

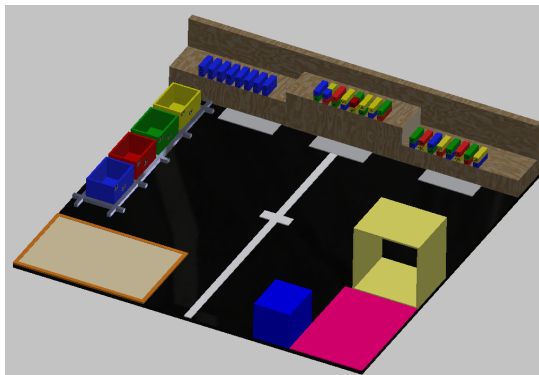
# Hampton Roads Shipping Container Terminal Challenge

## 1. Introduction

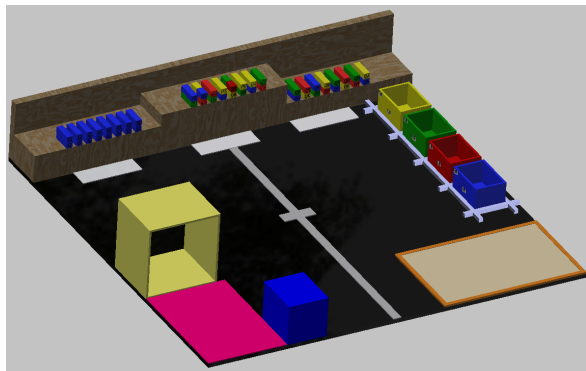
“Roadstead” or “roads” is a body of water sheltered from rip currents, spring tides or ocean swell outside a harbor where ships can lie reasonably safely at anchor without dragging or snatching while waiting for their turn to enter a port of call; in maritime law, a “known general station for ships, notoriously used as such, and distinguished by the name”. Charts and nautical publications substitute roadsteads for roads.

## 2. Objective

The IEEE SoutheastCon 2016 hardware competition is designed with the intention of simulating modern port logistics and its related traffic. This IEEE Roads port provides a challenging game of robotic skill and logistics. Each team has to successfully detect shipping goods on a barge (three types of shipping container) which are strategically placed in a harbor field. Correct shipping goods then have to be picked up and transported to the correct shipping zone, and they will be further transported by the boat, by rail or by truck. Each team will have 5 minutes to complete the task.



(a)



(b)

Figure 1: View of the Hampton Roads Terminal (a) version one\*; (b) version two\*

(\*All segments are modular, they are just shuffled into different positions, walls are shorter for easier view what is placed where)

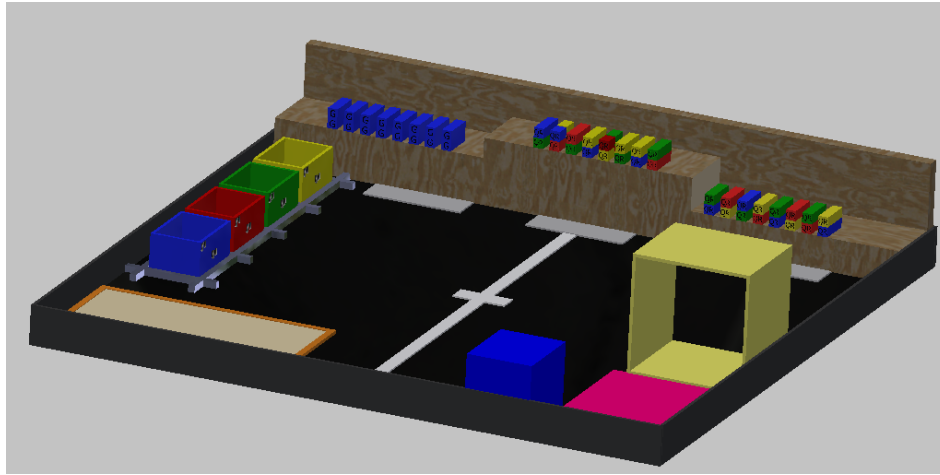


Figure 2: View of the Hampton Roads Terminal - version one

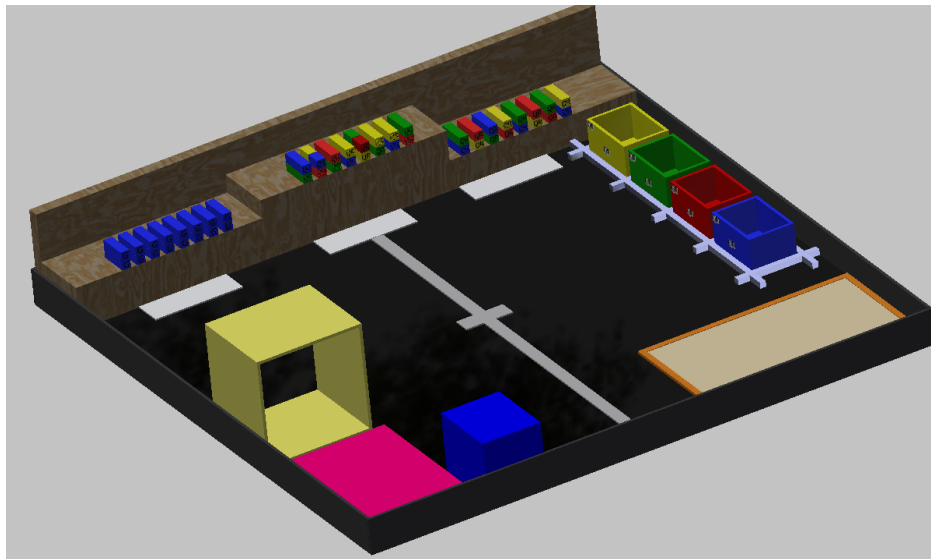


Figure 3: View of the Hampton Roads Terminal - version two

### 3. Playing Rules

This will be a competition with one autonomous robot picking and moving shipping goods during the five minutes. The robot will start the round in the designated starting point on its side.

Shipping goods will be located in the middle of the court, on three different parts of a central barge. There will be three types of shipping goods: a) generic shipping containers which are located in the barge zone A; b) shipping containers with QR codes located in the barge zone B (see section 9. about the QR codes); and c) containers which have different colors located in the barge zone C. Different locations on each side of the court are designated as the “shipping goods boat, rail and truck dropping zones.” A robot must travel to the central location - barge to collect more shipping goods.

The robot will be required to pick up shipping goods and to drop those shipping goods to the three available locations: boat, rail and truck to score, and then repeat the sequence. See table below for the scoring. Containers can be stacked in the zones on delivery. They do not have to be placed flat, they can also be on edge (i.e. laying against the railing car's walls). To be counted as points, the shipping good in the truck cannot touch the ground. If a shipping good is between two separate buckets, the score is zero. If the container falls on the floor, it does not count.

Teams will be instructed which side of the competition board they will be competing on immediately prior to the start of each game. It is highly recommended that teams build in a hard switch to instruct their robots before each game which course they will be competing on.

Limited number of shipping goods are available and will be used by a robot.

When the team is called to participate in the competition, they will have **1 minute** to place their vehicle in the designated starting area on the competition board and take all hands off the vehicle. The beginning of the competition will be signaled by a group of 4 red LEDs mounted in the center of the starting block. Each LED will be separated by 1 cm. Before each robot is placed on the board, the LEDs will be illuminated. The beginning of the competition will be signaled by the LEDs turning off.

Once the signal is shut off the timer is started and the vehicle will have a maximum of five minutes to navigate and pick up shipping goods and transfer them to their appropriate locations. The game will end when the five minutes expire or if any part of the robot leaves the playing board.

Judging will be done at the end. Any ruling of the judges is final.

## 4. Robot Specifications

The robot's dimensions cannot exceed 12" x 12" x 12" at the start of the match, however it can extend 8" in any one direction after leaving the starting point. The starting maximum dimensions are 12" x 12" x 12" and can expand to a maximum of 20" x 20" x 20" during the game.

The shipping good does not count as the part of that 8".

It must be self-propelled, autonomous and may not be remotely controlled in any manner, no tethers\* of any type (no wires to anything external to the board). It cannot contain any flammable liquids, gases, or explosives. The vehicles cannot project any objects either in the playing field or out of the playing field, and all parts of the vehicle must remain attached (i.e. the vehicle may not split into multiple pieces). The vehicle may not present any danger to the judges, the spectators, or the playing board. Use of cylinders storing any liquid or gas under pressure at the start of a round is prohibited. Use of any flammable or hazardous substance which may pose a safety threat in a robot is prohibited.

\*A **tether** is a cord, fixture, or flexible attachment that anchors something movable to a reference point which may be fixed or moving.

## 5. IEEE Port Specifications

Full court will be 8 foot x 8 foot. The court will be enclosed by a 6" high, 0.5 in thick wall. For more specific dimensions, refer to the appendices or download the zipped folder with all CAD drawings from the link provided at Facebook page (they will be available since August 15, 2015). Free version of Autodesk Inventor is available for download at Autodesk's website:

<http://www.autodesk.com/education/free-software/all>

There will be three separate zones for the scoring shipping goods delivery. They will stay fixed during the competition. They will be fixed to the playground. These are:

- Boat shipping zone
- Rail shipping zone
- Truck shipping zone

**Boat Shipping Zone** will be made from: Office Depot's "[Quartet® Economy Corkboard, 24" x 36", Natural Cork Board, Oak Frame](#)", 24" x 36", Item # 489740. It is permissible to drive on the cork board.

