2019 Student Division Robot Competition

Overview

Warehouse 4.0, the ATMAE warehouse, is introducing new receiving and storing robots. The upper management of the ATMAE warehouse wants to introduce just-in-time implications to help streamline deliveries and storage of the incoming shipments. During every shift, the warehouse receives a delivery of nine containers of three different weight barrels, three different weight square crates, and three different weight spherical containers at the loading dock (see Table 1). The ATMAE warehouse logistics team was able to have the suppliers color code the containers yellow, blue, and red for the different weights.

Warehouse 4.0 robot objectives:

1. Receive delivery: Robots will go to the loading dock to collect one container at a time.
2. Store delivery: Robots will have to store each container in the proper location.
3. Avoided obstacles: Robots will have to navigate the warehouse without colliding with equipment and or floor workers (employees).

Table 1: The containers

	Barrel			Crate			Sphere	
	1 Yellow	0.250 lbs ± 2%		1 Yellow	0.250 lbs ± 2%		1 Yellow	0.250 lbs ± 2%
	1 blue	0.5 lbs ± 2%		1 blue	0.5 lbs ± 2%		1 blue	0.5 lbs ± 2%
	1 red	1.0 lbs ± 2%		1 red	1.0 lbs ± 2%		1 red	1.0 lbs ± 2%

The Competition

Each robot will have a total of a 3-minute shift to try to support the objectives listed above with 15 seconds of the time designated for autonomous. Every successful objective completed will be awarded points to contribute to the overall score. The ATMAE warehouse has designated a room that is 18”x18”x18” for the robot to be stored when it is not in use. The robot must be able to fit in the room before it starts its 3-minute shift.

Scoring

Robots are awarded points during their shift. The wining robot is the team with the highest number of points.

Autonomous Period

Each shift will begin with a 15-second autonomous period when each robot operates only on preprogrammed instructions. During this period, robots work to support the three objectives listed above to contribute to their points. Hands must be off the controllers during the 15-second autonomous period. Points for these objectives are awarded as shown in Table 2 below.

Table 2: Autonomous point breakdown

Action	**Value**
Exit the robot storage room completely	5 points
Entering the loading zone	2 points
Obtaining a container (o a container in the air outside of dock station)	2 points crate, 3 points Barrell, 4 points sphere
Store delivery on shelf	4 points
Container color value upon storage	1 point brown, 2 points blue, 3 point red

Teleoperated Period

The remaining 2 minutes and 45 seconds of the shift, the teleoperated period, drivers control the robot remotely to support the three objectives listed above. Points for these objectives are awarded as shown in Table 3 below.

Table 3: Teleoperated point breakdown

Action	Value
Going to the loading zone	1 point
Receiving a container (have a container in the air outside of dock station)	1 point block, 2 points cylinder, 3 point sphere
Store delivery on shelf	2 points
Containers color value upon receiving in storage	1-point brown, 2-points blue, 3-point red

For example, if a robot during autonomous period exit out of the storage room and was able to remove a yellow crate out of the loading zone but did not store the crate on the racks during the 15 seconds, the robot would receive 5 points for leaving the storage room, 2 points going to the loading zone and 2 points for removal of the loading zone. The robot will receive a total of 9 point for the autonomous period.

Then during the teleoperated period, the robot stored the yellow crate in the racks, grabbed and stored the blue and red crates, then went into the loading zone to grab the last container when the shift ended. This robot will receive 3 points for storing the yellow create during the teleoperated period (2 points for storing and 1 point for a yellow container), 3 points going into the loading zone (1 point each visit), 4 points for storing the crates, and 5 points for the color value of the blue and red crates. The robot will receive a total of 15 point for the teleoperated period.

The total value will be will be 24 points for this shift (9 points autonomous and 15 points teleoperated).

