Competitor Information Document

Mobile Robotics

Submitted by:
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Introduction

Mobile Robots are playing an increasing role in support of medical staff in hospital settings. Amongst other responsibilities, Mobile Robots are used to manage the distribution of essential items in a hospital environment.

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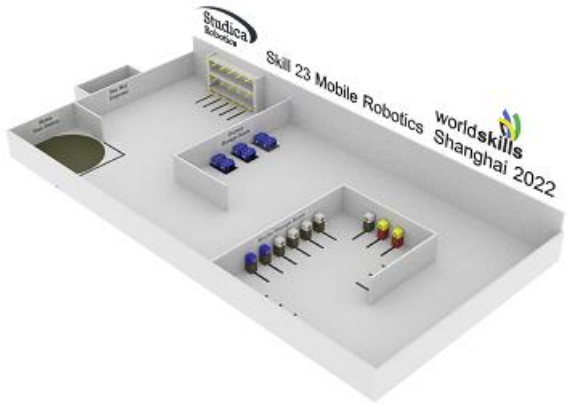
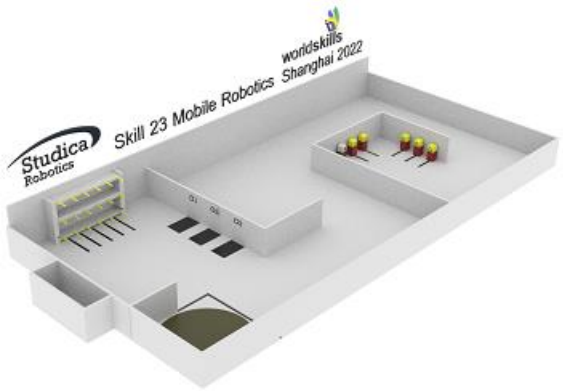
<tr><td colspan="2">Patient Room Support Mobile Robot</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">Dispensary Support Robot</td></tr>
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Medical Services Support Mobile Robots

The WorldSkills 2022 Shanghai Mobile Robotics Test Project requires Competitors to design, build and pperate a Mobile Robot capable of addressing ALL the performance requirements set by the Shanghai Hospital Network.

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/Gurneys) from different initial locations and deliver them to various destination locations in the performance environment.

Note: On Competition Day 1, when the focus is on Individual Robot Performance Elements, the robots will need to function/complete all the Individual Evaluated Performance Elements in **BOTH** Teleoperation and Autonomous Control Modes. This is intended to isolate the evaluation of mechanical/electrical systems from computer programming.

The performance environment detailed in this document will be the performance environment used on C-2 Competitor Familiarization Day, and C1 Core Robot Performance Evaluation Day.

Unique Performance Environment Layouts will be used on Competition Days C2, C3, and C4. These Performance Environment layouts will be presented to the Competitors during the AM Competitor Information Meeting on C2, C3, and C4.

Competitors can expect that additional, new performance requirements will be introduced during the C3 and C4 Competition Day AM Competitor Information Meetings.

Competitors may need to make alterations/changes to their robot on-site in response to the new performance requirements introduced by these ‘C3 and C4 Unknown In advance Test Project elements.’

The changes to the competition format have been introduced to:

1. Continue supporting the vital and essential role of pre-competition preparation by Competitors.
2. Maximize the role of ‘In the Competition Space’ Competitor work in determining the competition results.
3. Provide Nations and WorldSkills Regional Committees with an opportunity to connect their respective competition experiences to the WSC2022 Shanghai competition experience.

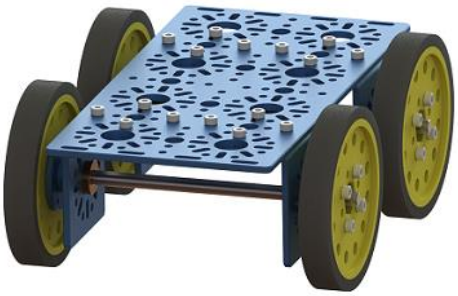
Instructions to the Competitor

Target Objects

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

	
There are two (White and Blue) of 65 mm by 65 mm by 65 mm Medicine Cubes. There is NO restriction on the number of medicine cubes that a robot may possess at one time.	

	Hazardous Material Cubes are Yellow 65 mm by 65 mm by 65 mm cubes. HazMat Cubes located on the Dispensary Shelves or Storage Room Stands are considered to be Clean HazMat 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 Contaminated Hazmat Cube(s), it MUST return to the Home Area, position itself on the 650 mm Dia. Sanitization Pad and Rotate through 540 degrees BEFORE handling medicine Cubes or Gurneys.



Robots will be required to (a) avoid moving Gurneys OFF their Assigned Gurney Pads, and, (b) retrieve Gurneys FROM or deliver Gurneys TO Designated Gurney Pads.