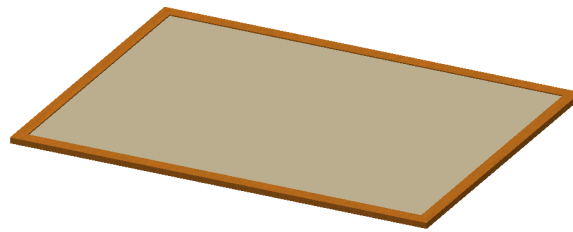


Figure 4: View of the boat shipping zone

**Rail Shipping Zone:** Dimensions of each rail car in the rail shipping zone: 10.75" L x 7.75" W x 5" H. The rail car position will be randomized. They will not always be at the same position. The rail cars will have QR code on them with one of the appropriate words "blue", "yellow", "red", or "green". The rail cars will be fixed to the ground. They cannot be moved during the competition. The walls are 0.5 in thick. They are made of plywood and painted with same colors as shipping goods: yellow, green, red, and blue.

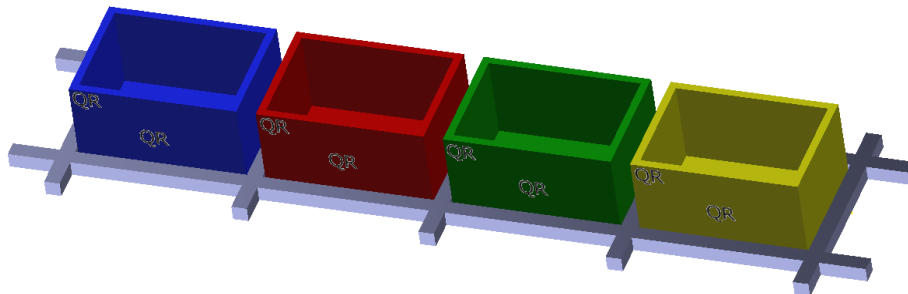


Figure 5: View of the rail shipping zone

- Green - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Hunter Green Oil-Base Paint](#)"; Item #: 558151; Model #: 7738502

- Red - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Carnival Red Oil-Base Paint](#)"; Item #: 558152; Model #: 7763502
- Blue - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Royal Blue Oil-Base Paint](#)"; item #: 558166; Model #: 7727502
- Yellow - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Sunburst Yellow Oil-Base Paint](#)"; Item #: 558162; Model #: 7747502

**Truck Shipping Zone** is shown in Figure 6.

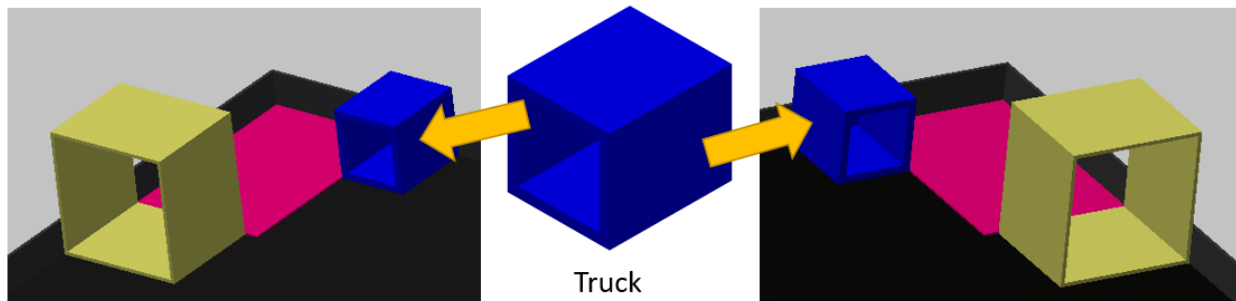


Figure 6: View of the truck shipping zone

The floor and walls of the court will be painted black using Lowe's "[Rust-Oleum Stops Rust Quart Size Container Interior Flat Black Oil-Base Paint](#)"; Item #: 558174; Model #: 7776502 black paint.

**Start Areas:** The start areas (Figure 7) are located in the top corners of the playing field and are shown by a square painted in the team's colour (dark pink on the left, pale pink on the right, as seen by the audience). This is the only starting area allowed for robots to start the game. Before the start, the robots must be entirely contained within the start areas. Start areas will be boards: Royal Brites 2 Cool Foamboard, 20" x 30", Pink; Item # 977958; OfficeMax # 24033662: <http://www.officedepot.com/a/products/977958/Royal-Brites-2-Cool-Foamboard-20/>

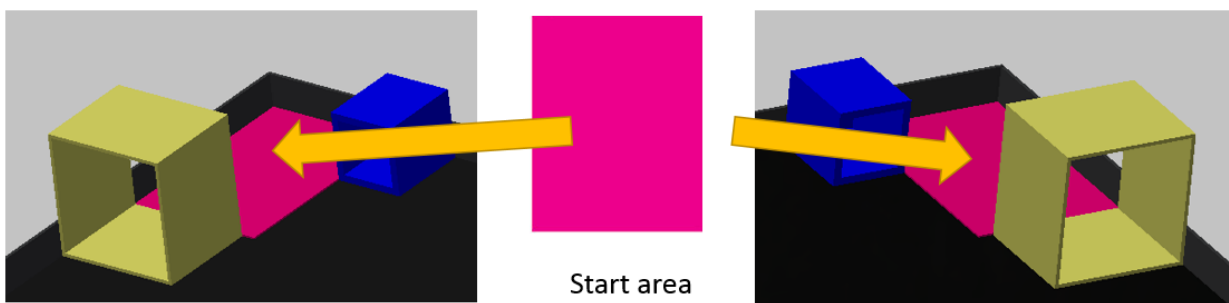


Figure 7: View of the start area

If a robot does not leave the start area before the end of the match, the match will be declared disqualified for that team and it will count as zero points.

The first obstacle through which robot has to navigate is the tunnel. The tunnel inside height is 17" by 17" width(see appendices). Tunnel is show in the Figure 8. It is made by 1 / 2 in plywood. There will be no transition from the tunnel which is 1 / 2 in. Tunnel will be fixed to the playground, you are not allowed to move the tunnel away from the base position. The robot can expand after the tunnel. To robot can be extended in any direction (not to the floor of course) by 8 past its initial size. Containers have to be placed within the truck. They cannot be stacked on top. Container can extend beyond the end of the truck but it cannot touch the ground.

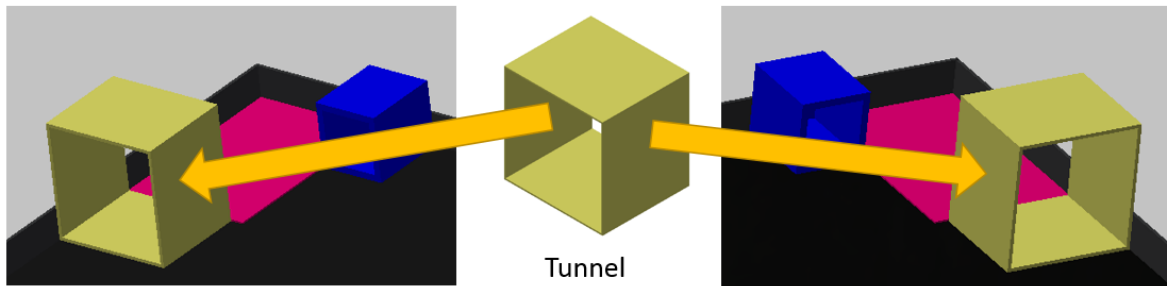


Figure 8: View of the tunnel and one tunnel with surroundings example

Shipping goods will be located on the barge in the center of the field. The maximum stacking height of the shipping containers on the boat are two containers as shown in the figure below. There will be 2 rows and 8 columns of containers in each one of the zones. The photo shows two. The barge has three different zones: A, B, and C, as shown in Figures 7 and 8.

Three zones with shipping containers at the barge are:

- A) generic containers with no QR code, same size, one color (blue)
- B) containers with QR tag, different colors (blue, red, green, yellow), 2 different sizes
- C) color containers with QR code, different colors (blue, red, green, yellow), same size

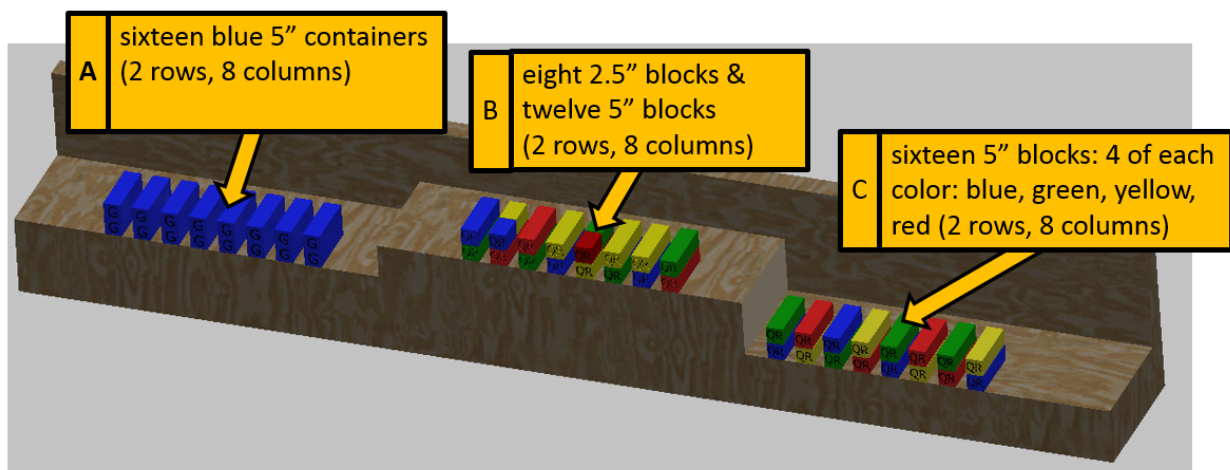


Figure 9: View of the barge and three shipping goods zones

## 6. Shipping Goods Specifications

Shipping goods will be placed rows on the the the barge. Individual block locations will be randomized, however the block organization into stacks and rows will be consistent at the beginning of each competition. Shipping containers will be all lined up on the edge. Shipping goods cannot be damaged during the competition, they cannot be pierced, drilled, cut during the game. These shipping containers were in use and their paint might be scraped in some areas. You have to make sure to include that variability in your designs. Containers will be made from Lowe's "Spruce-Pine-Fir Furring Strip" (Common: 2-in x 2-in x 8-ft; Actual: 1.5-in x 1.5-in x 96-in) - Item #: 4513, Model #: 22PFUR.8. Drawings are 2 in.