Penalties

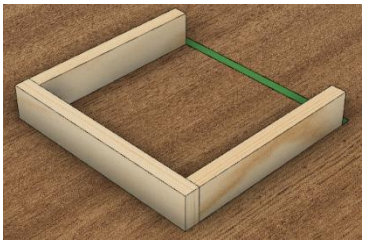
If a robot hits an obstacle (equipment, walls, and/or floor employees) there will be a time penalty and the robot must immediately stop for the required time penalty during the shift. This simulates the time needed for the team to complete paperwork and file a report to OSHA (simulation only no paperwork will be filed). Hitting equipment and/or walls will have a 5 second time penalty. Hitting an employee on the floor will have a 15 second time penalty.

If the penalty occurs during the automation period, the time penalty will be deducted from the teleoperated period points and the robot will have to wait the required time before it can start moving again.

Robot Requirements

1. Size: 18” x 18” x 18”
   - This limit applies to the resting position of the robot. The robot will start the competition in this configuration surrounded by three standard wooden 2 x 4’s on edge with an opening to the work floor as shown in Figure 1. Robots are allowed to exceed this dimension without hitting the walls of the storage room after the shift starts. For example, a robot may have an articulated arm that folds outside of the 18” x 18” x 18” volume. This is allowed provided that the robot can move itself into position without any help from an external person or object physically touching the robot.
2. Weight limit: None
3. Multiple teams per school are allowed and encouraged.
4. Cost: no limit to cost.

Figure 1: Robot storage room



5. Teams may not explicitly construct their robot out of a kit. 75%, of the robot as judged by the event coordinators, must have been constructed out of discrete components by the team.
6. Teams must design their robot so batteries can be quickly removed.
7. Teams are robots are not allowed to damage assets owned by the hotel, ATMAE or other teams.
8. All batteries must be labeled with your team name and a battery number. These batteries must be registered with the event staff during robot check-in.
9. Each robot is required to have a name. Teams are not allowed to have any offensive robot names.
10. Team members should be dressed professionally and appropriately (school branded shirts, clean, no loose clothing etc.)
11. A part list must be available. The part list should be organized professionally and display the overall cost of the robot.
12. The order of the robots during the competitions is random.

The Warehouse

The warehouse includes all elements and zones of the competition infrastructure that are required to compete in this year's Warehouse 4.0.

3D layout will be shared with the full version of the rules.

Zones and Markings

There are several areas within competition area that are described below. All lines are marked either using 1-inch gaffers' tape or 2x4's. For a robot to be in a zone, the robot must be completely across the 1-inch tape.

- Control station: The area where the robot operator is to control the robot in the teleoperated period located in central position on the side.
- Storage room: The location the robot will be placed to start the shift.
- Loading zone: The retrieval zone for the containers.
- Racking zone: The area to store the containers.

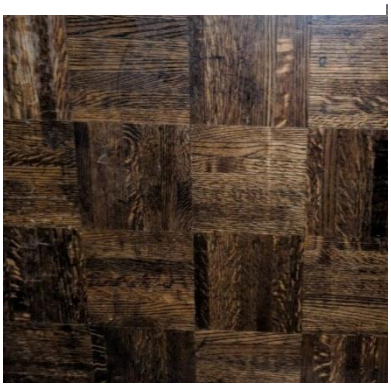
Layouts and sizes will be shared with the full version of the rules.

The Work Floor

The work floor is an area, bounded by 2 X 4 walls placed on edge on top of a hard floor (see figure 2). Obstacles to simulate employees and equipment will be placed within the floor.

Layouts and sizes will be shared with the full version of the rules.

Figure 2: Hard dance floor



The Containers

The containers will have three different shapes cylindrical, square, and sphere. That will be colored coded yellow for Light weight shipments, 0.250 lbs ± 2%, blue for medium weight shipments, 0.5 lbs ± 2% and red for heavy weight shipments, 1.0 lb ± 2%. The files will be available on the ATMAE website both in stl and object file format for teams to print using red, yellow, and blue PLA filament. The weight is obtained using BB's only in the center of the object during the printing process. The crate pallet can be purchased from amazon and should be glued on to the bottom of the crate using superglue.