Evaluation associated with Gurneys will be based on:

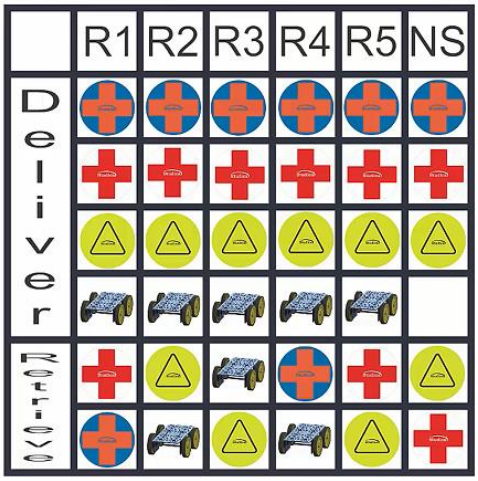
1. Are Gurneys not identified as targets that were to be moved still ON their Initial Gurney Pad?
2. Are Gurneys identified as targets that were to be moved now ON a Destination Gurney Pad in the hallway?

Whether a Gurney is ON or OFF, a 'Gurney Pad' will be determined by the position of the Gurney's wheels.

1. IF ONE or more Gurney wheels are Completely OFF the Gurney Pad / In Contact with the Performance Environment Floor surrounding the Gurney Pad, then the Gurney will be defined as 'Being OFF the Gurney Pad.'

IF ALL Four Gurney wheels are In Contact with the Gurney Pad, then the Gurney will be defined as 'Being ON the Gurney Pad.'

The Work Order Board



Identifies the Patient Room / Nurse's Station being serviced

Identifies the Destination for Blue Medicine Cubes retrieved from the Dispensary Shelves

Identifies the Destination for White Medicine Cubes retrieved from the Dispensary Shelves

Identifies the Destination for Clean HazMat Cubes retrieved from the Dispensary Top Shelf

Identifies the Gurneys that need to be moved from their Initial Locations to their Designated Locations

1st Shelf — Identifies Gurneys that need to be Returned to their Assigned Passageway Locations / Contaminated HazMat Cubes that need to be delivered to the HazMat Bin / Blue and White Medicine Cubes that need to be returned to the First and Second Dispensary Shelves

2nd Shelf

In Evaluated Test Project Runs, where the robot does not know the work details in advance, the robot will need 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.

There are similarities between the work robots are expected to do at all Shanghai Hospital Network locations. However, there are also work requirements that are unique to individual hospitals. Competitors must expect their robot will be required to work in more than one hospital setting and be capable of adjusting to the resulting changes in the work their robot must complete.

Hospital One defines ALL Robot Work Expectations through the Work Order Board mounted on a wall. This hospital expects robots to be able to:

a. Deliver White/Blue Medicine Cubes/Clean HazMat Cubes and Gurneys to Patient Rooms
b. Retrieve Contaminated HazMat Cubes from Patient Rooms and Deliver them to the HazMat Bin
c. Retrieve Gurneys from Patient rooms and place them on their Assigned Passageway Gurney Pad

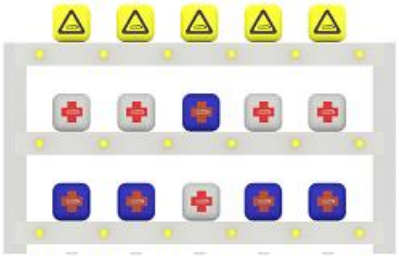
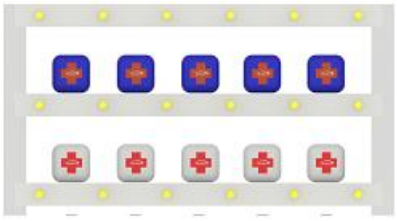
Hospital Two defines some Robot Work Expectations through the Work Order Board mounted on a wall, but it also expects the Robot to 'Interpret it's environment' and take Independent Actions under specific circumstances.

a. The Work Order Board will identify the Patient Rooms to which the robot is expected to deliver White / Blue Medicine Cubes and Gurneys.
b. If a robot detects the presence of a Gurney in a room then the robot is expected to take control of the Gurney and move it to a Passageway Gurney Pad.
c. If a robot detects the presence of a HazMat Cube in the room then the robot is expected to take control of the Contaminated HazMat Cube and deliver it into the HazMat Material Bin.

Hospital Three defines some Robot Work Expectations through the Work Order Board mounted on a wall, but, it also expects the Robot to 'Interpret it's environment' and take Independent Actions under specific circumstances.

a. The Work Order Board will identify the patient rooms to which the robot is expected to deliver White/Blue Medicine Cubes.
b. If a robot detects the presence of a Gurney in a room then the robot is expected to take control of the Gurney and move it to any available Passageway Gurney Pad.
c. If a robot detects the presence of a HazMat Cube in the room then the robot is expected to take control of the Contaminated HazMat Cube and deliver it into the HazMat Material Bin.

NOTE: The Dispensary Support Bot Layout in the document is a SAMPLE ONLY and will not be used on any of the Competition Days. A different Dispensary Support Bot Layout will be used on C2.

<table>
<tr>
<td> 
Evaluated Test Project Attempt 1</td>
<td> 
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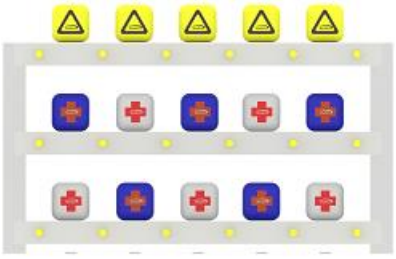
<td> 
Evaluated Test Project Attempt 3</td>
</tr>
<tr>
<td colspan="3">When the day's Test Project focus is on a Dispensary Support Robot the Competitors will receive directions during the AM Information meeting regarding the specific work their robot must accomplish.