Containers with QR codes (green, red, blue, yellow) will be painted with the following colors:

- Green - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Hunter Green Oil-Base Paint](#)"; Item #: 558151; Model #: 7738502
- Red - Lowe's - "[Rust-Oleum Stops Rust Interior Gloss Sunrise Red Oil-Base Paint](#) (Actual Net Contents: 32-fl oz)"; Item #: 558155; Model #: 7762502
- Blue - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Royal Blue Oil-Base Paint](#)"; item #: 558166; Model #: 7727502
- Yellow - Lowe's - "[Rust-Oleum Stops Rust Quart Size Container Interior Gloss Sunburst Yellow Oil-Base Paint](#)"; Item #: 558162; Model #: 7747502

These colors are oil based paints, they can withstand more wear and tear but they need at least two coats, each one is recommended to dry in 2 hours (Latex based paint (one coat spray paint) are not recommended to us because they cannot go through lot of wear and tear. They do dry in one hour and need one coat only).

**Zone A** will have sixteen shipping containers of the same size, same color (blue). They are 1.5 in x 1.5 in x 5 in. They do not have QR code attached to them. They are actually the same as blue shipping containers in zone C, just without QR code glued on to them. See Figure 10.

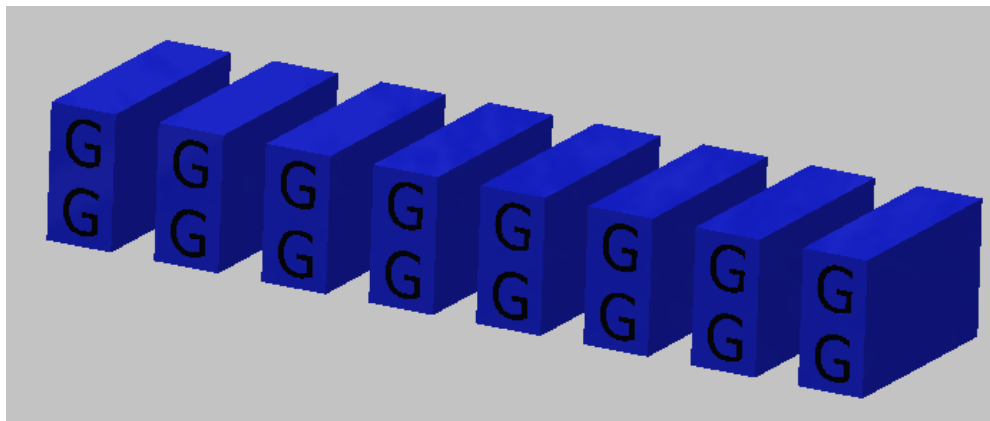


Figure 10: Shipping containers in zone A (same size, same color, no QR code)\*

**Zone B** will have eight 1.5" x 1.5" x 2.5" shipping containers (two of each color: blue, green, red and yellow) and twelve 1.5" x 1.5" x 5" shipping containers (three of each color: blue, green, red and yellow). They will be placed in 2 rows and 8 columns, as shown in Figure 11.

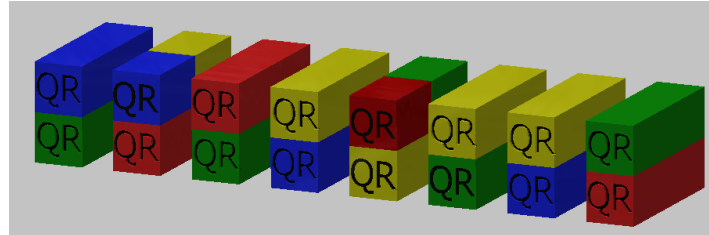


Figure 11: Shipping containers in zone B (two sizes, four colors, with QR code)\*

**Zone C** will have sixteen 1.5" x 1.5" x 5" shipping containers (two of each color: blue, green, red and yellow), as shown in Figure 12.

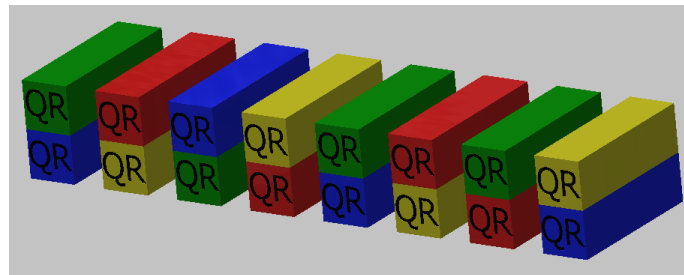


Figure 12: Shipping containers in zone C (one size, four colors, with QR code)\*

\*Note: \*All containers do not have rounded edges - they are cut from the stock. There will be 2 rows and 8 columns of containers in each one of the zones.

## 7. QR Codes

There will be four types of QR codes, invented by Denso Wave, generated with color words: "yellow", "red", "green", and "blue". These codes are generated from text with the online generator: <http://www.qr-code-generator.com/#>. Their dimension will be 1.5 in x 1.5 in (one side of the shipping containers in zone B with QR codes will be covered with the code). QR codes will be facing forward but they can be in any orientation. More about QR codes find from here: <http://www.qrcode.com/en/>. They will be printed black on the white paper, low gloss paper. The will be glued to the surface of rail cars, one in the top left corner, other in the middle, as shown in Figure 13. QR codes will be fastened with glue. They will be printed on cardstock and glued on.

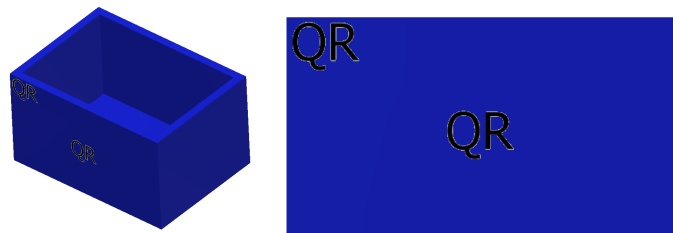


Figure 13: QR codes will be located in the upper left corner and the middle of the front side





Figure 14: QR code for the word “yellow”



Figure 15: QR code for the word “red”



Figure 16: QR code for the word “green”



Figure 17: QR code for the word “blue”

## 8. Navigation

Robots will simply start by pressing a "Go" button on the robot itself.

Three areas will be painted with lighter color in front of the Zones A, B, and C on the playground floor for easier navigation. See Figures 18, 19 and 20 below.

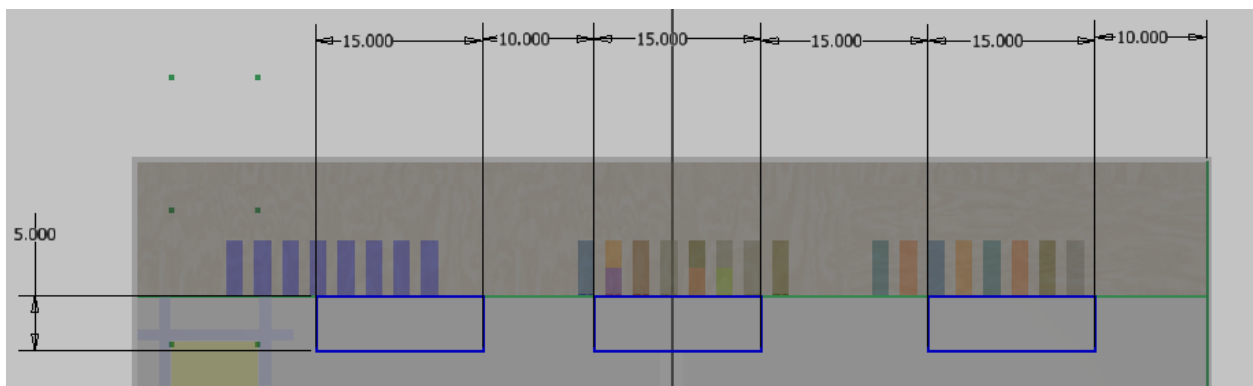


Figure 18: Dimensions of the navigation stripes



Figure 19: Brighter area for easier navigation

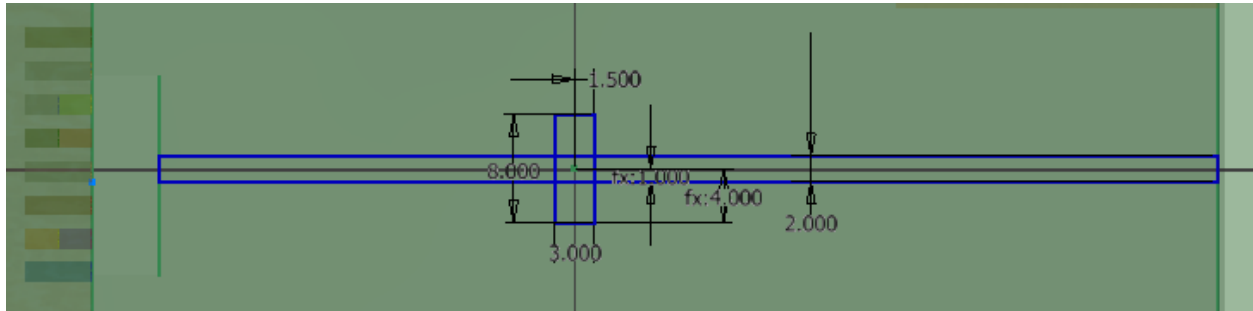


Figure 20: Dimensions of white cross in the middle of the playground

*Important information:* While the organizational team strives to be as accurate as possible while building the playing area, there may be deviations from the official dimensions because of manufacturing tolerances ( $\pm 0.125$  in). No responsibility will be accepted regarding these deviations. If any modifications are made to the specifications, they will be made available in a complementary document on the website of IEEE SoutheastCon 2016 website. Please note that the surface finish of the painted areas may differ between each playing field, and may deteriorate over time. The rules, the specifications of the playing field and of the playing elements might be changed if problems are discovered. We strongly recommend that teams regularly check both IEEE SoutheastCon 2016 website <http://sites.ieee.org/southeastcon2016> and the Facebook IEEE 2016 SoutEastCon page <https://www.facebook.com/2016ieeesoutheastcon> and the IEEE 2016 SouthEastCon Hardware Competition page <https://www.facebook.com/groups/SouthEastCon2016HardwareCompetition/> to check for updates to the rules or specifications.

