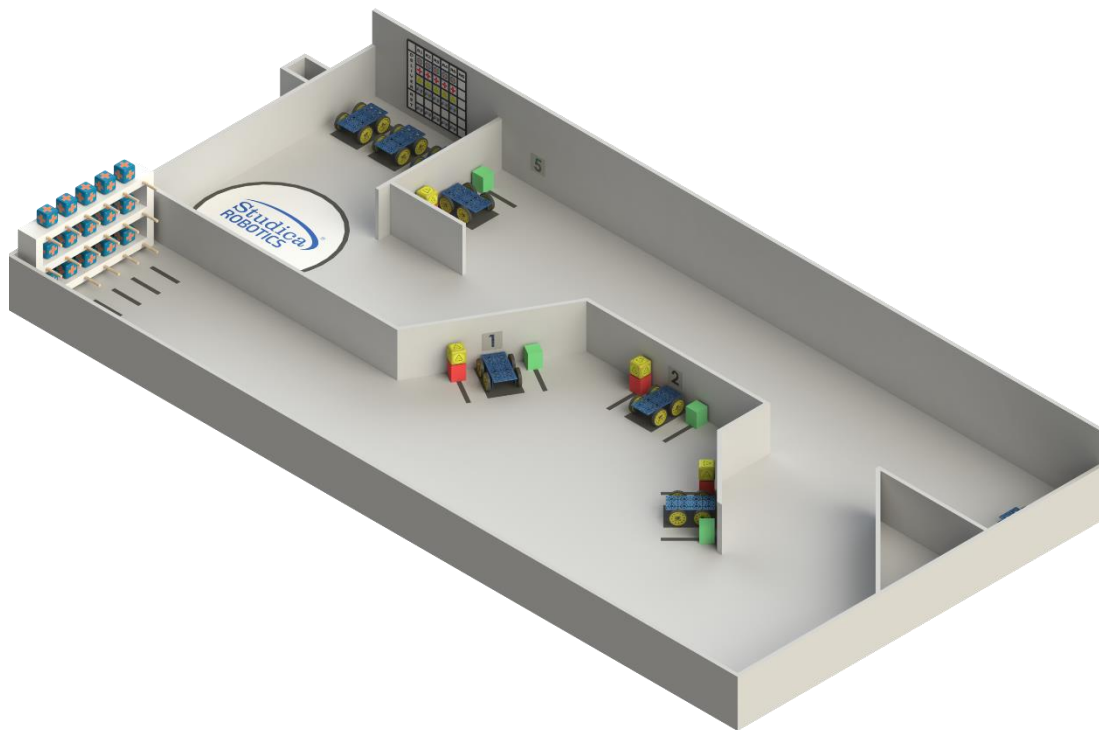


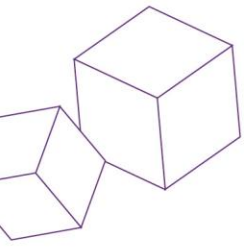


1. INTRODUCTION

Mobile Robots are playing an increasing role in supporting medical staff in hospital settings. Amongst other responsibilities, Mobile Robots are used to manage the distribution of essential items in a hospital environment. The WorldSkills Asia 2022 Mobile Robotics Test Project requires competitors to Design, Build and Operate a Mobile Robot capable of addressing ALL the performance requirements set by the Asia Hospital Network.

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2. DESCRIPTION OF PROJECT AND TASKS

Teams of two students / competitors are required to design and build a mobile robot that will efficiently operate in a simulated hospital environment.

The robot must be built to function autonomously.

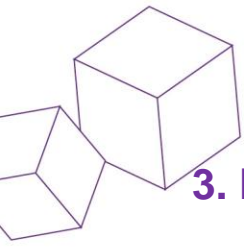
Competitors are expected to identify the Primary Set of Mobile Robot Performance Requirements through analysis of the information provided in this document:

1. Robots are required to Read / Interpret information presented through a Work Order Board in the performance environment,
2. Robots are required to Move in Autonomous Control Mode throughout the provided performance evaluation environment, and,
3. Robots are required to Take control of the various target objects (Cubes) from different initial locations and deliver them to various destination locations in the performance environment.

Note: On Competition Day 1 Session 1, when the focus is on Individual Robot Performance Elements, the robots will need to function/complete all the Individual Evaluated Performance Elements in Autonomous Control Mode.

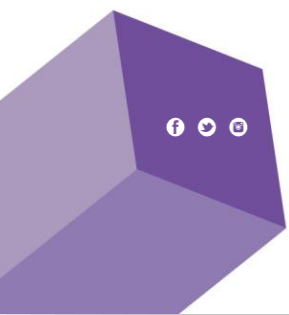
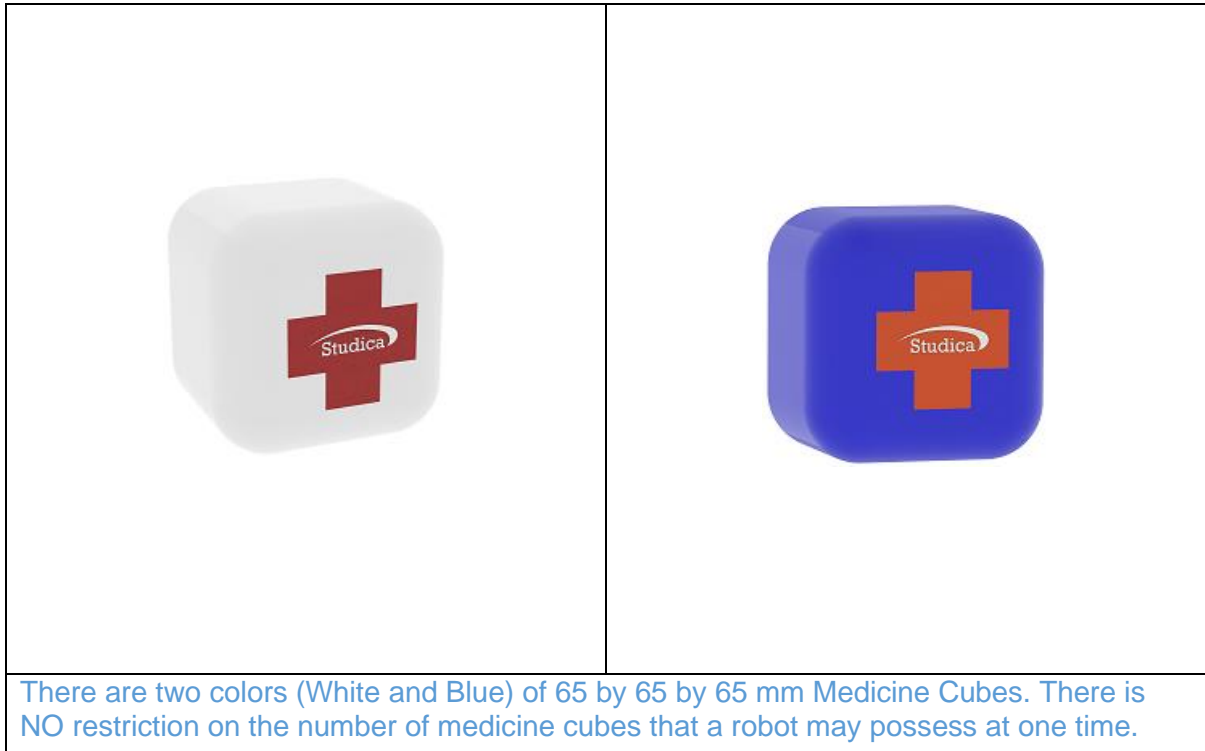
The performance environment detailed in this document will be the performance environment used on C1 Session 1 through to C2 Session 2. C1 Session 1 - Core Robot Performance Evaluation Day. C1 Session 2, C2 Session 1 & 2 are Competition Days.