The images above display samples of the type of images that will be provided to Competitors the start of the Competition Day. Note: The Shelf Pattern may be the same OR different different for each of the three Evaluated Test Project Attempts on a single Competition Day.</td>
</tr>
</table>

Equipment, machinery, installations, and materials required

1. Competitors are expected to develop their mobile Robots using the components provided in the WorldSkills 2022 Shanghai Mobile Robotics Component Collection.
2. On C3 and C4, there may be a design change implemented to the challenge that would require a robot to be redesigned to handle the added task. To accommodate this, an accessory kit will also be provided to each team on C-1. Competitors will also have access to some sheet material and a shared fabrication workspace. Competitors may use the parts in the accessory kit for their robot on any of the days C1 to C4.

Shanghai Accessory Kit		
Qty	**Product**	**Part #**
1	Mecanum Wheel Set (2 left, 2 right, 100mm, w/6mm Hub)	76240
2	Rack & Pinion Set (1 Rack, 1 Pinion, 2 Glides)	76170
1	Linear Slide Kit, 250mm Slide and Block	72064
2	432mm U-Channel	76010
2	192mm U-Channel	76015
4	30 Tooth Bevel Gear (1.2 Mod) (2 Pack)	76219-2
1	Flange Bearing 6mm ID, 14mm OD, 15mm Flange (12 pack)	76302-12
1	Collar 6mm ID D-Shaft, 12mm OD (6 pack)	76304-6
1	Shaft Spacer Plastic 6mm ID x 10mm OD x 1mm L (24 pack)	76305-24
1	Shaft Spacer Plastic 6mm ID x 10mm OD x 5mm L (12 pack)	76307-12
1	M3 x 12mm Socket Head Cap Screw (pack of 100)	76202-100
1	M3 x 10mm Button Head Cap Screw (pack of 50)	76203-50
1	M3 Kep Nut (pack of 100)	76204-100
1	48mm Standoff (12 pack)	76181-12
2	Servo Mount Flat Plate	76145
2	Servo Mount Offset Plate	76146
2	Servo Horn 25T	76148
2	6mm D-Shaft Servo Hub 25T	76149
1	96mm Adjustable Flat Bracket (2 pack)	76083-2
1	L Bracket (2 pack)	76087-2
1	Inside L Bracket (2 pack)	76089-2
1	144mm x 40mm Flat Bracket (2 pack)	76064-2
1	96mm Flat Beam (2 pack)	76047-2
2	96mm Square Beam	76107
2	Multi-Mode Smart Servo	75002
1	IR Range Sensor (10 cm to 80 cm)	40117
1	IR Range Sensor Bracket	40118

1. It is expected that Competitors will build a complete mobile robot during their at-home competition preparation experiences.
2. Competitors must leave their built during their preparation experiences robot at home when they travel to Shanghai.
3. Competitors will be provided with a new WorldSkills 2022 Shanghai Mobile Robotics Component Collection in the competition space on C-2 Familiarization Day, plus a Shanghai Accessory Kit.
4. Competitors can incorporate 'Competitor Designed/Created Custom Components' into their robot design based on the following restrictions:
    a. All 3D-Printed elements must be created using ABS, PLA, Nylon, PETG, HIPS, ASA, or Carbon Filled Fiber with a maximum overall weight of 1.2 kg. This should be proved in the Technician's Journal, along with a visual evaluation.
    b. All components developed using sheet material must be created using any polycarbonate material with a maximum overall sheet size of 1000 by 1000 mm (maximum thickness – 10 mm). This should be proved in the Technician's Journal, along with a visual evaluation.
    c. Competitors will bring these Competitor-made custom components to Shanghai.
    d. On C-2 'Familiarization Day' ALL competitor-made custom components will be examined to ensure competitors are incompliance with these restrictions. If Competitors exceed these restrictions, then they will be required to modify their robot design to bring it into compliance with these restrictions BEFORE being allowed to compete.
    e. Competitors are also allowed to bring custom cabling and electrical wires required for the robot's wiring.
    f. Competitors are required to bring three copies of the Micro SD Card used on the VMX. This is due to the restriction of no internet on-site, which means all packages and software must be installed ahead of time.