## 9. Scoring

Shipping Container (starting location and description)		Destination (location of block at end of game)						Total Number of shipping containers on barge at start of competition
		Boat	Truck	Rail Red	Rail Green	Rail Blue	Rail Yellow	
Zone A	5" Blue Block (no QR)	3	-1	-1	-1	-1	-1	16
Zone B	2.5" Red Block	-2	-2	10	-2	-2	-2	2
	2.5" Green Block	-2	-2	-2	10	-2	-2	2
	2.5" Blue Block	-2	-2	-2	-2	10	-2	2
	2.5" Yellow Block	-2	-2	-2	-2	-2	10	2
Zone B	5" Red Block	-2	-2	15	-2	-2	-2	3
	5" Green Block	-2	-2	-2	15	-2	-2	3
	5" Blue Block	-2	-2	-2	-2	15	-2	3
	5" Yellow Block	-2	-2	-2	-2	-2	15	3
Zone C	5" Red Block	-1	5	-1	-1	-1	-1	4
	5" Green Block	-1	5	-1	-1	-1	-1	4
	5" Blue Block	3	-1	-1	-1	-1	-1	4
	5" Yellow Block	-1	5	-1	-1	-1	-1	4
Additional Scoring*								
Robot moves		25 points						
Robot drives through tunnel		25 points						
Robot successfully moves any shipping container		10 points						

\*Robots may only claim each of these categories one time per game.

## 10a. Qualification Round

The robot must completely leave the start area to be qualified for the competition. In addition, teams must be able to demonstrate that their robot will fit through the tunnel to verify robot size limitations.

## 10b. Tournament Format

The competition consists of three rounds. Each team will have three rounds in which to base their final score. Scores will be summed up from each round. At the end of the three rounds, the final scores will be calculated. Final 4 teams will qualify for finals which will be held during the banquet. Each team will run one game, 5 minutes. The team which scores the most number of points is the winner of the competition.

If there are two teams which have the same number of points - remaining number of seconds will win (just in case of the tie breaker). The shorter time will be acknowledged at the moment when the team informs the judge about the completion.

If in the opinion of the judges and the host committee that time constraints require us to speed the completion of the competition after the second round, the host committee, at their discretion, can cut up to 1/2 of the lowest scoring teams.

Robots will be positioned to the location in the sequester A where they will stay until the the first round starts. After completion of the first round, the robots will enter the sequester B. Robots will stay in the sequester between Round 1 and Round 2. They will be released to the teams in between Round 2 and Round 3. Before Round 3, robot will be brought again to the sequester until the time for the final round comes.

If the team representative fails to appear for sequester after your team name is called twice, the team will not be allowed to play in that round. All teams must be sequestered prior to the start of the round. Two team representatives handles the robot during the competition. Each team representative has one minute from arriving at their competition course to set their games and robot. At the end of 1 minute, hands off, the start light goes out, and play time begins. Between rounds, all games will be lined up off the course at the starting end for your team representative to place.

Flash photography will not be allowed. On board lighting is allowed as long as you are not flashing and interfering with operation of the robot at the other side. All designs should take this into account. Reasonable noise levels should be accounted for by teams during practice and competition. Every effort will be made to maintain courses between rounds, but in the interests of time minor scuffs (etc.) will not be addressed.

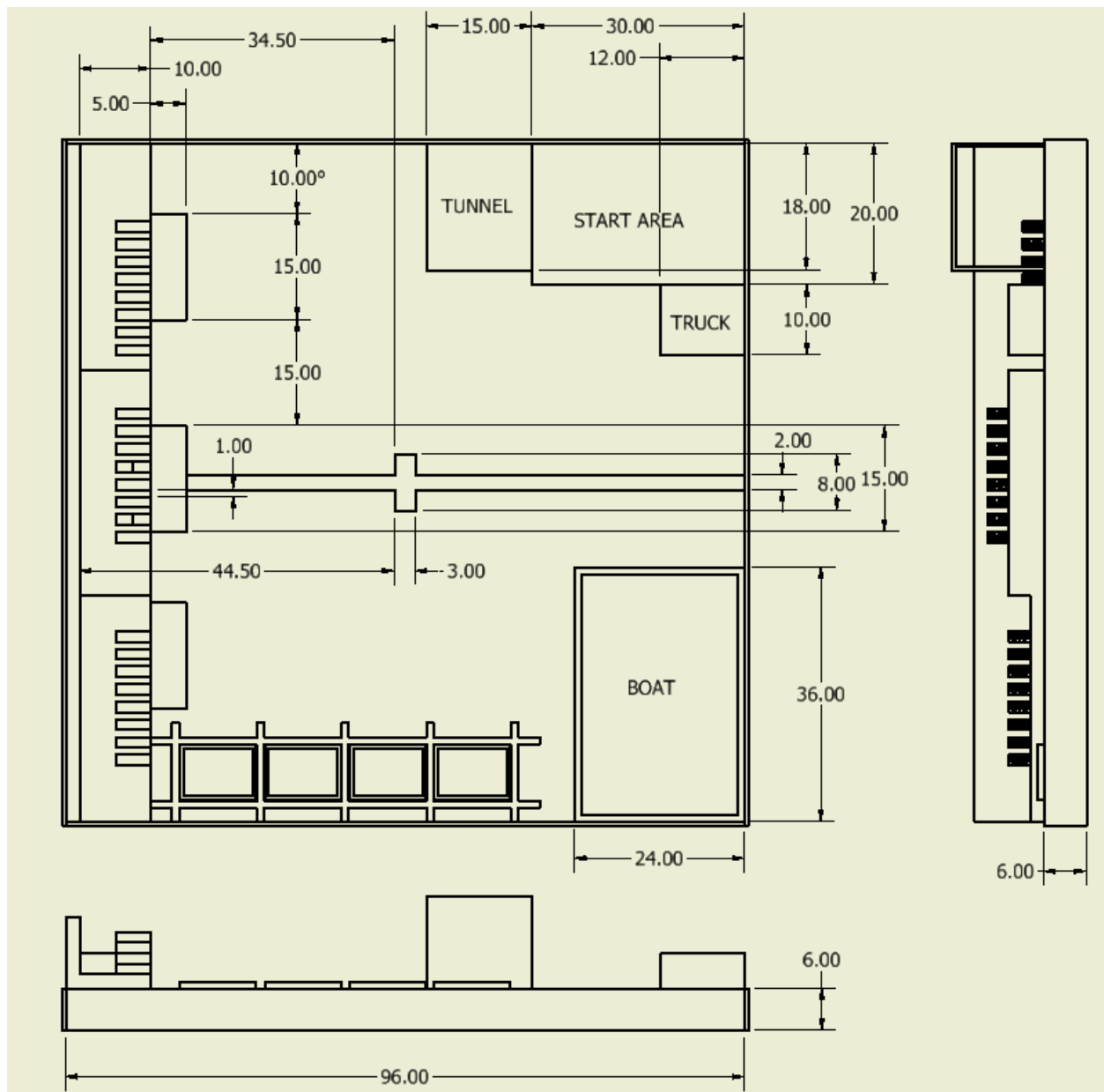
You are members of professional organizational which professional organization. Any unprofessionalism could disqualify you from the competition.

## 11. End of Timing (Game):

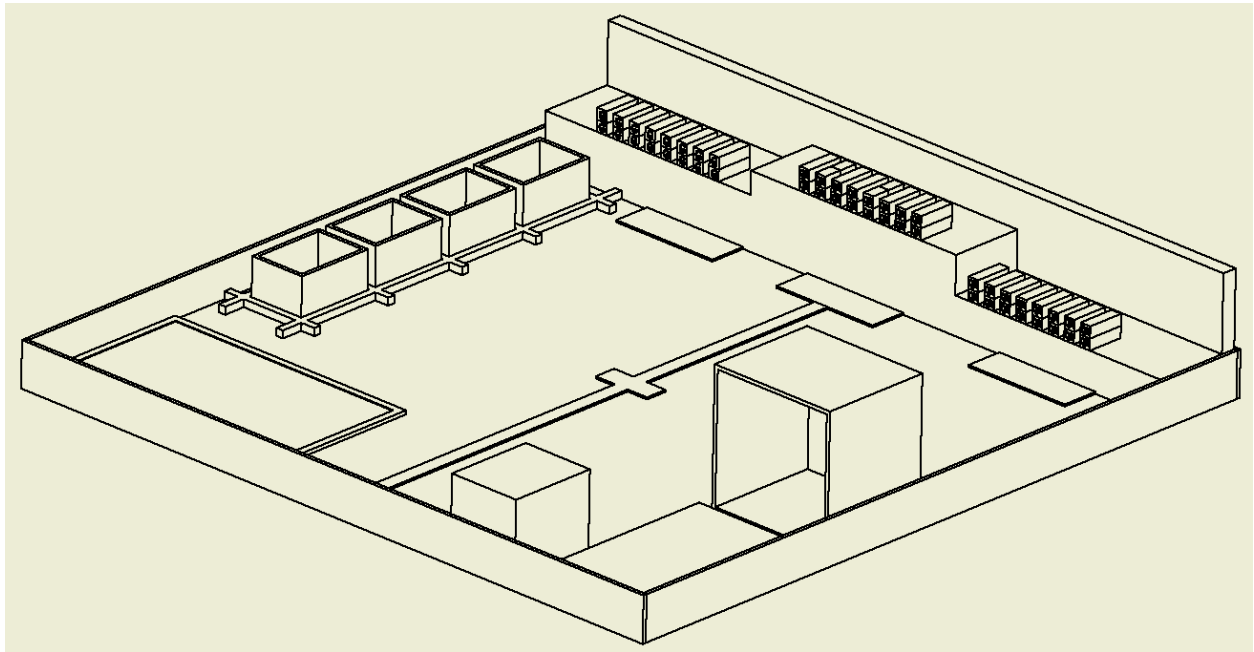
The game is over once the the time ends, at the 300-second buzzer. After that, judges will add points obtained.