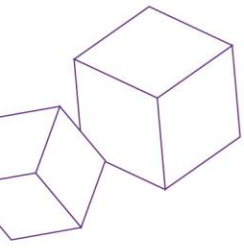




3. INSTRUCTIONS TO THE COMPETITOR

There are FOUR Target/Obstacle Objects with which the Mobile Robots must interact.



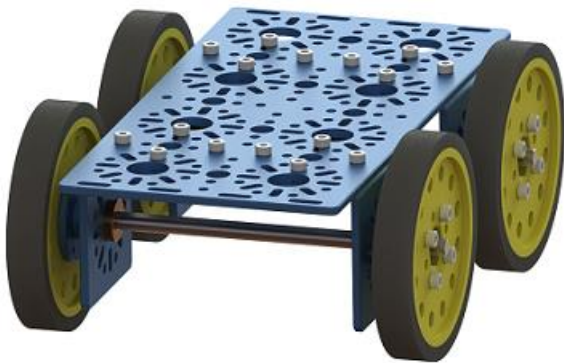


Hazardous Material Cubes are Yellow 65 by 65 by 65 mm cubes.

HazMat Cubes located on stands in Patient Rooms are 'Contaminated Hazmat Cubes.'

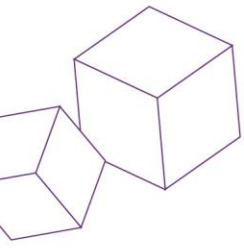
There are Two Rules related to Contaminated Hazmat Cubes:

1. Robots cannot be in possession of either Medicine Cubes at the same time they are in possession of a Contaminated Hazmat Cube.
2. AFTER a robot has completed handling a Hazmat Cube(s), it MUST return to the Home Area and position itself on the 650 mm Dia. Sanitization Pad and Rotate through 540 Degrees BEFORE handling medicine Cubes.



Robots will be required to handle gurneys.

1. A gurney may be required to be delivered from the storage area to a hospital room.
2. A gurney may be required to be retrieved from a hospital room and placed in the storage area.



Robot Work Expectations are defined through the Work Order Board mounted on a wall, but it also expects the Robot to 'Interpret its environment' and take Independent Actions under specific circumstances.

- The Work Order Board will identify the patient rooms to which the robot is expected to deliver White/Blue Medicine Cubes and Gurneys.
- The Work Order Board may also request a Gurney to be retrieved from a hospital room and placed on one of the storage pads.
- If a robot detects the presence of a HazMat Cube in a room. The robot is expected to take control of the Contaminated HazMat Cube and deliver it into the HazMat Material Bin.

The Work Order Board

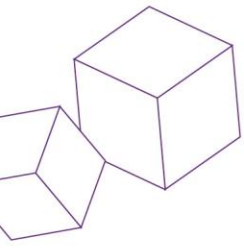
In Evaluated Test Project Runs, where the robot does not know the work details in advance, the robot needs to travel to the location of the 'Work Order Board' and 'Read the Board' to determine what it must do.

There are NO restrictions on the number of times a robot can return to 'Read' the Work Order Board during an individual evaluated test project run.

The following image explains how the robot is to interpret the Work Order Board for WSA 2022.

	R1	R2	R3	R4	R5	NS	Room Number to be serviced
D E L I V E R							Blue cube deposit location retrieved from dispensary shelf
							White cube deposit location retrieved from dispensary shelf
R E T							Gurney deposit location retrieved from storage area
							Starting position for gurney that must be returned to storage area

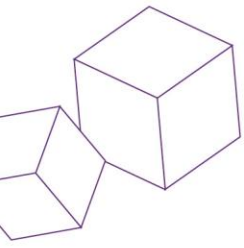




Each session, competitors will receive instructions on the order board and shelving configuration for that session. NOTE: Right before the competitors run, they will be told where the hazardous cubes will be placed. This will ensure that the hazmat cubes are being detected via vision.

An example session is included for testing purposes.





4. EQUIPMENT, MACHINERY, INSTALLATIONS, AND MATERIALS REQUIRED

1. All competitors will use a VMX and Titan. All other components must be Studica Robotics equipment or sensors. There is no restriction on the number of components used except for 3D printed and Polycarbonate materials.

The Studica Robotics section described at: <https://www.studica.co/shop> will serve as the equipment source for competitors attempting this Test Project.

4.1 Additional Components Restrictions

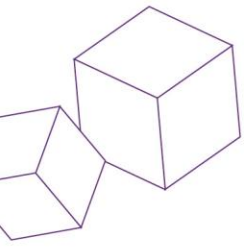
Maintaining an equal level of access to resources is an essential requirement for maintaining an equal level of opportunity for success on the part of all Competitors.

All ready-to-use performance or related structural components must be obtained through Studica to ensure compatibility with the 2022 WorldSkills Mobile Robotics Component Collection.

Competitors can incorporate "Competitors Designed / Created Components" into their robot design based on the following restrictions:

- a. All sheet-based elements must be created using any polycarbonate material with a maximum overall sheet size of 1000mm by 1000mm by 4mm thick. This should be proved in the Technician's Journal, along with a visual evaluation.
- b. ALL 3D-Printed elements must be created using ABS, PLA, Nylon, PETG, HIPS, ASA, or Carbon Filled Fibre with a maximum overall weight of 1.2 kg. This should be proved in the Technician's Journal, along with a visual evaluation.
- c. The Challenge Evaluation Process will assign marks based on compliance with these restrictions.
- d. In their Technician's Journal, competitors must include a description of the creation process (Task Analysis Stage / Design Stage / Fabrication Stage) for all 'Competitor created custom components.'





4.2 Other Required Components

Gurneys (Available through Studica)

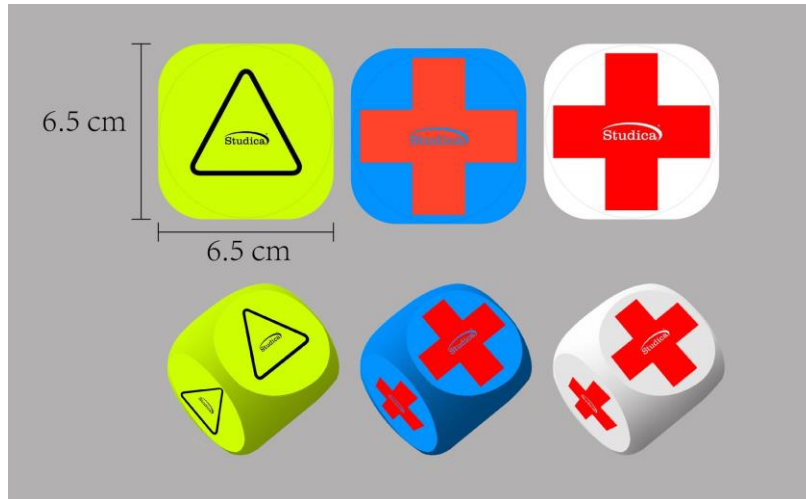
<https://www.studica.co/shanghai-gurney>

NOTE: Cad file available above so teams can create their own non-official version for training and local use.