Marking Scheme

Sub Criterion	Shanghai Marking Scheme Description	C1	C2	C3	C4	Total
A	Work Organization and Management	1	1	1	1	4
B	Technicians Journal	8				8
C	Robot Fabrication and Assembly	6				6
D	Core Robot and Object Management System Evaluation Experiences	10				10
E	Test Project Evaluation Run 1		8	8	8	24
F	Test Project Evaluation Run 2		8	8	8	24
G	Test Project Evaluation Run 3		8	8	8	24
	Totals	25	25	25	25	100

1. Sub Criterion A – Work Organization and Management have a total value of 4 Marks (1 Mark per Competition Day). The evaluation focuses on:
    a. Competitor Interactions with others in the Competition Space
    b. Maintenance of a Safe Working Environment in their Assigned Workspace
    c. Adherence to Competition Time Schedules
2. Sub Criterion B – Technician's Journal HAS A Total Value of 8 Marks. The evaluation focuses on:

Aspect ID	Shanghai Technitian's Journal Evaluation	Marks
B 1	Definition and Task Analysis	1
B 2	Bill of Materials	0.25
B 3	Overall Quality of the Assembly Drawing	1.5
B 4	Robot Design and Design Process	1.5
B 5	Electrical System Organization / Wiring Diagrams	1.5
B 6	Object Management System	1
B 7	Software Programing Section (Code Development)	1
B 8	Summary	0.25
	Total	8

3. Sub Criterion C – Robot Fabrication and Assembly have a total value of 6 Marks. The fabrication and assembly evaluation process will involve the direct inspection of the Competitor's robot and object management systems by an Expert Jury Panel. The focus is on the physical status of all elements.

Aspect ID		Shanghai Fabrication and Assembly Evaluation	Marks
C 1	Wiring	Wiring installation meets Industry Standards for secure / safe installation. Examination of the Robot's Wiring (secure wire placement, efficient wire organization, quality of connections, protection from Abrasion, inclusion of appropriate fusing and master safety switch)	2
C 2	Robot Base	Frame Assembly meets Industry Standards for fit and alignment of components. Examination of the Robot Frame's Structural Integrity (fit between connected components, accuracy of component alignment angles, sizes etc.)	2
C 3	Object Management Structural Elements	Object Management System meets Industry Standards for fit and alignment of components. Examination of the Object Management System's Structural Integrity (fit between connected components, accuracy of component alignment angles, sizes etc.)	2
		Total	6

Aspect ID		Shanghai Core Performance Element Evaluation	Aspect ID		Shanghai Core Performance Element Evaluation
D 1	Cube Management 1	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and retrieve a cube from the 1st shelf	D 10	Robot Movement Management 1	The robot will be positioned in a Patient's Room in possession of a yellow cube and required to move to the HazMat Bin and deliver the yellow cube into the HazMat Bin
D 2	Cube Management 2	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and retrieve a cube from the 2nd shelf	D 11	Robot Movement Management 2	The robot will be positioned in front of the HazMat Bin and required to move Home and onto the Sani-Disk then rotate through 540 degrees
D 3	Cube Management 3	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and retrieve a cube from the top shelf	D 12	Work Order Board Interpretation	The robot will be positioned in the vicinity of the Work Order Board and required to move in front of the Work Order Board then move to the Dispensary Shelves and touch a cube matching the one displayed on the Work Order Board
D 4	Cube Management 4	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and deliver a cube onto the 1st shelf	D 13	Gurney Management 1	The robot will be positioned in the passageway NOT in possession of a Gurney and required to move to a Passageway Gurney, take possession of the Gurney and move the Gurney to a position where it is completely OFF the Passageway Gurney Pad
D 5	Cube Management 5	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and deliver a cube onto the 2nd shelf	D 14	Gurney Management 2	The robot will be positioned in the passageway, enter a Patient Room and detect if a Gurney is present. If NO Gurney is present then the robot will send a text report (string) back to the shuffleboard or front panel on the competitor host computer (control station)
D 6	Cube Management 6	The robot will be positioned in the vicinity of the Dispensary Shelves and required to move into position and deliver a cube onto the Top Shelf	D 15	Gurney Management 3	The robot will be positioned in the passageway IN possession of a Gurney and required to move the Gurney to a position where it is completely ON the Patient Room Gurney Pad
D 7	Cube Management 7	The robot will be positioned in the passageway outside a Patient's Room, IN possession of a cube and required to move into the patient's room and place the cube on the correct stand, Red Stand for Yellow Cubes and the Green Stand for White or Blue Cubes.	D 16	Gurney Management 4	The robot will travel the Passageway and Stop beside 'Empty Passageway Gurney Pads' that the robot recognizes as being 'Empty'. Then the robot must move its' Object Management System (Gripper) over the empty Passageway Gurney Pad and send a text report (string) back to the shuffleboard or front panel on the competitor host computer (control station)
D 8	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 sends a text report back to the shuffleboard on the competitor host computer (control station).	D 17	Gurney Management 5	The robot will be positioned in a Patient Room NOT in possession of the Gurney in the room. The robot will take possession of the Gurney and move it to a position where the Gurney is completely on a Passageway Gurney Pad. .
D 9	Cube Management 9	The robot will be positioned in the passageway outside a Patient's Room, IN possession of a cube and required to move into the patient's room and place the cube on a cube already on a designated stand	D 18	Text Messagingt 1	The robot will need to demonstrate the ability to send a text report (string) back to the shuffleboard or front panel on the competitor host computer (control station)

NOTE: The list of Core Performance Evaluation Elements shown above **WILL** be expanded by the introduction of a number of additional Core Performance Evaluation Elements in the Shanghai Competition Space.

1. Sub Criterion D - Core Performance Element Evaluation has a Total Value of 10 Marks
   While the evaluation is focused on a singular element, each of these evaluation 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.