Team will remove robot from board.

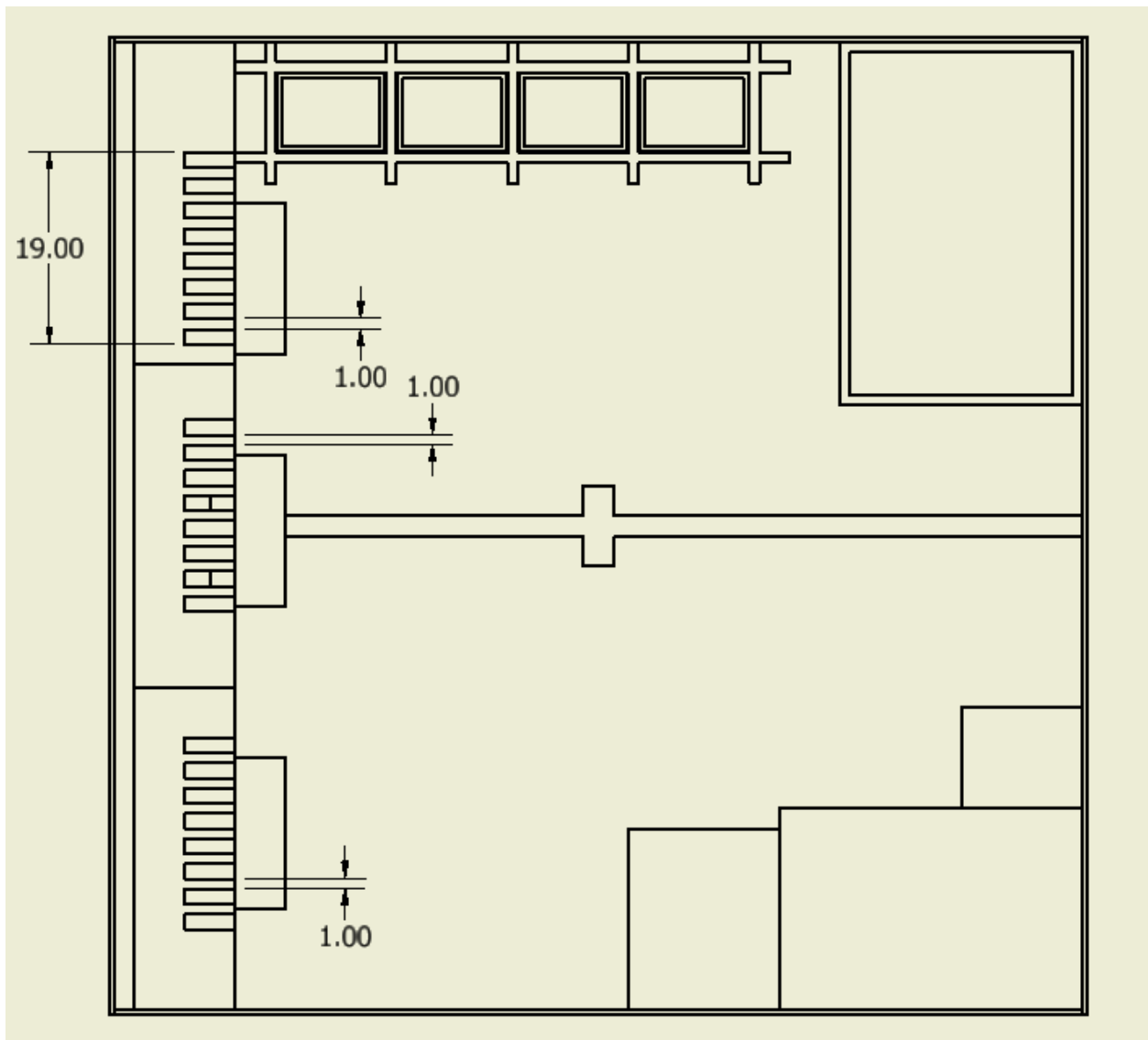
## Appendixes



Location of navigation strypes and distance behind the shipping goods



Note: Navigation cross and rectangles are flat, they are colored. They only have a height in CAD model to be distinguished

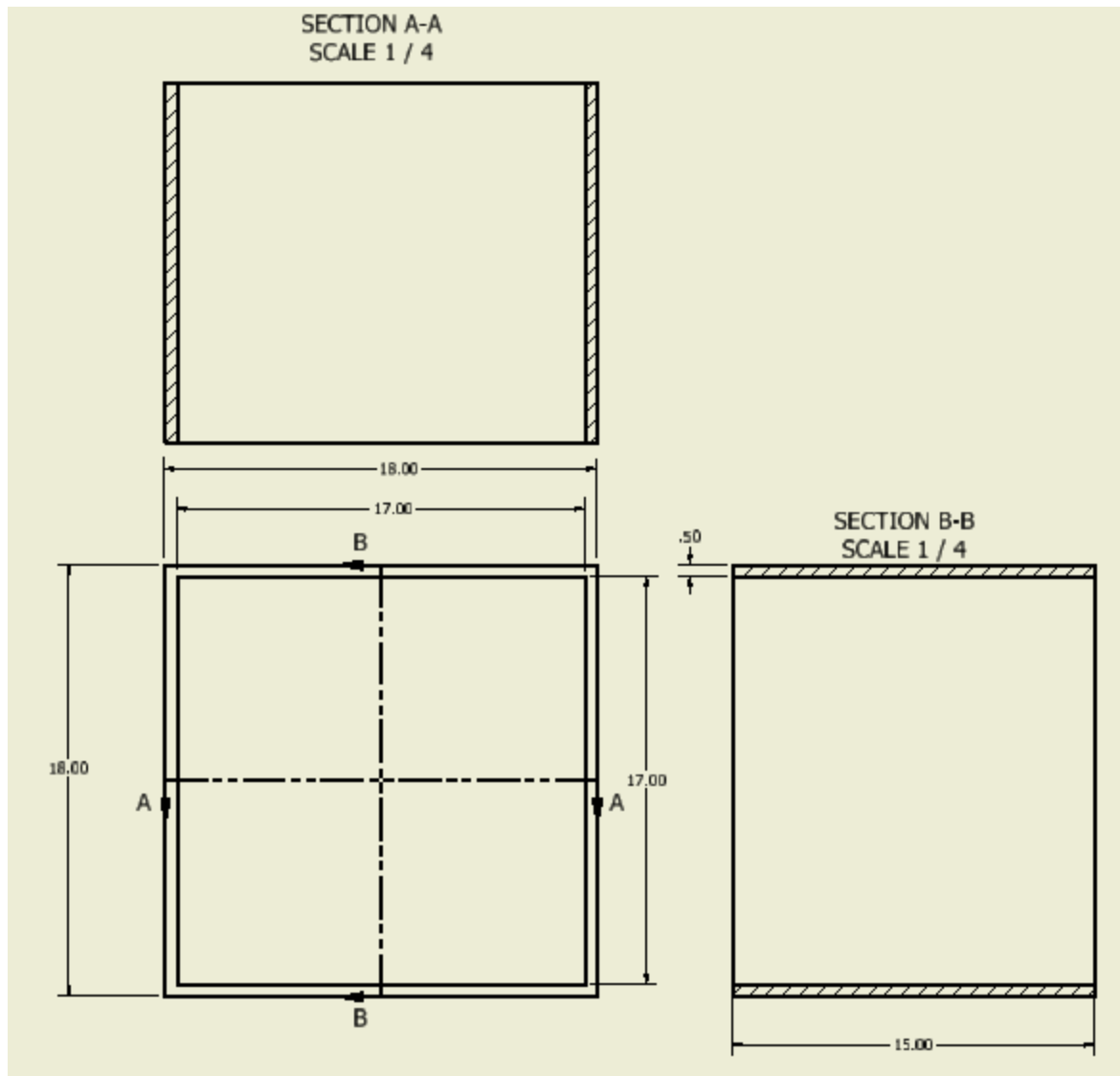


Drawing of a playing field (8 foot by 8 foot) surrounded by 6 in tall walls

8 oz. Rust-Oleum Flat Black Protective Enamel Paint  
Home Depot: Model # 7776730; Store SKU # 448087

