IEEE Latin American Robotics Competition for Student

RULES OF OPEN Category – 2018/2019

Version 1.0 – March, 2018

Supporting Robots for Port Operations

introduction

In globalization, cargo traffic at a port has reached its operational limit, making it increasingly difficult to avoid delays in the departure of ships and trains arriving daily. To solve this serious problem, it requires an autonomous system that is able to improve the process of unloading and loading the containers in ships and trains to increase the efficiency of the port terminal and guarantee the demands of different companies.

This is a challenge that professionals will have in the very near future. Thinking about a possible solution, this challenge was planned - re-edited from (LARC / CBR 2009), that through a robotic competition, the participants should develop a robot that is fast and precise in the handling of the containers.

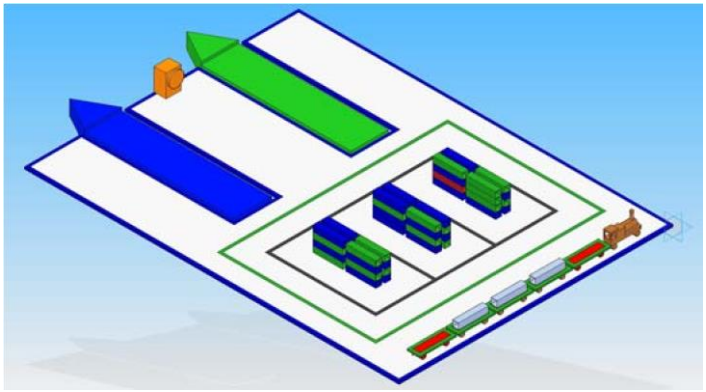


Figure 1 – general view of the contest

The main goal

In the port scenario (Figure 1), a robot must unload (orderly) the largest number of containers for two ships and one train. Containers will be painted in three different colors: red, green and blue. The robot should be able to distinguish the colors of the containers and based on this information must decide whether to carry it on the train or on a ship.

The competition consists of three objectives, which can be executed in any order and is not mandatory to carry out all.

1. The robot must carry two red containers in two wagons of the train with precision. That is, the robot must be able to deposit the containers within a rectangle whose dimensions exceed the dimensions of the container by 4 mm. Also, the container should not touch the boundaries of the rectangle. The dimensions of the area where the containers are to be deposited are 48 mm x 208 mm.

2. The robot must carry **green and blue containers** inside ships of the **same color**. The ships can be loaded in three ways: a) forming a container floor b) making towers with the containers c) mixing the two previous methods. The more containers that are loaded on the ship the higher the score will be. Containers placed correctly will be scored according to the level they are on.

3. In a port, there is communication between the operators of the crane, the conductors of the ships and the train. For this communication they often use horns. For this reason, once the two train containers are loaded, the robot must press a button on the edge of the stage, located between the two ships, to play a horn signaling the end of the precision step. The button is composed of a 10 cm diameter disc to facilitate the area of contact with the robot.

Arena Settings

The arena´s setting is built on white MDF. It consists of two levels, in the first level are located the zones of port and zone of the ships, and in the second level is located a train to be loaded.To differentiate the various elements of the scenario, the silhouettes of each zone (ships and train) will be demarcated with insulation tape. The area will have no walls, only a "step" in the train zone.