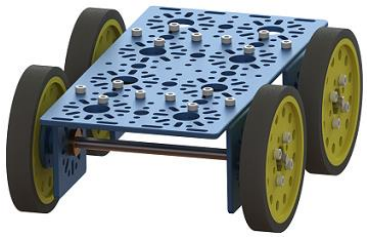
2. Sub Criterions E, F, and G all share the following common marks Distribution Pattern.

a. The marking process will occur when the 10-minute maximum available time to complete an Evaluated Test Project Run has ended.
b. Competitors will have three separate Evaluated Test Project Runs on Competition Days C2, C3, and C4.
c. The robot will be transferred to new hospitals for each of C2, C3, and C4. This will result in new Performance Environment Hospital Layouts being introduced on each of C2, C3, and C4.
d. Competitors will have one attempt to complete each of the three evaluated Test Project runs each Competition Day.

e. Evaluated Test Project runs have a value of 8 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:
Time Mark Awarded = (Fastest Team's Time/Marked Team's Time) X 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 Sani-Pad or returning to the home area at the conclusion of the Evaluated Test Project run

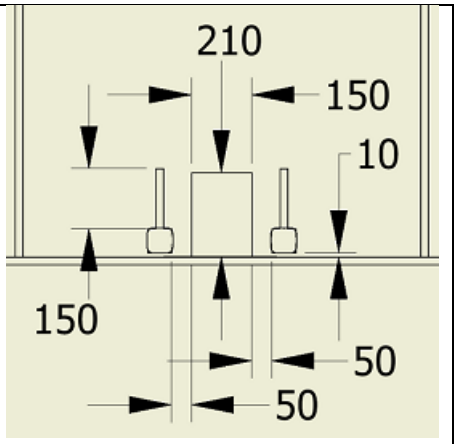
Other

This section provides information required to establish a Competition Performance Environment equal to the one presented in this document.