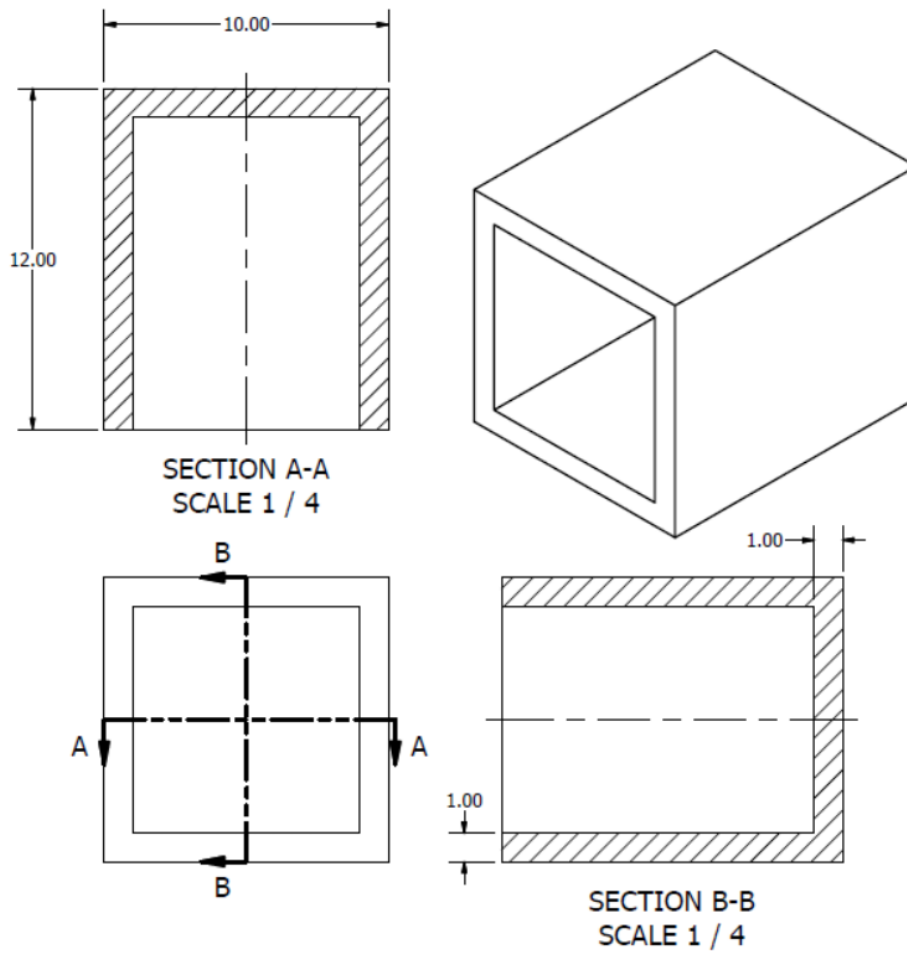
8-oz. Rust-Oleum Flat White Protective Enamel Paint  
Home Depot: Model # 7790730; Store SKU # 448575

4 pieces of 5/8 in. x 4 ft. x 8 ft. Sanded Pine Plywood  
Home Depot: Model # 326135; Store SKU # 326135