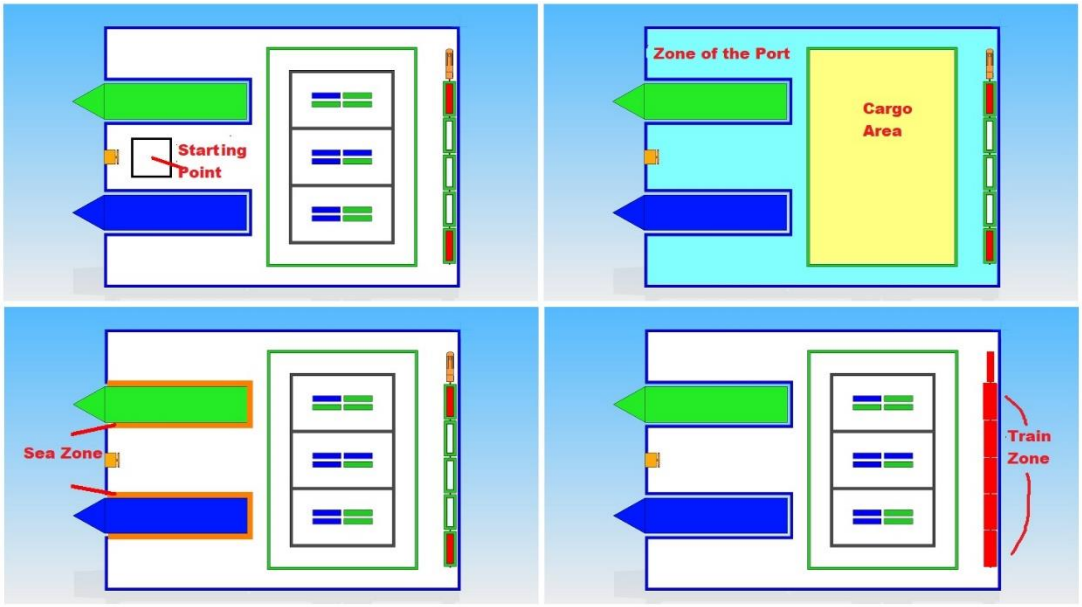


Figure 2 – Zones defined by colored tapes

In the scenario the following zones are identified:

- **The zone of the port** is delimited by blue tape (e.g. 3M® tape of 19 mm). The robot will be penalized if it touches this tape.

- **The cargo area** is located within the port area. The identification is made by green insulation tape (e.g. brand 3M® of 19 mm). The cargo area contains 03 rectangular areas within which will be centralized 16 containers stacked in groups of 04, totaling 48 containers. Each stack of containers will be spaced 2 cm apart. Rectangular areas are marked with black 3M® mark 19mm insulation tape.

- **The train zone** will be raised 50 ± 2 mm from the first level, and will have a simplified model of a train. The loading area of the train shall be delimited by green marking tape (for example 3M® mark of 19 mm). The silhouette of the train will be drawn with black tape 3M® of 19 mm. The train zone will be composed of 05 in-line wagons of which the first and the last will be free in each round. In this space (first and last wagon) the red containers must be deposited. The other three wagons will be occupied by fixed containers.

- **The area of the ships** is defined by the silhouettes of the ships, which are made with pieces of colored MDF, one painted green and the other blue. The dimensions of the ship will be such that there will be 20 mm of empty space between the port area and the ship.

- **The sea zone** is understood as everything around the port area and the tiny separation between the port area and the ship zone which is 20 mm and covers the entire perimeter of each ship.

- **The starting point** of the robot is 10 cm from the horn button, and it is a 30 cm square on the side. It is delimited by black insulation tape, 3M® mark of 19 mm. The robot can start its round within the starting point area and its front part can be directed to any side of the port, as long as it is inside the starting point.

The horn button will be built in wood and stuck to the scenery. When pressed properly, it may or may not, at the discretion of the organization, play a sound or turn on an upper light. The button will be **red** in color, like the containers that should go to the train. A drawing of the button with dimensions in mm is shown in the Appendix.

There will be **48 containers**, 02 of red color, 23 of green color and the other 23 in blue. They will be made of square SAE 1010 (structural steel) steel profiles of 01 mm thick and 40 mm side. Its length will be 200 ± 1 mm and will have a weight of 250 ± 10 g. These containers will have both ends open and three of their outer faces painted **red**, **green** or **blue**. The fourth face will be painted **black** and it will be in direct contact with the floor. There will be 3 more red containers fixed on the train. Containers will always be located in the same physical position within the scenario and there will always be 04 containers per tower. In each round, for each team, the color order of the towers'

containers will be randomly changed. Details and measurements of the arena, button and container are in the Appendix.

Lighting Conditions

The local committee will try to provide uniform lighting throughout the arena. However, teams should be prepared to calibrate their robots based on the lighting conditions of the venue. The local committee will take actions to minimize the effects of shadows and natural light, however these factors cannot be completely eliminated. Therefore, it is highly recommended that competitors design their robots to be immune to the variations of lighting that can be presented in the venue during the competition. Once the competitions have begun, the teams will "play" under existing lighting conditions without discussion or claims.

The Robot

The robot must be a fully autonomous mobile device, it must be able to walk the stage and fulfill the objectives, without human intervention, without communication with computer equipment external to the robot, and using only the devices that it takes on board.

There are no manufacturing restrictions on materials, mechanical and electronic components, and may contain an unlimited number of parts, sensors, actuators, and pre-fabricated or hand-made processors (manufactured by competitors).

There are only few restrictions that all robots must follow:

- The robot's wingspan should not exceed (at the beginning of the round) a 30 cm cube
- The robot should not communicate with external devices or human in any way.
- It should not damage the scenery.
- It must have only one start button, which will be used in all rounds of the competition. This will ensure that the information used by the robot is obtained by its own sensors and not those observed by the team members.