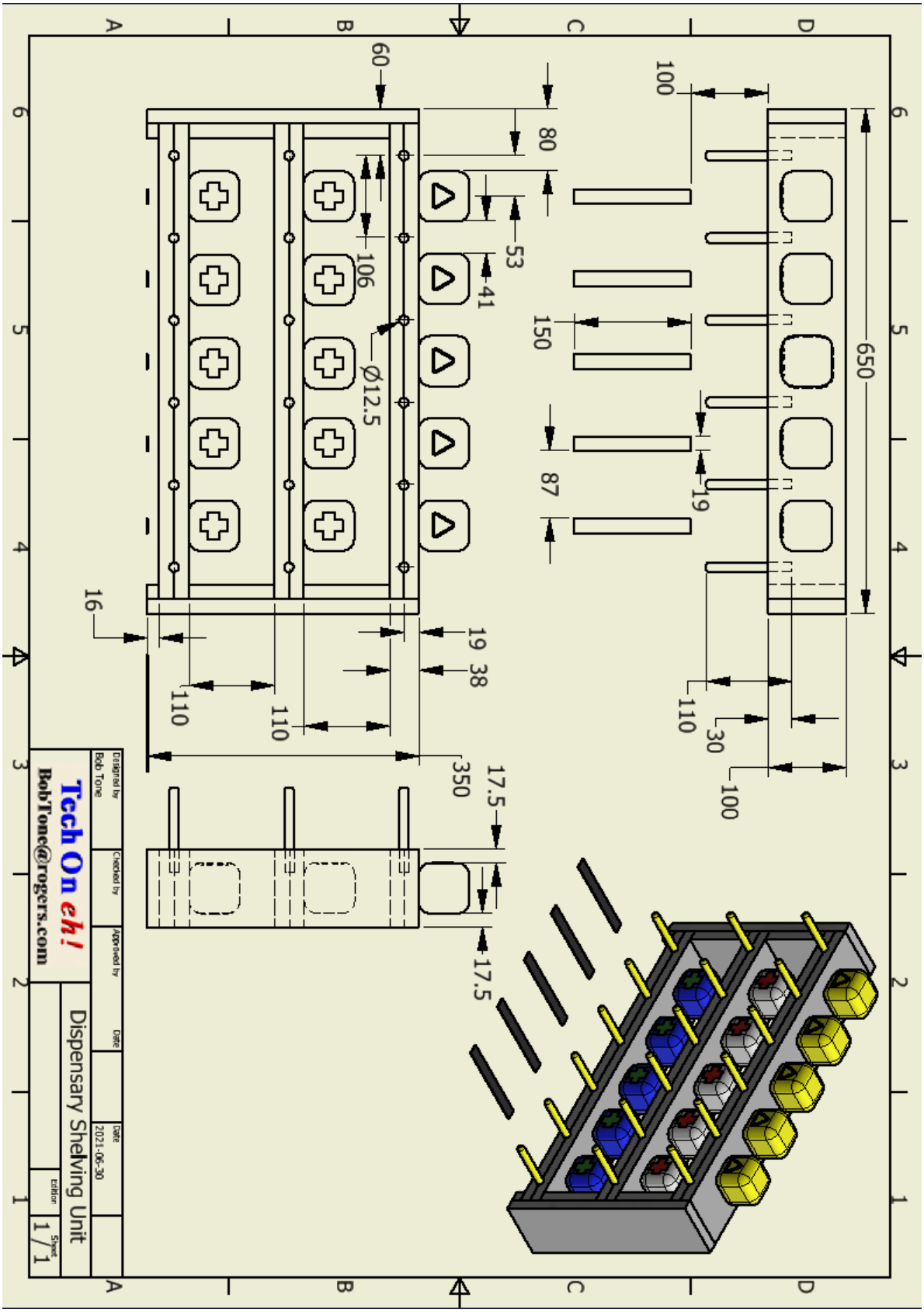


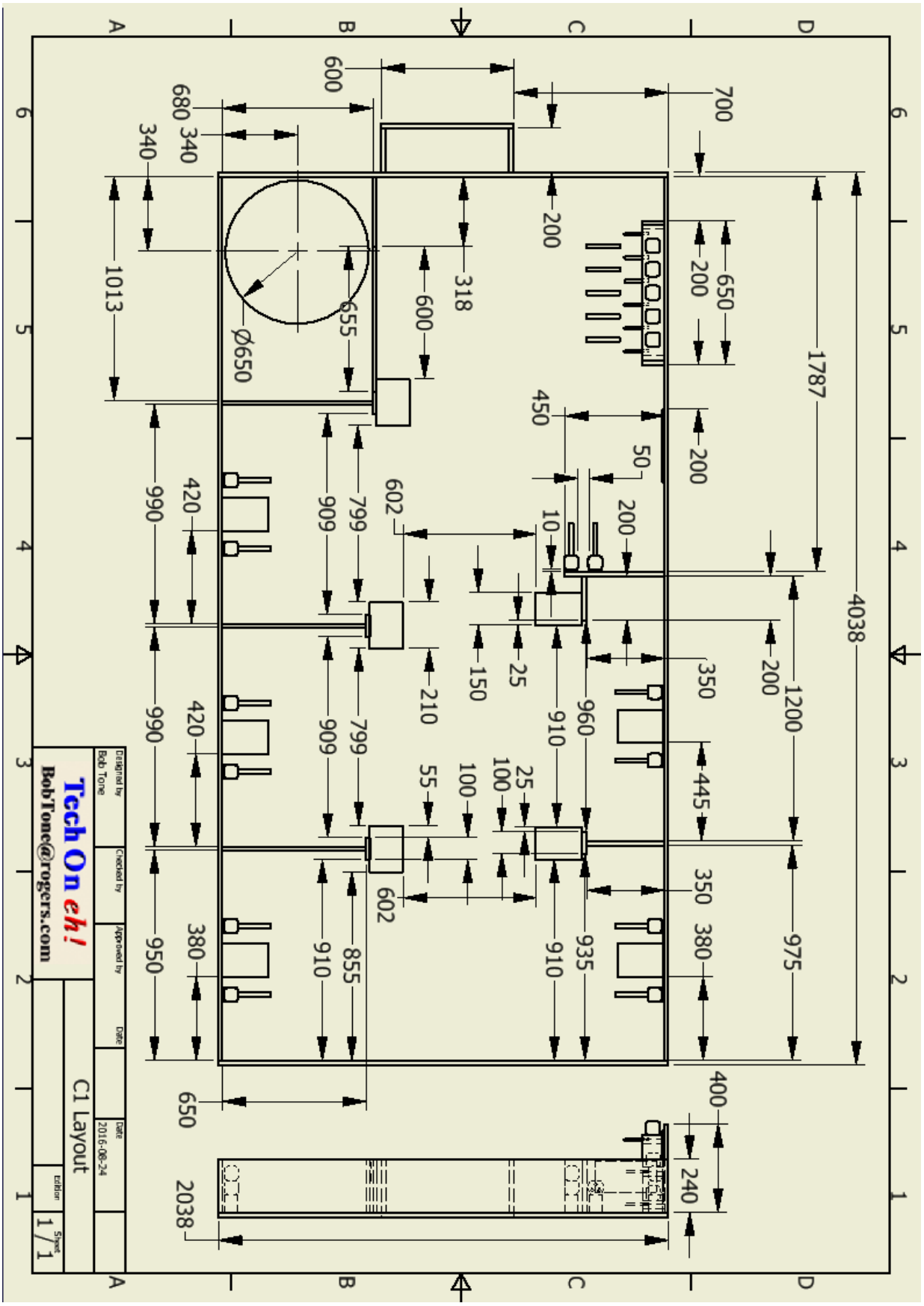
Gurney #75102		
Qty	**Product**	**Part #**
1	192mm x 96mm Flat Bracket	76066
2	L Bracket (2 pack)	76087-2
2	6mm x 140mm D-Shaft	76164
4	Bronze Bushing 6mm ID x 14mm OD	76301
4	75mm Drive Wheel - 60A, 12.5mm wide, 1/2" Inner Hex, Black	76271
1	Shaft Spacer Plastic 6mm ID x 10mm OD x 1mm L (24 pack)	76305-24
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