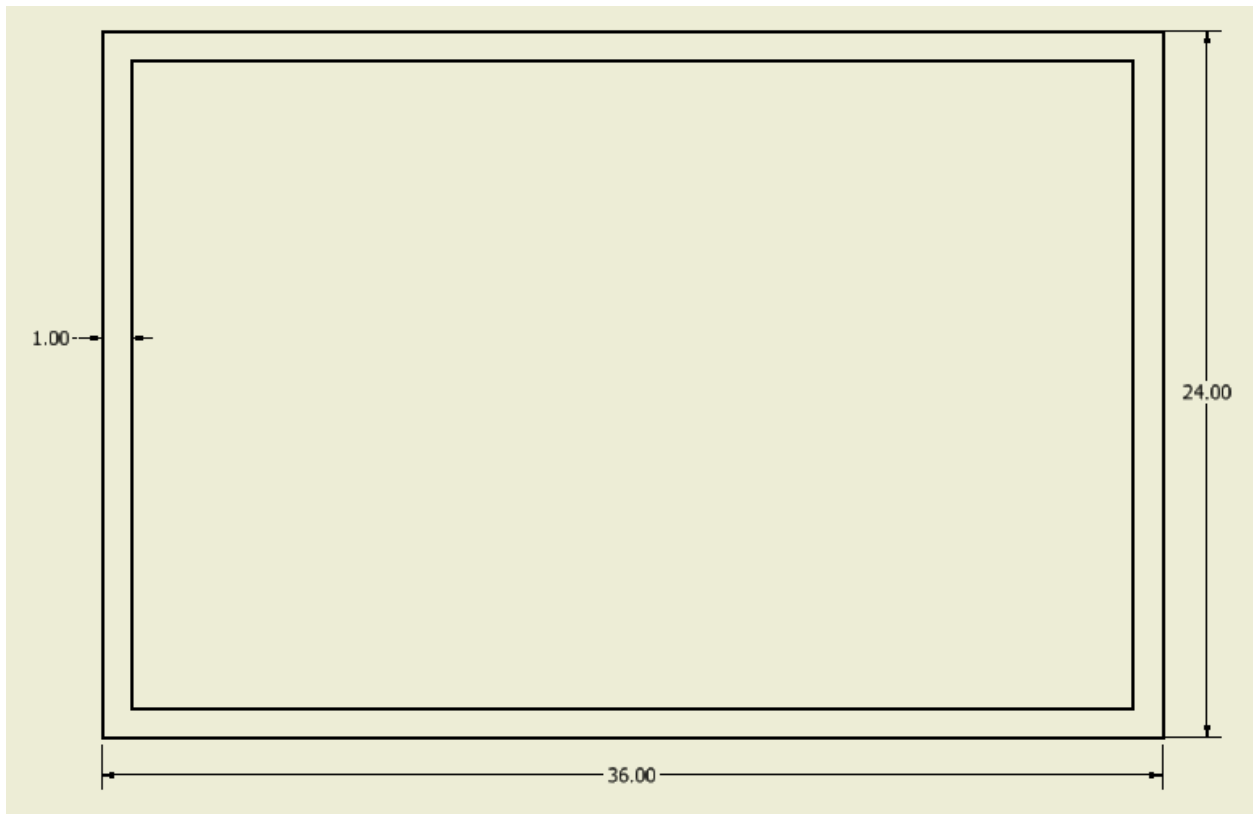


Tunnel drawing

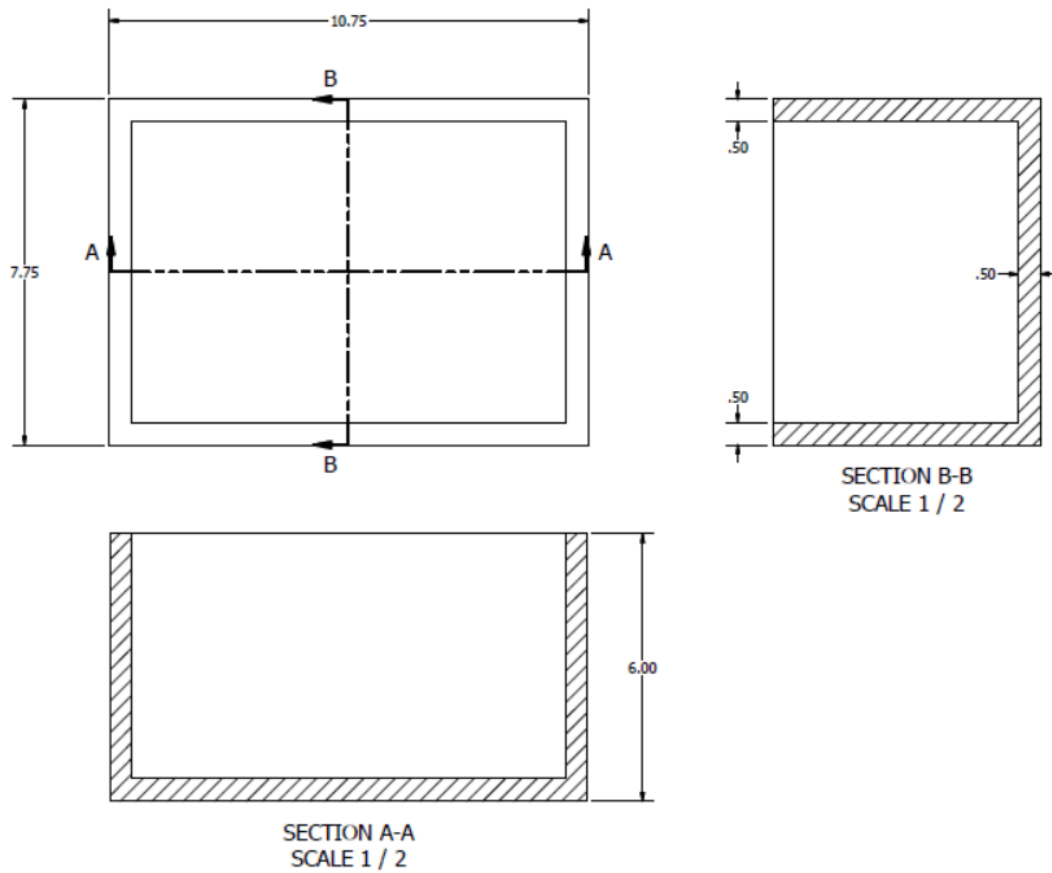




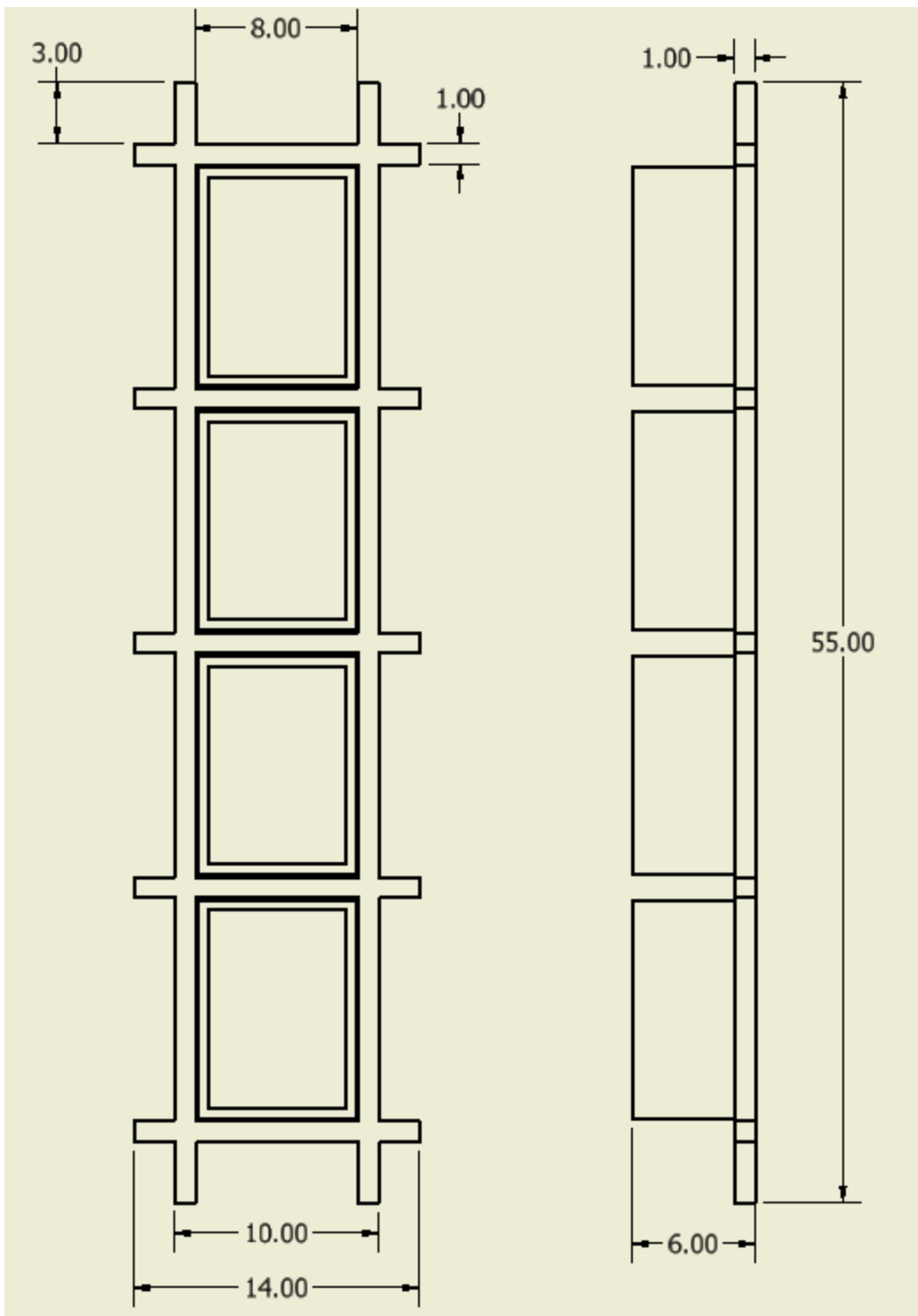
Truck drawing



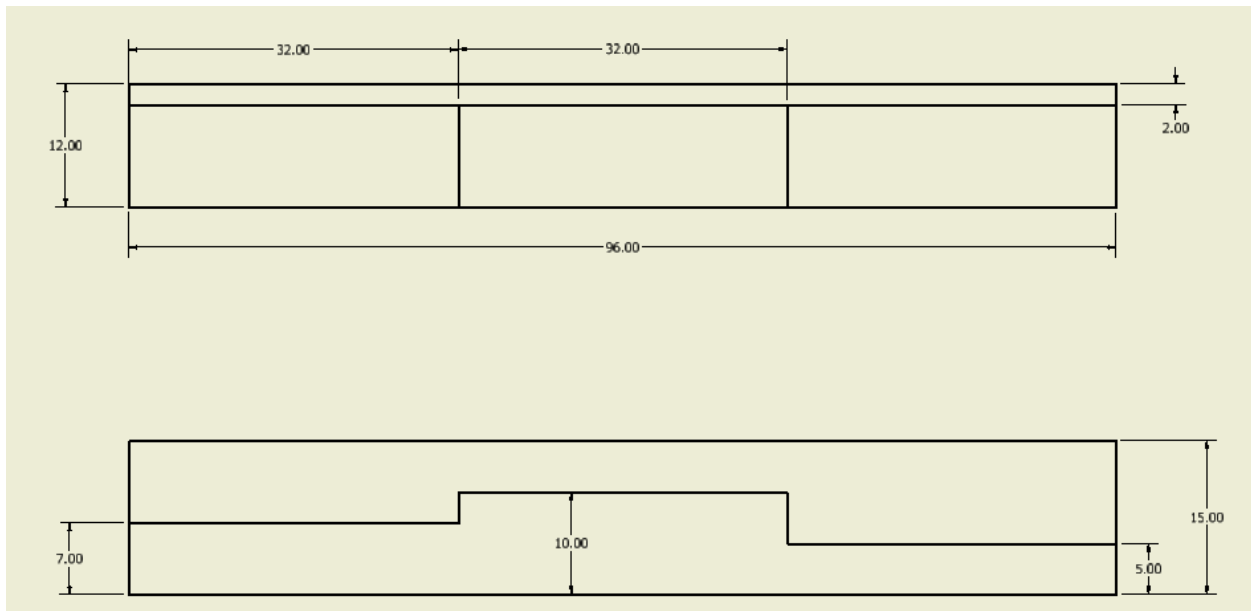
Drawing of a boat shipping zone



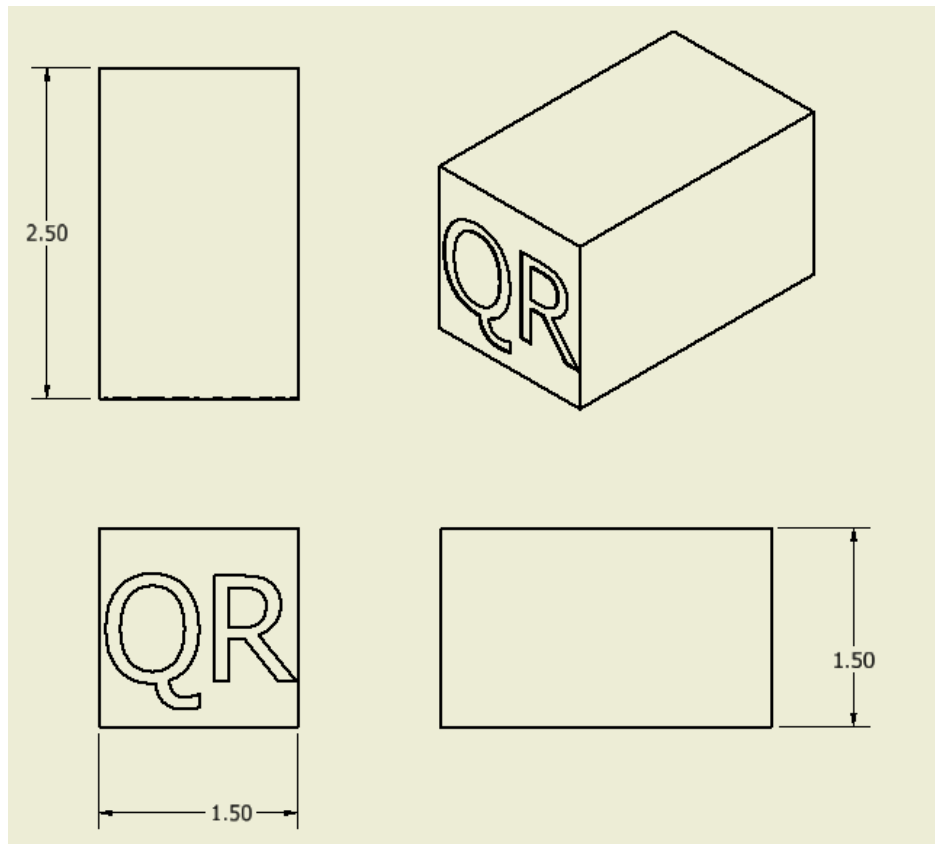
Rail shipping zone have four containers  
Dimensions of each railing car: 10.75" L x 7.75" W x 5" H.