Violating any of the above restrictions is a condition of disqualification.

The Competition Rules

For each team in each round, a lottery will be made to define the positions of the containers. After the lottery, the team will not be able to modify their robot in any way. Changes and re-scheduling are allowed only after the round has ended.

When the robot starts its round no intervention can occur, otherwise it will be considered as a restart. The robot starts the race at the starting point and will be transferred to this position on each restart. Each robot will have a maximum of three attempts per round, therefore, 2 authorized restarts.For each restart, all moved containers are placed back in the initial position of the first attempt, but without stopping time. The organizing team will be responsible for re-packing the containers.

If the robot presents an obvious mechanical problem, if the judge allows, the participating team can make an intervention in the robot. They can start again (it does not count as a restart) and the time does not stop. A mechanical problem is evident, for example, the detachment of a wheel, motor, sensor, battery without power, or any difficulty not associated with a bad design that prevents its normal operation and can be repaired within the framework of the form fast. The team, in this case, and only after authorization of the judge, can go to his bench and fix the robot. If the judge does not understand that there was a mechanical problem, it will not authorize the maintenance of the robot. Time does not stop at all.

The robot cannot leave the port zone, i.e. it cannot enter the sea zone or the train zone. Each time you leave the port zone, you will be punished with **- 100 points** and the **fourth time** that this occurs the round will be finished. Exiting the port zone means when any part of the robot comes in contact with the lines that define the area or beyond them. If the robot gets stuck or loses its balance by moving into forbidden zones, team members can make an intervention in their robot, but it will be considered a restart, and time measurement will not stop.

Two red containers should be taken to the train area. The container of green or blue color must be taken to the ships of the respective colors. At all times the black face should be facing the ground (base of the scenery).

Containers should be transported one by one, and also **be removed one by one** in order from top to bottom. They can not be placed or forgotten in the corridors of the cargo area or port area, otherwise it will be penalized with **-100 points**. Containers will be considered "well-deposited", if they not leave the ship's area and be parallel to the ship's edge. For example, a container that is misplaced is the one that trespass the ship's area. Figure 3 shows some examples of correct and incorrect ways of depositing containers on ships.

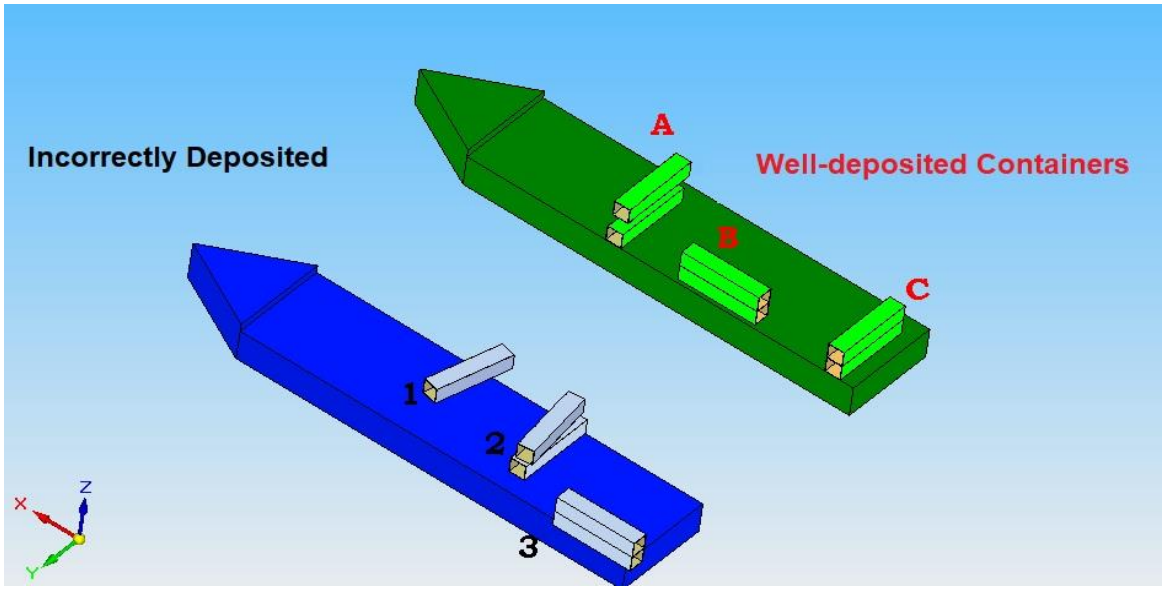


Figure 3 – Correct and incorrect ways to deposit containers on the ships

Containers will be considered "well-deposited" if:
A) The leveled containers are not perfectly aligned, but the first (in the bottom) is aligned with the ship.
B) All perfectly aligned.
C) Perfectly aligned, and with one border of the container touching the ship's edge.