Figure 3: cylindrical container

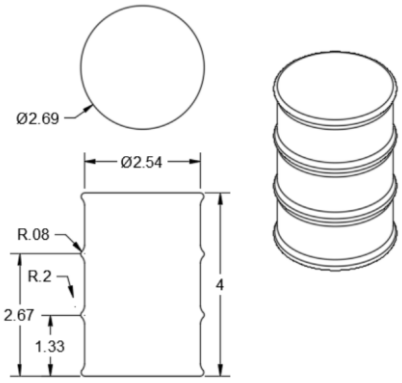


Figure 4: sphere container

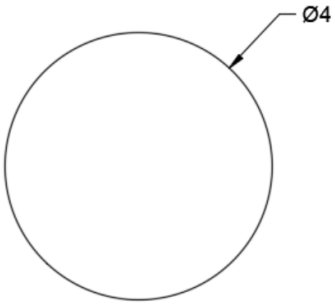
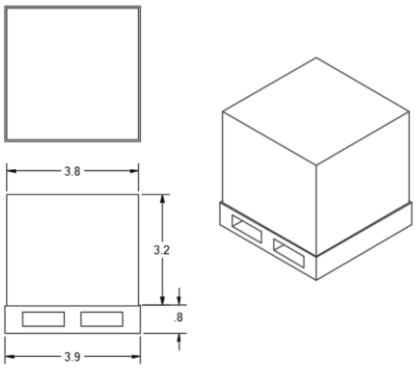


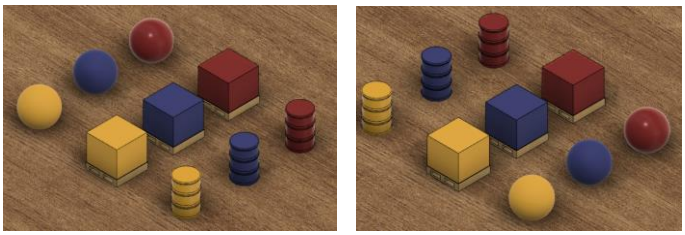
Table 4: crate



Loading Zone

The loading zone is used to retrieve the shipments. Trucks have already unloaded the shipments on the floor for you to collect. Crates are always unloaded in the middle with the sphere and barrels unloaded randomly at each side, see figure 5 below for the two possibly configurations.

Figure 5:Two possible of loading zone configurations



Additional layouts and sizes will be shared with the full version of the rules.

Racking Zone

The racking zone is the final destination for the containers. To store the containers properly, only one shape can be stored on the same level. For instance, you cannot store all three crates on the bottom level; one crate can be on the bottom, one can be on the middle, and one can be on the top. Lateral locations are not restricted. The racks are made up of four standard wooden 2 x 6's held to the floor with 1-inch gaffers' tape. On the top of the racks will be tissue paper tacked on to represent the celling of the warehouse. If you break the celling, there will be a 5 second time penalty. There will be six 18'' 18-gauge wire taped along the front and back edges of the shelf and placed on the floor directly below the rack edges with black gaffers' tape to help hold the spheres in place. The wire is acting as a lipped edge on the rack to prevent the sphere from rolling off on its own accord but not hindering a mistake of bumping the sphere off with the robot.