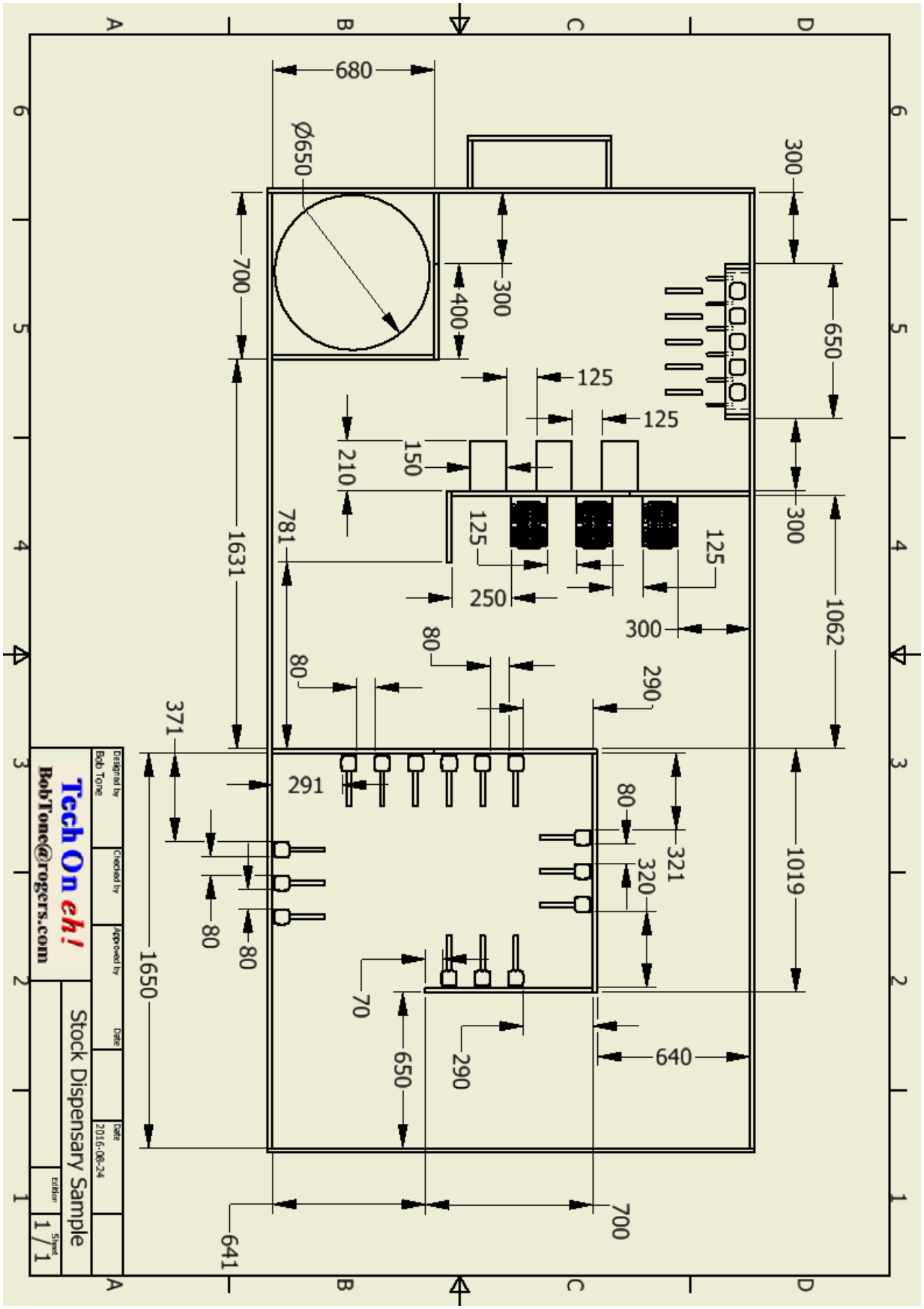
The Cube Stands and Gurney Pads in ALL Patient Rooms are positioned along the back wall of each Patient Room and placed based on the dimension pattern shown in the image on the right. The specific information related to the position of the Gurney Pad relative to the walls to the right and left of the Gurney Pad can be found in the full layout drawing.



Shanghai CID Sample Performance Environment Components			
Qty	**Core Performance Environment Box**	**Qty**	**Dispensary Shelves**
1	4038 by 2038 by 19 mm White Melamine Floor	3	612 by 80 by 19 mm White Melamine Shelf Boards
1	4038 by 240 by 19 mm White Melamine Wall Board	2	293 by 80 by 19 mm White Melamine End Boards
2	2000 by 240 by 19 mm White Melamine Wall Boards	4	110 by 80 by 19 mm White Melamine End Insert Boards
		2	16 by 80 by 19 mm White Melamine End Insert Foot Boards
	Interior Elements	18	95 mm Dia.6mm Hardwood Dowels
4	100 by 240 by 19 mm White Melamine Wall Boards		
2	200 by 240 by 19 mm White Melamine Wall Boardl		**Gurneys**
1	350 by 240 by 19 mm White Melamine Wall Board	10	210 by 150 mm Gurney Pads (Tape Rectangles 210 by 150 mm)
2	400 by 240 by 19 mm White Melamine Wall Boardl	5	Gurney Kits
1	450 by 240 by 19 mm White Melamine Wall Board		
1	600 by 240 by 19 mm White Melamine Wall Boardl		**Cube Stands**
2	650 by 240 by 19 mm White Melamine Wall Boards	16	60 by 60 by 80 mm Cube Stands (6 Red and 10 Green)
1	680 by 240 by 19 mm White Melamine Wall Board	15	65 by 65 by 65 mm Target Object Cubes (5 White, 5 Blue and 5 Yellow)
1	700 by 240 by 19 mm White Melamine Wall Board		
1	1050 by 240 by 19 mm White Melamine Wall Board	1	**Work Order Board**
1	Sanitization Station Peal and Stick Viynl Disc Diameter 650 mm		