Gurney #75102		
Qty	Product	Part #
1	192mm x 96mm Flat Bracket	76066
2	L Bracket (2 pack)	76087-2
2	6mm x 140mm D-Shaft	76164
4	Bronze Bushing 6mm ID x 14mm OD	76301
4	75mm Drive Wheel - 60A, 12.5mm wide, 1/2" Inner Hex, Black	76271
1	Shaft Spacer Plastic 6mm ID x 10mm OD x 1mm L (24 pack)	76305-24
1	6mm Shaft Hub (4 pack)	76284-4
1	M3 Kep Nut (pack of 100)	76204-100
1	M3 x 10mm Socket Head Cap Screw (pack of 100)	76201-100

Target Object Cube Sets (Available through Studica)

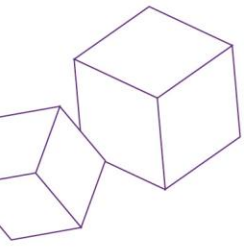
Shanghai Challenge Elements - 15 pack



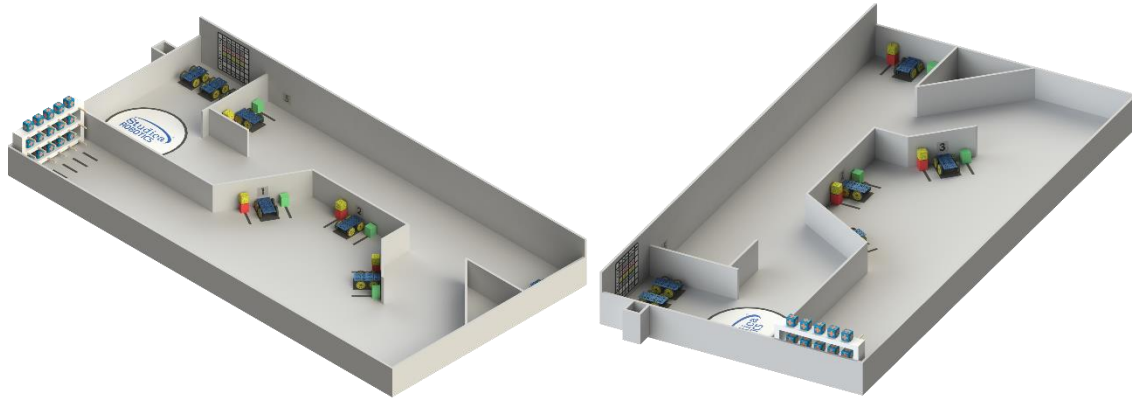
<https://www.studica.co/shanghai-challenge-elements-5-pack>

NOTE: 65MM X 65MM Cubes can be used locally, graphics are available for download,





4.3 Court Design and Layout



Core Court

Found in the attached drawing files.

Dispensary Shelving Unit

Found in the attached drawing files.

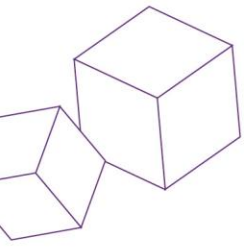
Cube Pads and Gurney Stands

Found in the attached drawing files.

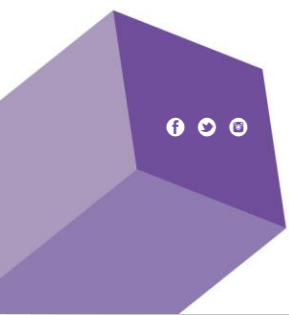
Court Tape Lines

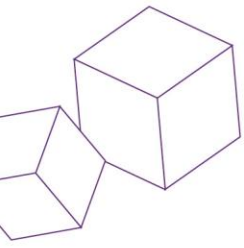
The court Tape Lines will be created using Black Tape – 19mm (3/4")





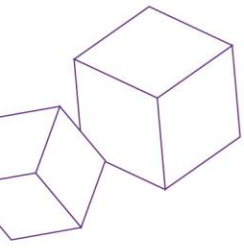
Patient Room	1
Patient Room	2
Patient Room	3





<p>Patient Room</p>	<p>4</p>
<p>Patient Room</p>	<p>5</p>

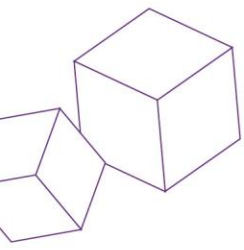




Hazardous Material Bin

Home Sanitation Station





5. MARKING SCHEME

All Competitor Assessment experiences will be conducted in compliance with the WorldSkills ASIA Computer Information System (CIS) Guidelines. The overall marking pattern is based directly on "Section 2.2 WorldSkills Standards Specification" stipulated in the Technical Description. The essential details defining the categories are listed below:

A Technical Journal (Communication and Interpersonal Skills)	10	Marks Total
B Robot Inspection (Design, Prototyping and Assembly)	8	Marks Total
D Core Robot and Object Management System Evaluation	10	Marks Total
E Test Project evaluation Run 1	24	Marks Total
F Test Project evaluation Run 2	24	Marks Total
G Test Project evaluation Run 3	24	Marks Total

11.1 Technical Journal Sub Criterion A

Are required to be submitted on C-1. All marking will be conducted by groups of 3 assigned experts using WorldSkills' CIS.

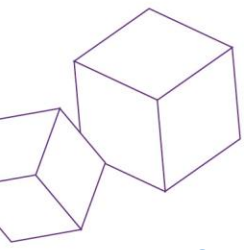
Definition and Task Analysis	1
Bill of Materials	1
Overall Quality of the Assembly Drawing	1
Robot Design and Design Process	2
Object Management System	2
Electrical System	1
Software Programming Section (Code Development)	1
Summary	1

11.2 Robot Inspection (Design, Prototyping, and Assembly) Sub Criterion B

Assessment will be based on the video inspection of the Competitors Assembled Robot submitted on Day C-1 by a panel of 3 experts. The focus is on Robot compliance with technical requirements in the following areas/items. There will be a checklist to use for the video.