Figure 7: The storage racks

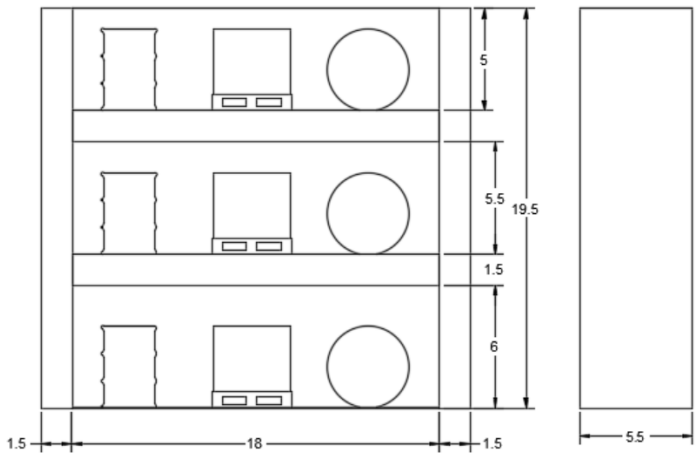


Figure 6: Racks showing tissue paper ceiling

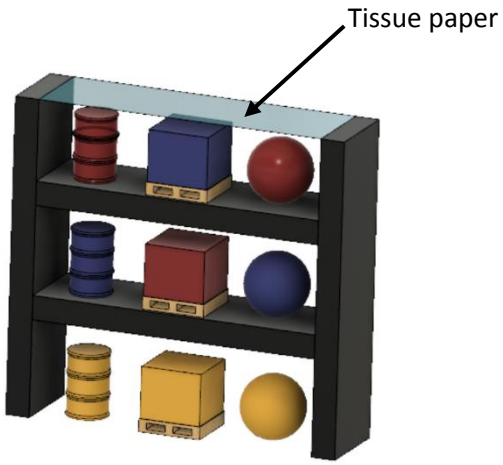
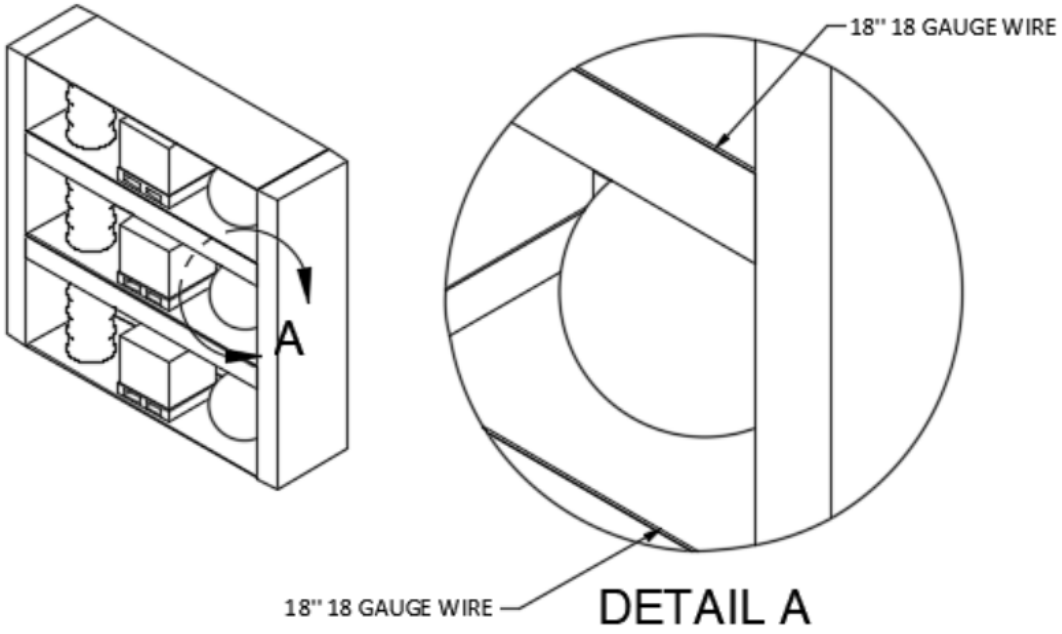


Figure 8: Close up of the placement of the wire to help retain the sphere in the racks.



Safety Requirements:

Emergency Stops:

All robots must have a mechanical emergency stop mushroom button (similar to this) mounted on the exterior in an easily accessible location. This emergency stop button must control an inline main power relay to function as a mechanical disconnect means to disconnect power to all components of the robot. No components of the robot are to be energized while the emergency stop is activated. In addition, all robots must have an emergency stop button located on the hand-held robot controller. The hand-held controller is required to be held by a qualified driver at all times while the robot is energized (i.e., while either emergency stop buttons are NOT activated). The following technical brief should be used as a design guide: Emergency Stop Push Buttons.

Teams are required to demonstrate both emergency stop mechanisms before the event to the event judges to be eligible to compete.