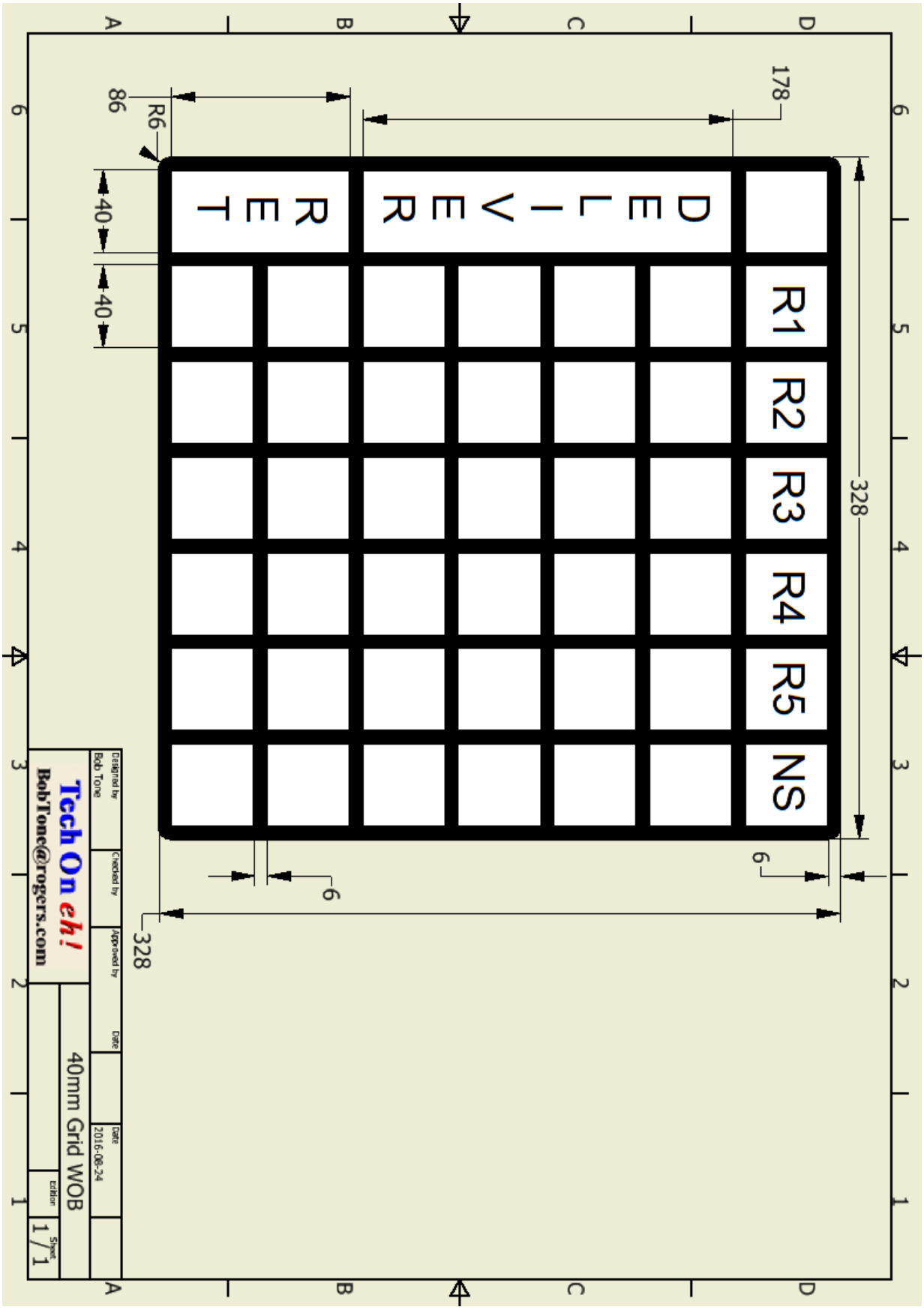
G1	G2
G3	G4
G5	

Gurney Pad Signs

Patient Room	1
Patient Room	2
Patient Room	3

Patient Room	4
Patient Room	5
Nurse's Station	
Hazardous Material Bin	

Home Sanitation Station



Work Order Board Magnetic Plates

			
Blue Medicine Cube	White Medicine Cube	Hazardous Material Cube	Patient Gurney

The Work Order Board System consists of:

* One Magnetic Work Order Board
* Five Blue Medicine Cube Magnetic Plates
* Five White Medicine Cube Magnetic Plates
* Five Yellow HazMat Cube Magnetic Plates
* Five Patient Gurney Magnetic Plates

NOTE: The final images on the plates will **NOT be exactly as shown above** due to the production processes involved in the plate creation.