Wiring	2
Robot Base	3
Object Management System and Structural Elements	3

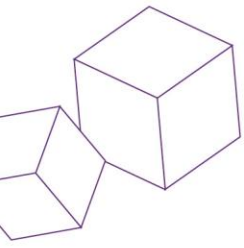




Core Performance Elements

Aspect ID		Core Performance Element Evaluation
D1	Cube Management 1	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and retrieve a cube from the bottom shelf
D2	Cube Management 2	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and retrieve a cube from the middle shelf
D3	Cube Management 3	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and retrieve a cube from the top shelf
D4	Cube Management 4	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and deposit a cube on the bottom shelf
D5	Cube Management 5	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and deposit a cube on the middle shelf
D6	Cube Management 6	The robot will be positioned in the vicinity of the Dispensary Shelves and is required to move into position and deposit a cube on the top shelf
D7	Cube Management 7	The robot will be positioned in the passageway outside a Patients room, IN possession of a cube, and is required to move into the patient room and place the cube on the correct stand
D8	Cube Management 8	The robot must enter a patient room and detect if a hazard cube is present. If no HazMat cube is present, the robot must indicate there is no cube.
D9	Cube Management 9	After completing D8 without touching the robot or computer, a HazMat cube is placed in the patient room. The robot must indicate there is a cube.
D10	Cube Management 10	The robot will be positioned in the passageway outside a Patients room, IN possession of a cube, and is required to move into the patient room and place the cube on a cube already on a designated stand
D11	Cube Management 11	The robot will be positioned in a Patients Room in possession of a HazMat cube and will be required to move to the HazMat Bin and deliver the HazMat cube into the HazMat Bin
D12	Gurney Management 1	The robot will be positioned outside a patient room in possession of a gurney. The robot will be required to place the gurney completely on the gurney pad inside the patient room.
D13	Gurney Management 2	The robot will be positioned outside a patient room, travel into the room, and pick up a gurney.
D14	Gurney Management 3	The robot will be positioned inside a patient room in possession of a gurney. The robot will be required to deliver the gurney to any of the three storage locations in front of the work order board.
D15	Robot Movement Management 1	The robot will be positioned in front of the HazMat Bin and will be required to move onto the cleaning pad and rotate 540 degrees.
D16	Robot Movement Management 2	The robot will be positioned on the cleaning pad and will be required to move to patient room 1
D17	Vision Management 1	The robot will be positioned on the cleaning pad. The robot is required to drive to the order board, read the order board and report the order back to the competitor pc.
D18	Vision Management 2	The robot will be positioned in the vicinity of the Dispensary Shelves. The robot is required to take stock of the cubes on the dispensary shelves and report the stock back to the competitor's pc.
D19	Vision Management 3	The robot will be positioned on the cleaning pad with a single magnet placed on the work order board to indicate the patient room. The robot is required to drive and read the order board. The robot is then required to process the order and drive to the patient room indicated by the order board.
D20	Robot Safety Management 1	The robot will start moving by hitting the start button on the control panel. Once the robot starts moving, the E-Stop should be pressed, and the robot should stop.





1. Sub Criterion D - Core Performance Element Evaluation has a Total Value of 10 Marks. Each evaluation is worth 0.5 marks. While the evaluation focuses on a singular element, each of these experiences involves a small set of support steps required to complete the evaluation performance element. Core evaluation element marking is conducted when the evaluation attempt has been completed and is marked on a Complete/Incomplete Basis. No partial marks will be awarded. The three Experts involved in the marking must agree on the outcome.

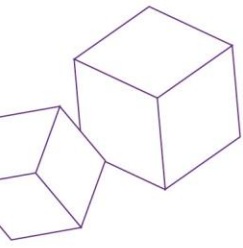
Competitors will be provided with ONE evaluation experience for each of the Core Performance Aspects being marked.

2. Sub Criteria E, F, and G share the following common Marks Distribution Pattern.

- a. The marking process will occur when all uploaded videos have been distributed to the marking panel.
- b. Competitors will have one separate Test Project Runs on competition C1 Session 2, C2 Session 1 & 2.
- c. The robot will use the same hospital layout for each day.
- d. Competitors will have one attempt to complete each of the Evaluated Test Project Runs each competition day.
- e. Evaluated Test Project Runs have a value of 24 Marks each.
- f. Evaluated Test Project Run marks are distributed over the following categories:
 - i. Are Target Objects in the correct locations? Note: The mark value per Target Object will vary depending on the number and type of Target Objects involved in each Evaluated Test Project Run.
 - ii. Time Marks will be available ONLY to competitors whose robot completes all Evaluated Test Project Run elements in less than 601 seconds.
 - iii. Time Marks will be calculated using the following formula:

$$\text{Time Mark Awarded} = (\text{Fastest Team's Time} / \text{Marked Team's Time}) \times \text{Total Available Time Marks}$$
 - iv. In ALL Evaluated Test Project Runs, robots are expected to avoid contaminating clean objects (Cubes / Gurneys). For marking purposes, this means IF a robot is observed, by the three marking Experts, taking possession of a Clean Object AFTER it has been in possession of a Contaminated Cube and WITHOUT traveling to and rotating on the Sani-Pad, then the Experts will END the Evaluated Test Project Run. Competitors will be awarded marks for all work successfully completed before the Evaluated Test Project Run was terminated.





- v. Did the robot complete specific, defined movements such as traveling to and rotating on the Cleaning Pad or returning to the Home Area at the conclusion of the Evaluated Test Project Run

6. DAILY COMPETITION SCHEDULE

The primary goal is to create an Online Competition Experience that as much as possible mirrors a traditional WorldSkills Asia competition experience. Local time schedules will be provided in advance of the competition. These will include a Start of the day Competitor Information / Question and Answer Session / Competitor and Compatriot Expert Communication Session. The competition committee will try to adhere to the following based up

Sample Competitor Schedule Example (Competitor Group 1 – UTC +8)

NOTE: All assessment experiences are done at the same time. This is to introduce the HazMat cube locations right before the assessment. Running simultaneously will prevent any advantages to a team not running at the same time.

Competitor Information / Question and Answer Session 1	8:00am – 8:15am
Competitor and Compatriot Expert Communication Session 1	8:15am – 8:30am
Local Court Time and Task Preparation/Practice Session 1	8:30am – 11:30am
Assessment Experience Window Session 1	11:30 – 11:45 am

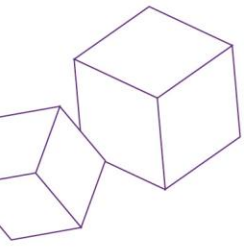
NOTE: While this is a 15-minute window, the maximum time allocated for a complete test run is 10 minutes.

Upload of Test run video complete Session 1	12:30 pm
Break	12:30 pm – 1:00 pm
Competitor Information / Question and Answer Session 2	1:00 pm – 1:15 pm
Competitor and Compatriot Expert Communication Session 2	1:15 pm – 1:30 pm
Local Court Time and Task Preparation/Practice Session 2	1:30 pm – 4:30 pm
Assessment Experience Window Session 2	4:30 pm – 4:45 pm

NOTE: While this is a 15-minute window, the maximum time allocated for a complete test run is 10 minutes.

Upload of Test run video complete Session 2	5:30 pm
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Competition Day 1 Session 1: Competitors have their robot complete Core Performance Evaluation Elements based on a completely known in advance court layout. Competitors will be provided with ONE evaluation experience for each of the Core Performance Aspects being marked.

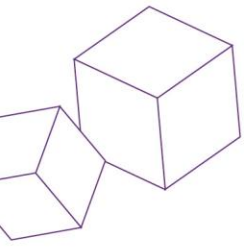
- o Competitor Technician Journals are submitted for evaluation
- o Competitor Robots Inspection Videos are submitted and are Inspected / Evaluated

Competition Day 1 Session 2: Competitors have their robot complete an Evaluated Test Project Run Experience based on a completely known in advance court layout and a set of randomly assigned variables

Competition Day 2 Session 1: Competitors have their robot complete an Evaluated Test Project Run Experience based on a completely known in advance court layout and a set of randomly assigned variables

Competition Day 2 Session 2: Competitors have their robot complete an Evaluated Test Project Run Experience based on a completely known in advance court layout and a set of randomly assigned variables






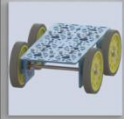



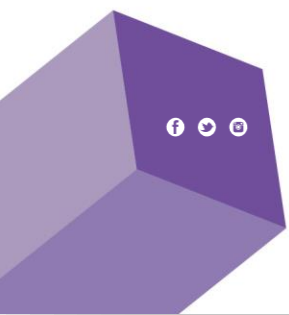


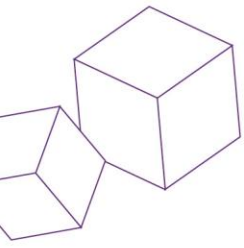
7. EXAMPLE TEST PROJECT RUN

Below is an example run that competitors will receive on C1 Session 1 or C2.