Lithium Batteries

Lithium Battery Fires (From: http://www.towerhobbies.com/help/ama_lipo/index.html)

Lithium batteries are becoming very popular for powering the control and power systems in our models. This is true because of their very high energy density (amp-hrs/wt. ratio) compared to NiCd's or other batteries. With high energy comes increased risk in their use. The principal risk is FIRE which can result from improper charging, crash damage, or shorting the batteries. All vendors of these batteries warn their customers of this danger and recommend extreme caution in their use. In spite of this, many fires have occurred as a result of the use of Lithium Polymer batteries resulting in loss of models, automobiles, and other property. Homes and garages and workshops have also burned. A lithium battery fire is very hot (several thousand degrees) and is an excellent initiator for ancillary (resulting) fires. Fire occurs due to contact between Lithium and oxygen in the air. It does not need any other source of ignition, or fuel to start, and burns almost explosively. These batteries must be used in a manner that precludes ancillary fire.

The following is required:

1. Store, and charge, in a fireproof container; never in your robot.
2. Charge in a protected area devoid of combustibles. Always stand watch over the charging process. Never leave the charging process unattended.
3. In the event of damage from crashes, etc, carefully remove to a safe place for at least a half hour to observe. Physically damaged cells could erupt into flame and after sufficient time to ensure safety, should be discarded in accordance with the instructions which came with the batteries. Never attempt to charge a cell with physical damage, regardless of how slight.
4. Always use chargers designed for the specific purpose, preferably having a fixed setting for your particular pack. Many fires occur in using selectable/adjustable chargers improperly set. Never attempt to charge Lithium cells with a charger which is not specifically designed for charging Lithium cells. Never use chargers designed for Nickel Cadmium batteries.
5. Use charging systems that monitor and control the charge state of each cell in the pack. Unbalanced cells can lead to disaster if it permits overcharge of a single cell in the pack. If the batteries show any sign of swelling, discontinue charging and remove them to a safe place outside as they could erupt into flames.
6. Most important: NEVER PLUG IN A BATTERY AND LEAVE IT TO CHARGE UNATTENDED OVERNIGHT. Serious fires have resulted from this practice.
7. Do not attempt to make your own battery packs from individual cells.

These batteries CANNOT be handled and charged casually such as has been the practice for years with other types of batteries. The consequence of this practice can be very serious resulting in major property damage and/or personal harm. Violation of any of these battery safety protocols can result in the termination of your team from the competition.

More information to come with the full release of the rules

This announcement should allow your team to start brainstorming the design of your robot. More details will be shared soon and will include additional details such as:

- Robot quarantine requirements while at the conference;
- Additional layouts, sizes, and pictures;
- Additional details on judging that includes but not limited to: robot design, fabrication, presentation, and team spirt.

Summary of robot competition

- Robot size 18” x 18” x 18” at the start of the shift.
- 15 second autonomous period.
- 2 minutes and 45 seconds teleoperated period.
- 3 different shaped containers: cylindrical shape, square, and a sphere.
- 3 different weights and colors: yellow for 0.25 ± 2%, blue for 0.5 ± 2 %, and red for 1.0 lb ± 2%
- Safety switch is required.
- 75% of the robot must not come from a kit.
- Quick battery removal is required.
- Highest overall points win.
- Time penalty for hitting obstacles.
- Part list is needed.
- No required robot poster competition and no required paper.
- Have fun!

Robot Tag

This fun competition will continue from previous ATMAE conferences. This is a competition that is just for fun – no points.

In this single elimination event each team will attempt to capture a flag that is magnetically attached to each robot. The flags will be attached to each robot via a small magnet. There will be between 2 and 4 robots competing at any one time. The flag material will be typical, non-adhesive 1” plastic ribbon. Magnets and flag materials will be provided for this event by ATMAE.

Teams are allowed to build a remotely operated mechanism, if desired, to assist with the capturing of an opponent’s flag. This mechanism is allowed to be removable for the other events. The only way that this mechanism can be used is to pin or grab your opponent’s flag. Teams robots must be able to fit in the same storage area in warehouse 4.0 for tag.

Overly aggressive mechanisms, or mechanisms which operate in constant motion will not be allowed. Remember, we have spectators, and we do not want any flying debris.

Purposefully aggressive behavior will immediately disqualify a team. This is not a battle! Robot Tag will be the last competitive robot event.

Additional details will be shared with the release of the full competition rules.