Drawing of a rail shipping zone

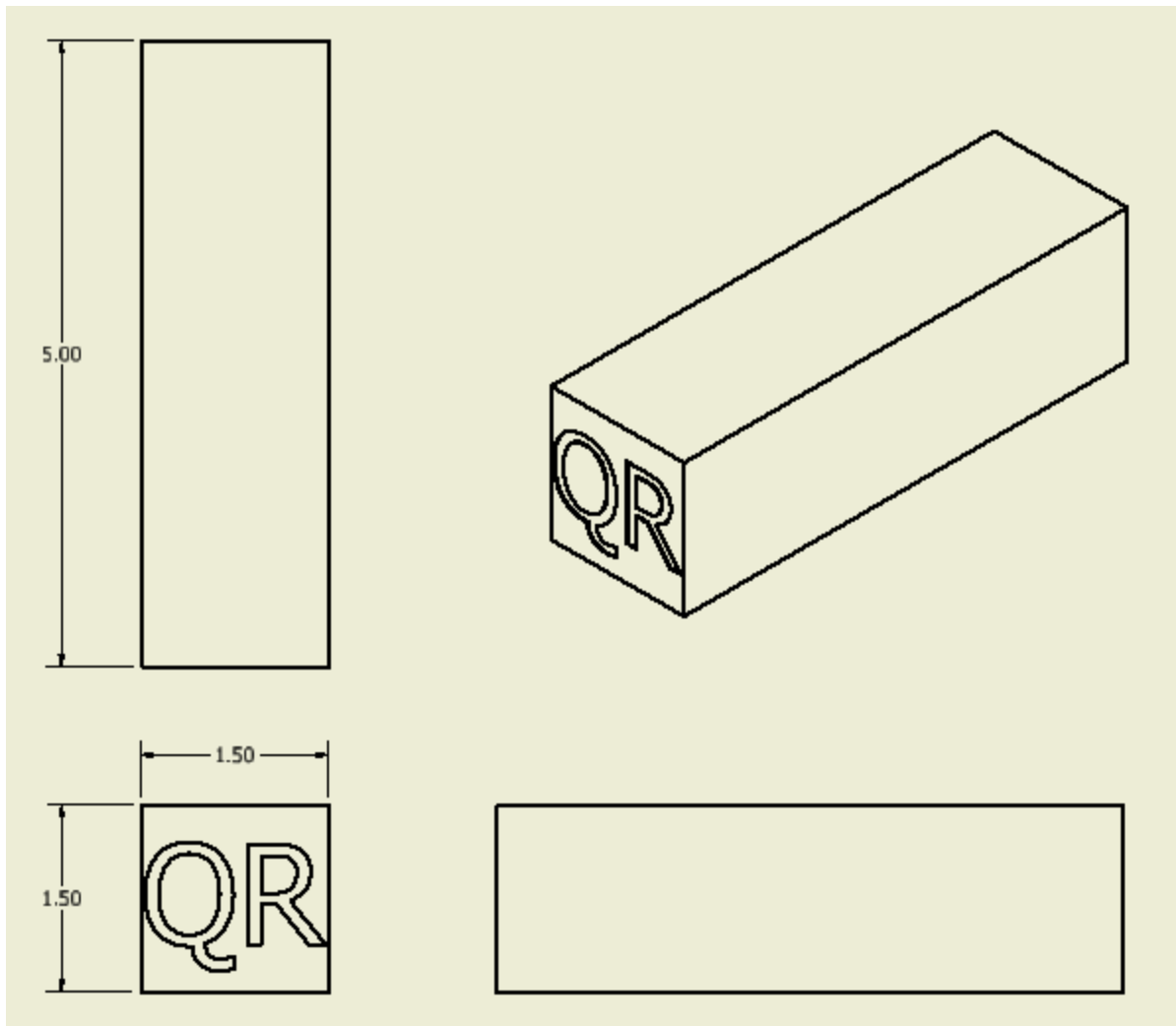


Drawing of a barge



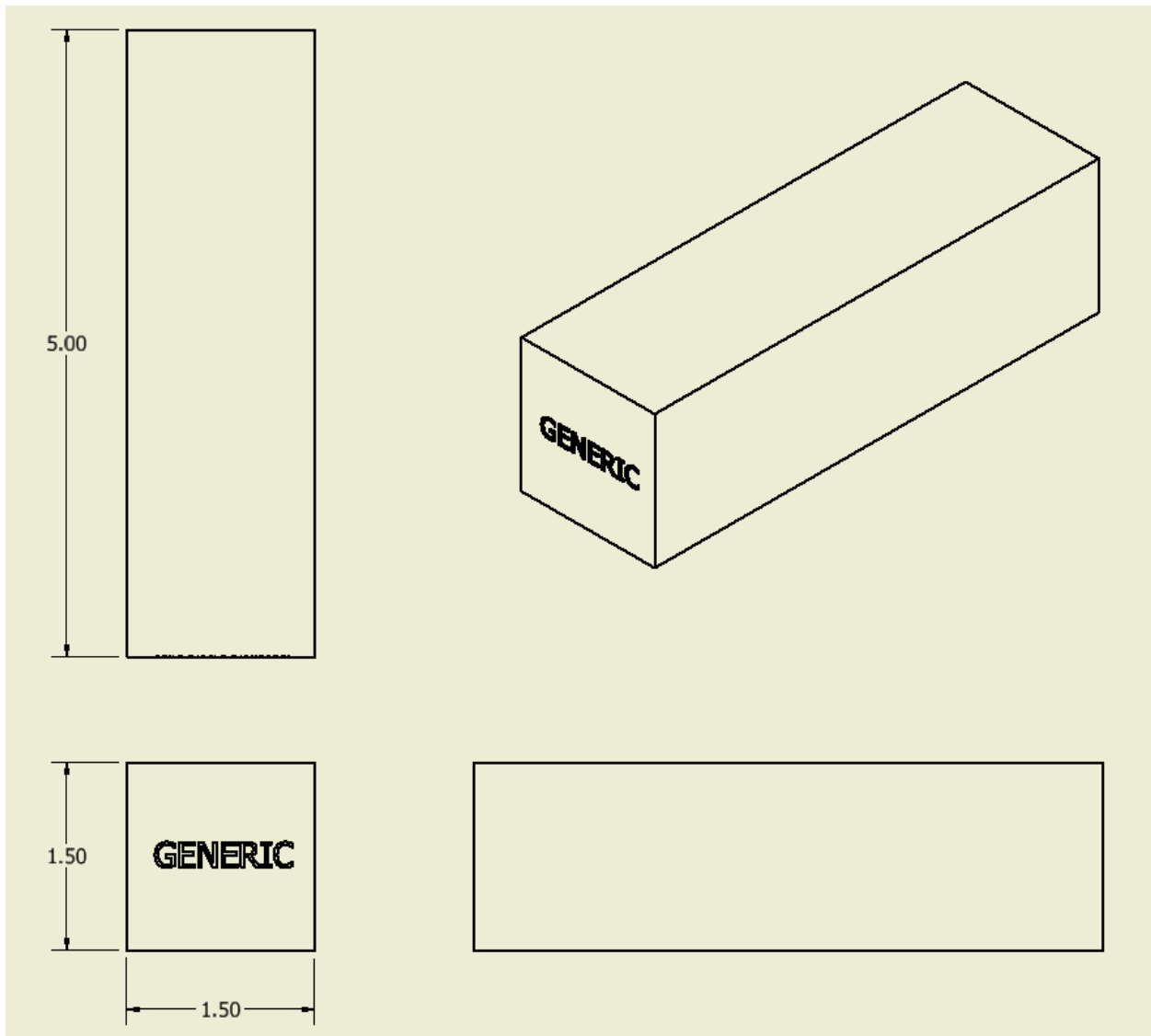
Shipping containers in zone A -QR codes a) 1.5 in x 1.5 in x 2.5 in

\*The word "QR" is just placed on them to see visually which one they are, they will be plain wooden colored blocks with QR code glued to them (QR code will correspond to their color)



Shipping containers in zone A -QR codes b) 1.5 in x 1.5 in x 5 in

\*The word "QR" is just placed on them to see visually which one they are, they will be plain wooden colored blocks with QR code glued to them (QR code will correspond to their color)



Drawing of shipping containers in zone C (1.5 in x 1.5 in x 5 in; same color (blue), no QR code)

\*The word "GENERIC" is just placed on them to see visually which one they are, they will be plain wooden blue blocks with no word on them



## Questions and Answers

**Q:** How will the current contest/scoring information be displayed to the crowds?

**A:** LCD projector.

**Q:** How close do you allow team members/visitors to be to the course?

**A:** Everyone will be at least 4 feet from the board's edge.

**Q:** Will you be using liquid or spray paint and how will it be applied?

**A:** The paint will be rolled on liquid black & white paint.

**Q:** Will the playing surface be elevated?

**A:** No, it will be on the floor.

**Q:** If the flash goes out during the round is that grounds for rerun?

**A:** No. It will be requested that the attendees do not take flash photography. However, it should be expected that an attendee may accidentally take a picture with flash. Also, most modern digital cameras use IR range detection to focus which could potentially interfere with the robot.

**Q:** Kind of a silly question, but I need to ask anyway, is the competition going to be held inside our outside?

**A:** Inside, in the ballroom of [Marriott Hotel in downtown Norfolk](#). Pictures of ballroom will be added later to this document.

**Q:** Finally, the two documents posted in the facebook page contradict one another. For example, look at the barge container zone contents. Which document do I use as a reference?

**A:** Only this google document which you are currently reading. All other versions are deleted from the Facebook page.

**Q:** Will the physical layout of the playing field remain the same throughout the competition or will there be any changes made between rounds ? For example, will the rail drop off point remain in the same position & orientation as depicted in the drawings between rounds?

**A:** The physical layout of the playing field will remain the same throughout the competition. There will be two versions as shown in Figures 1, 2, and 3. The sequence of colors will be unknown.

**Q:** Are the QR labeled containers painted the same color as the railing cars they are supposed to be dropped off in? If so, do the labels actually match the paint color or can a 'yellow' railing car have a yellow label but be painted green? Same question for the containers. Can a container have a 'yellow' label but be painted green?

**A:** The QR code on the railing car will match its color. Yellow label QR code will be placed on a yellow railing car.

**Q:** In Zone B, the scoring matrix states there are 8 5" blocks and 8 2.5" blocks (equivalent to 4 5" blocks) which totals 12 5" blocks. The drawings show 14. The same is true of Zone C, where the scoring matrix states 12 and the drawings have 14. Which is correct?

**A:** To avoid the confusion, now they are two rows, seven columns of shipping containers in each zone.

**Q:** Finally, the blue blocks in Zone A are scored positively when deposited in the boat. Are they considered generic as well?

**A:** Blue shipping containers in Zone A are generic. The issue in figures is now fixed.