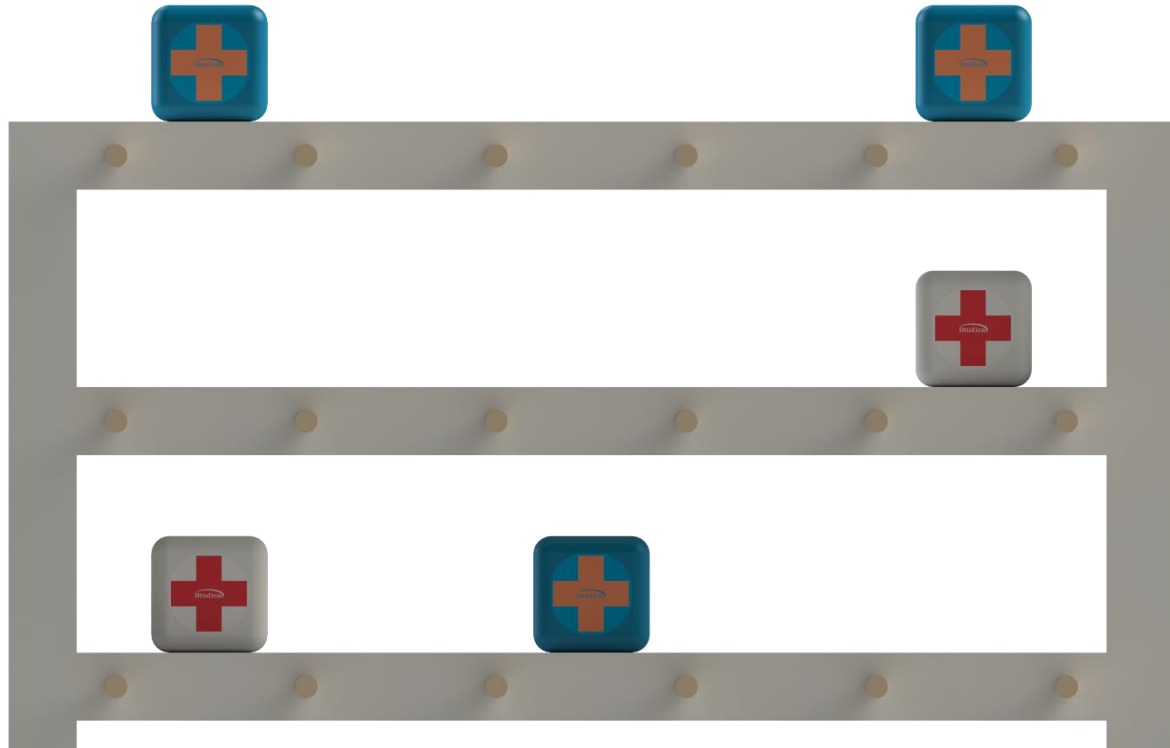
Order Board

	R1	R2	R3	R4	R5	NS
D E L I V E R						
						
						
R E T						

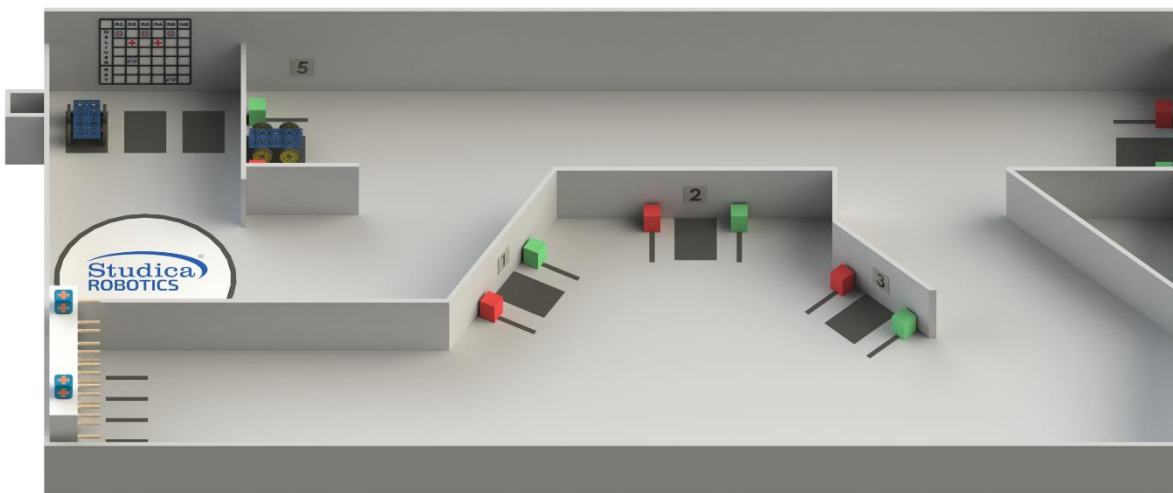


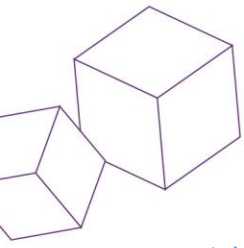


Dispensary Shelf

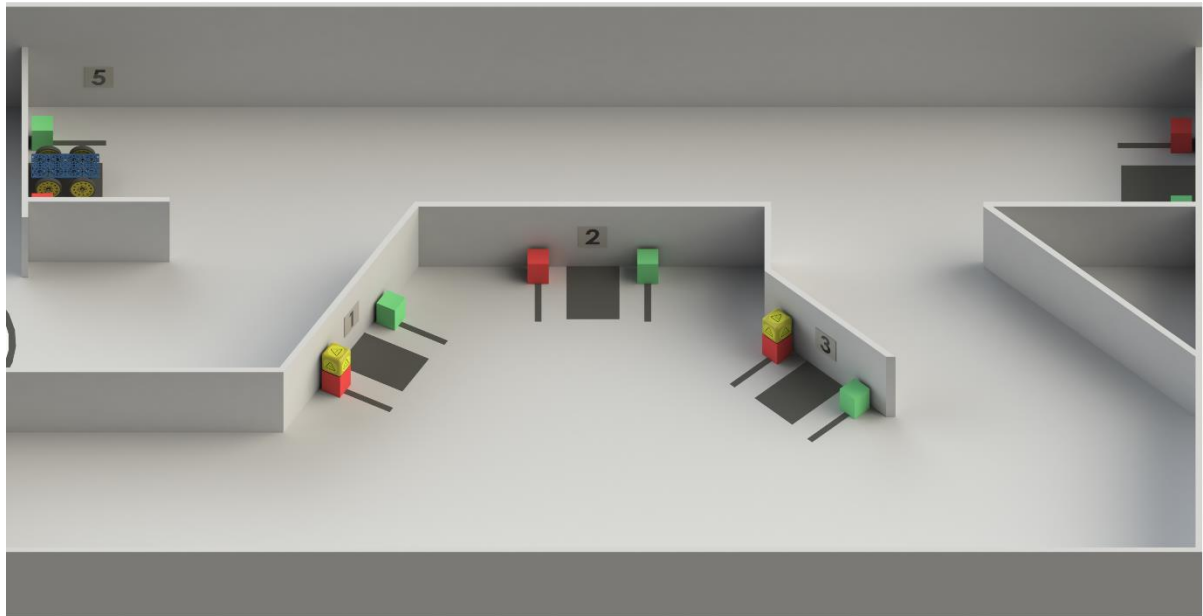


Court Layout

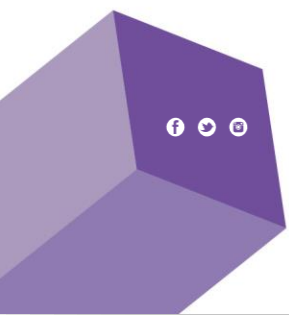




Right before running HazMat Cube locations



HazMat Cubes are located in patient rooms 1 and 3.



4

3

2

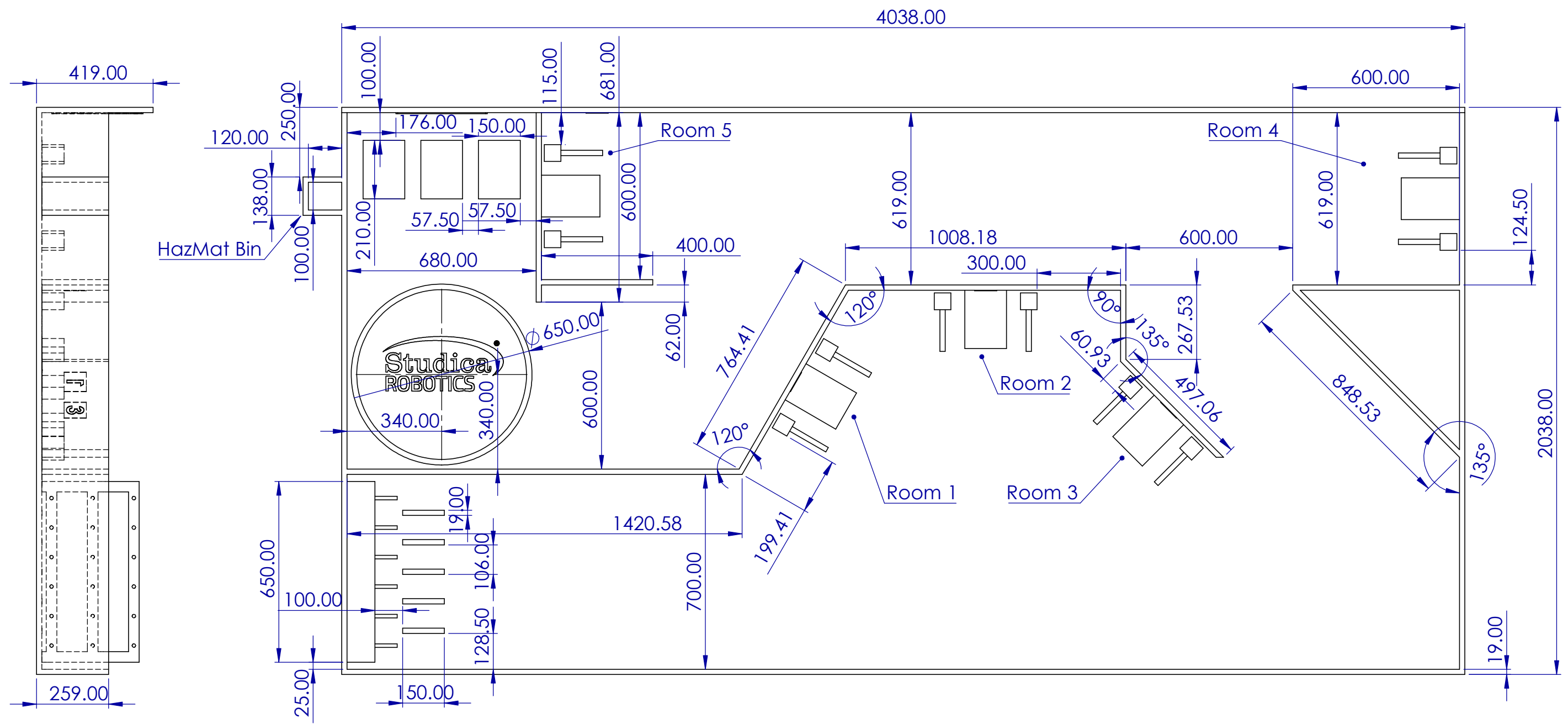
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B

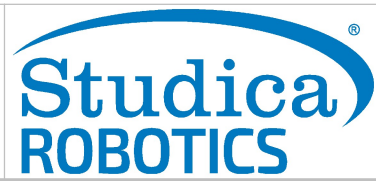
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MATERIAL		COMMENTS:	
FINISH			
DO NOT SCALE DRAWING			

TITLE:			
Court Layout for Asia Skills			
SIZE	DWG. NO.	REV	
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SCALE: 1:50 WEIGHT:			SHEET 1 OF 1

4

3

2

1

4

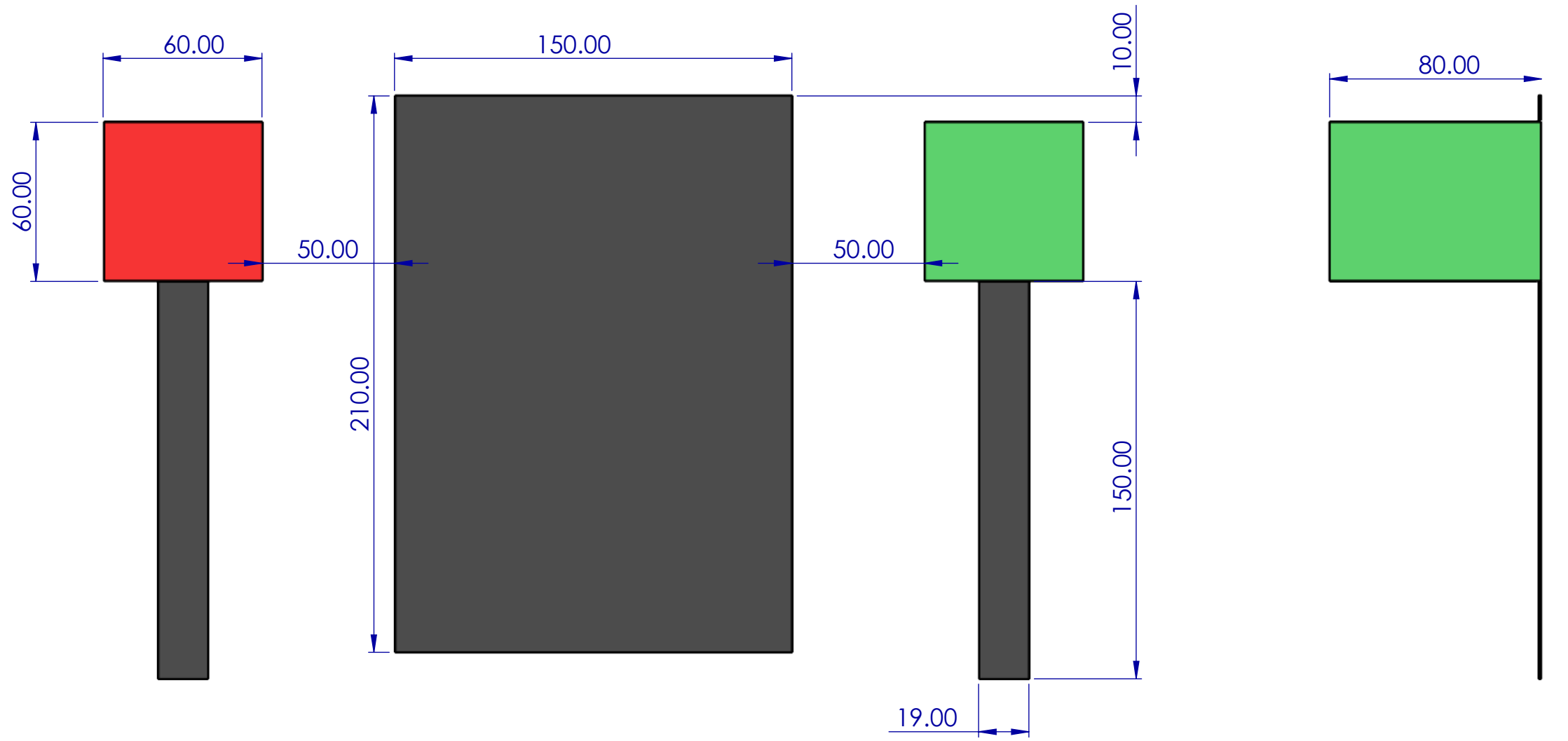
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2

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MATERIAL	COMMENTS:		
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DO NOT SCALE DRAWING			

TITLE:		
SIZE	DWG. NO.	REV
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SCALE: 1:5	WEIGHT:	SHEET 1 OF 1

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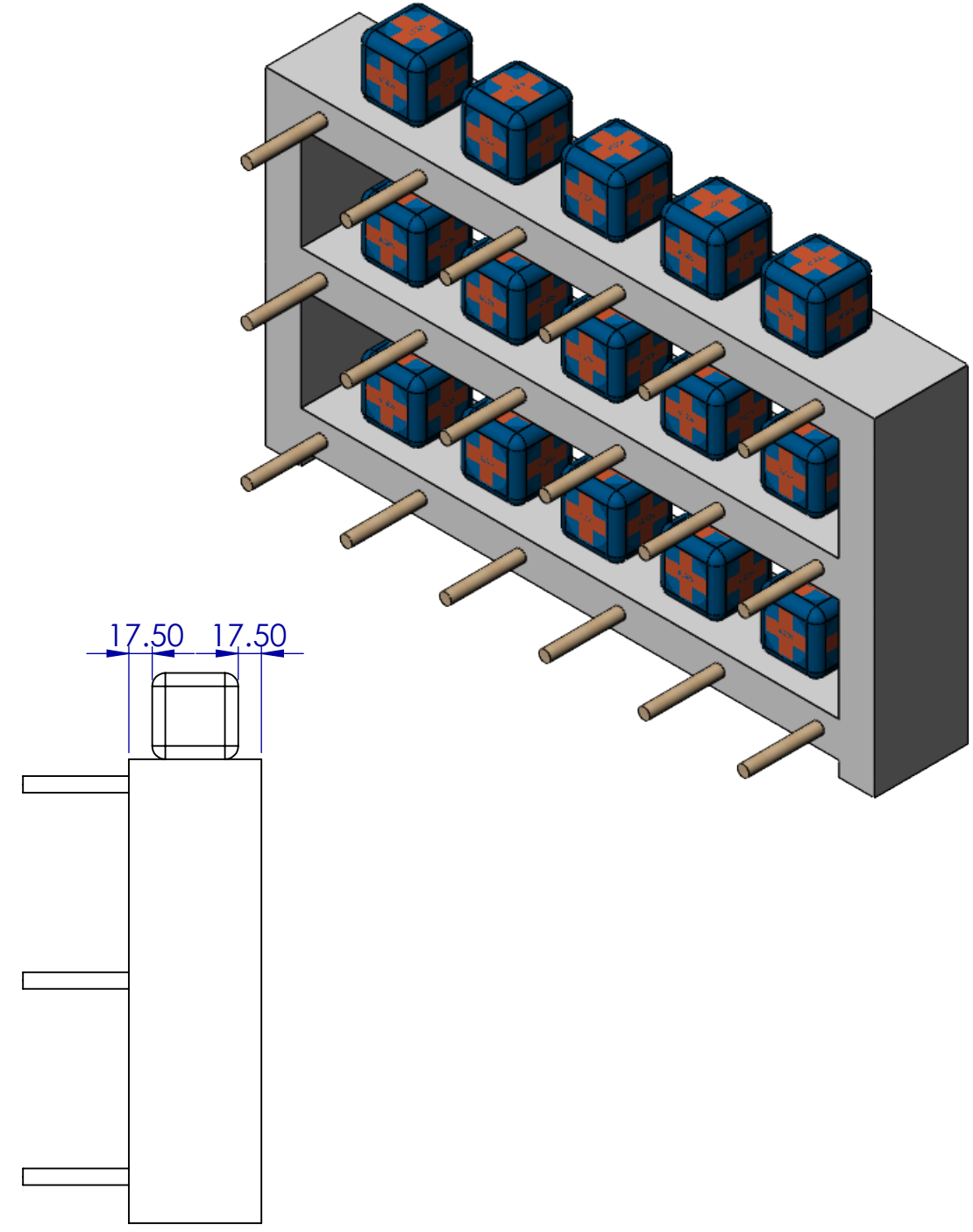
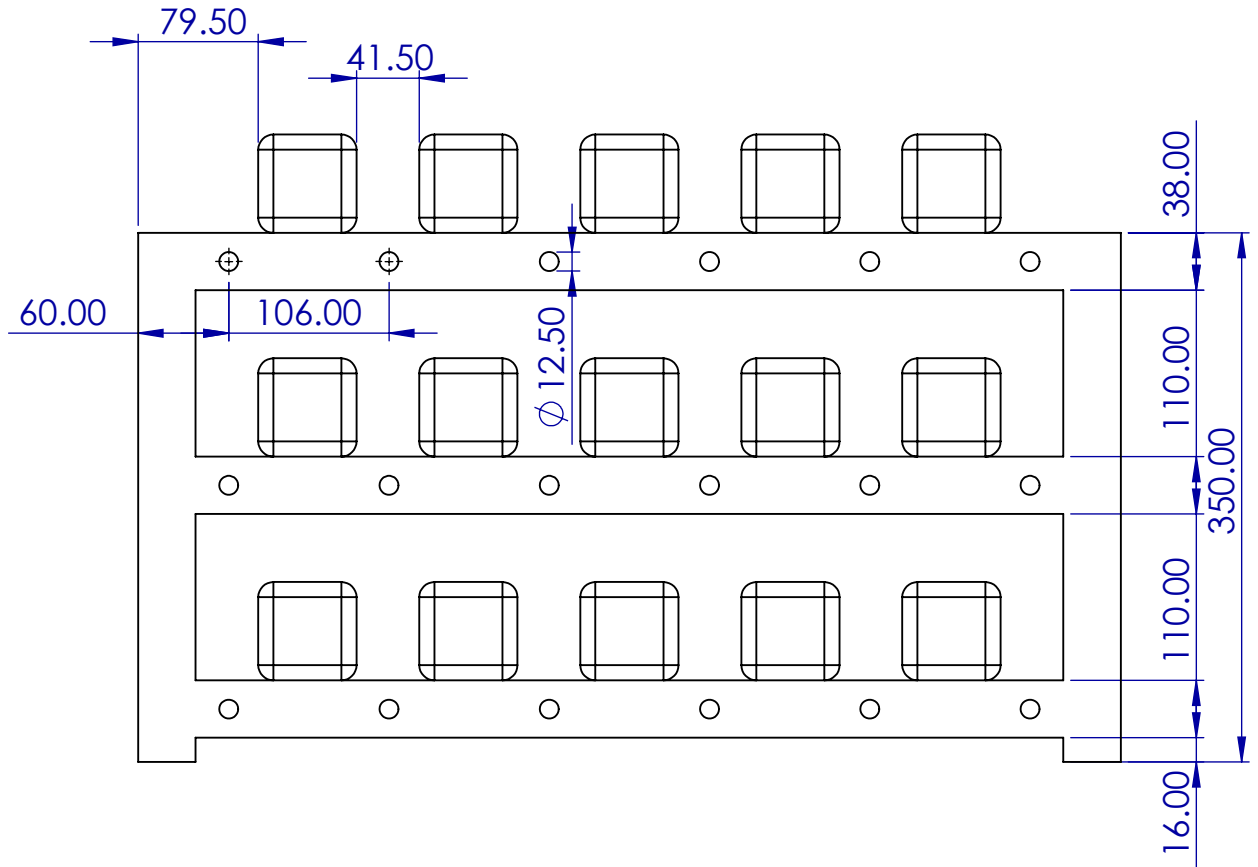
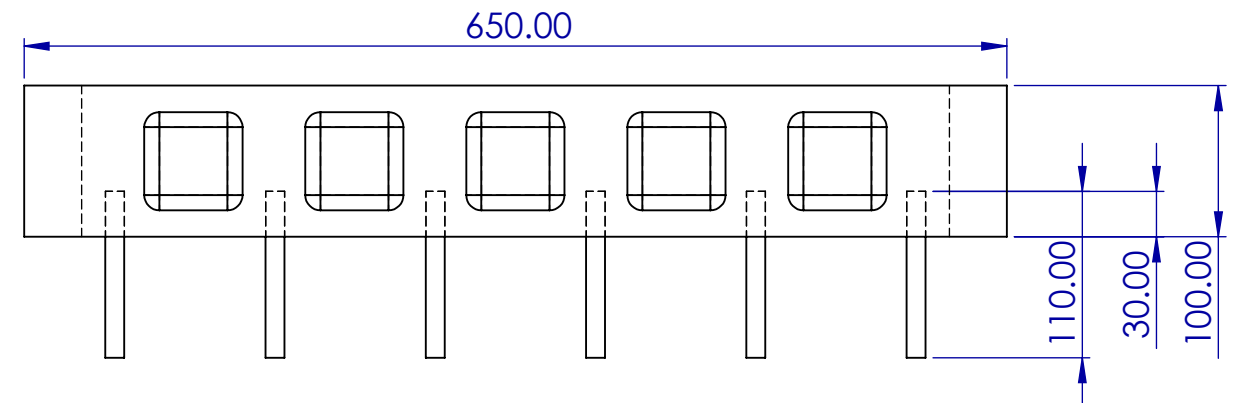
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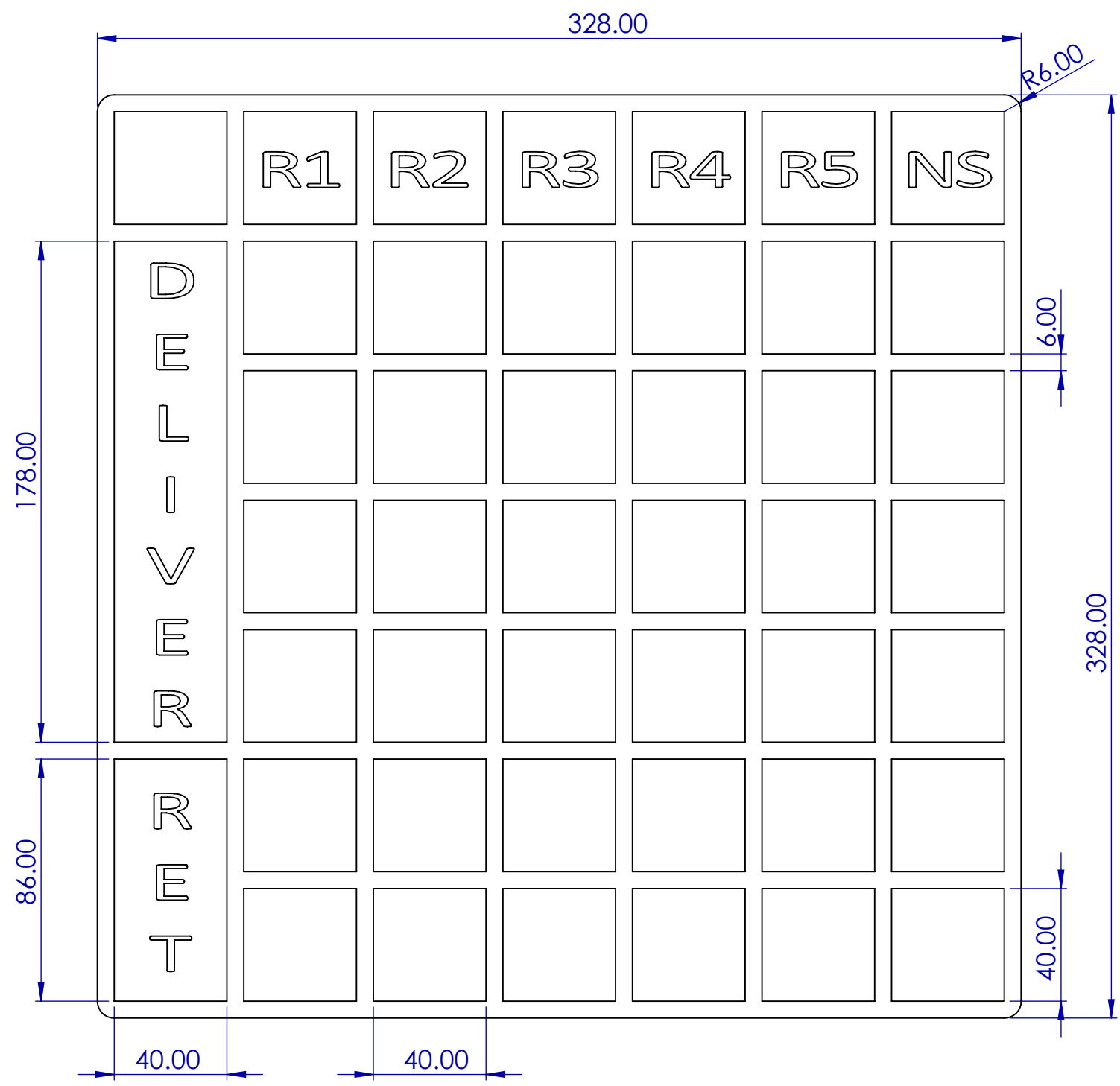
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MATERIAL		COMMENTS:	
FINISH			
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TITLE:		
SIZE	DWG. NO.	REV
B	Order Board Assembly	A
SCALE: 1:5	WEIGHT:	SHEET 1 OF 1