Containers will be considered "incorrectly deposited" if:
1) Containers are not aligned with the ship. Part of the container is off the ship.
2) The upper container is not aligned in relation to the first.
3) Although the containers are aligned with the ship and with each other, part of one container leaves the ship.

A round is declared finished in three ways:

- If the round´s time is finished (5 minutes).
- If the team decides to terminate its participation, even if all goals have not been met. It is worth the score obtained and the time spent until the moment of closure.
- The robot has already used the 2 authorized restarts.
- When all containers are positioned in an appropriate location.
- If the robot enters the sea zone or the train zone four times

Punctuation

The punctuation form will depend on the zone and the activity performed.

Train Zone (precision zone):

- If this is a precision zone, the two containers must be correctly positioned on the wagon. For each correctly positioned container it will be assigned **500 points**. If they are positioned in this area, but in an incorrectly way, it will be considered only **100 points each.**
- If the robot presses the button after having deposited the two containers on the train, **1000 points** will be added to the score.

Ships Zone:

- For each container placed within the ship zone and on the first floor **100 points** will be awarded, the second floor **200 points**, **300 points** in the third and so on. If the first container is not within the loading zone, the tower score will not be considered and -**100 points** will be removed.
- The score assigned to each container will be valid once the robot is no longer in contact with it, that is, after completing the loading. There is no limit to the number of containers that one wishes to stack in the ship zone.

General rules:

- For each restart, the score is reset, the time is kept and the containers return to the starting position. Each round has a maximum of two restarts. It is up to the team to decide whether to keep the score so far and to end the participation or if they will try a restart, with a new score returned to zero. It will ALWAYS BE CONSIDERED as the team's score for the round, the score of the last try.

- Place a container in the wrong zone, **-100 points.**
- If a container falls inside the cargo area or over the ship zone it will be penalized with **-100 points.**
- If a container falls into the sea zone it will be **-100 points**.
- Each time the robot enters the sea zone, you must deduct **-100 points.**
- The first and main criterion for determining the winner is the highest score. If there is a tie the second criterion will be the shortest time. In the case of a tie in both criteria, an extra round for tie-break will be held. During the final rounds, when there is a tie in the score, there will be an extra round immediately to determine the 1st, 2nd and 3rd places

Any consideration or exception is at the discretion of judges and organizers..

The execution of the rounds

Before starting the rounds, if the team finds it is necessary to do a color or lighting calibration, an extra minute will be given to each team before its round.There are two types of rounds, qualifying and final:

Qualifying rounds:

- All registered teams in the IEEE Open category must participate.
- Consists of 04 rounds per team. This number may vary, at the discretion of the judges / organization of the event.
- The maximum time per team to perform the round is 5 minutes with 1 extra minute of initial calibration.
- Each team can restart their robot twice per round. For each restart the score will be zero and the time will not stop (time running).
- The best score of the four rounds will be taken into account to decide which teams will advance to the final rounds. The four best teams will be qualified to finals.
- If there is a tie, it will be chosen who got the score in the shortest time. If the tie persists, a new round between the tied teams should occur.
- Each team has 1 minute to appear in the arena, after that period, the time of the competition begins to run.

Final Round:

- The top four teams in the qualifying rounds are in attendance.
- It consists of 03 rounds.
- Maximum time per team to perform the test is 5 minutes + 1 minute of calibration.
- Each team can restart their robot twice per round. For each restart the score will be zero and the time will not stop (time running).
- The best score of the 03 rounds will be taken into account to determine the champions.
- If a tie occurs, a fourth round will be played between teams tied to define their place.
- Each team has 1 minute to appear in the arena, after that period, the time of the competition begins to run.

Requirements to Participate

Those interested in participating in the Latin American Robotics Competition LARC IEEE OPEN category must form teams of undergraduate or graduate students in any educational institution in any country. Nevertheless, high school students will also be allowed to participate. To register, teams must submit a document describing the development and operation of the robot (TDP) in IEEE format. This TDP will be used for the winners to make a brief report to the other competitors. Please, verify the deadlines on the event website.

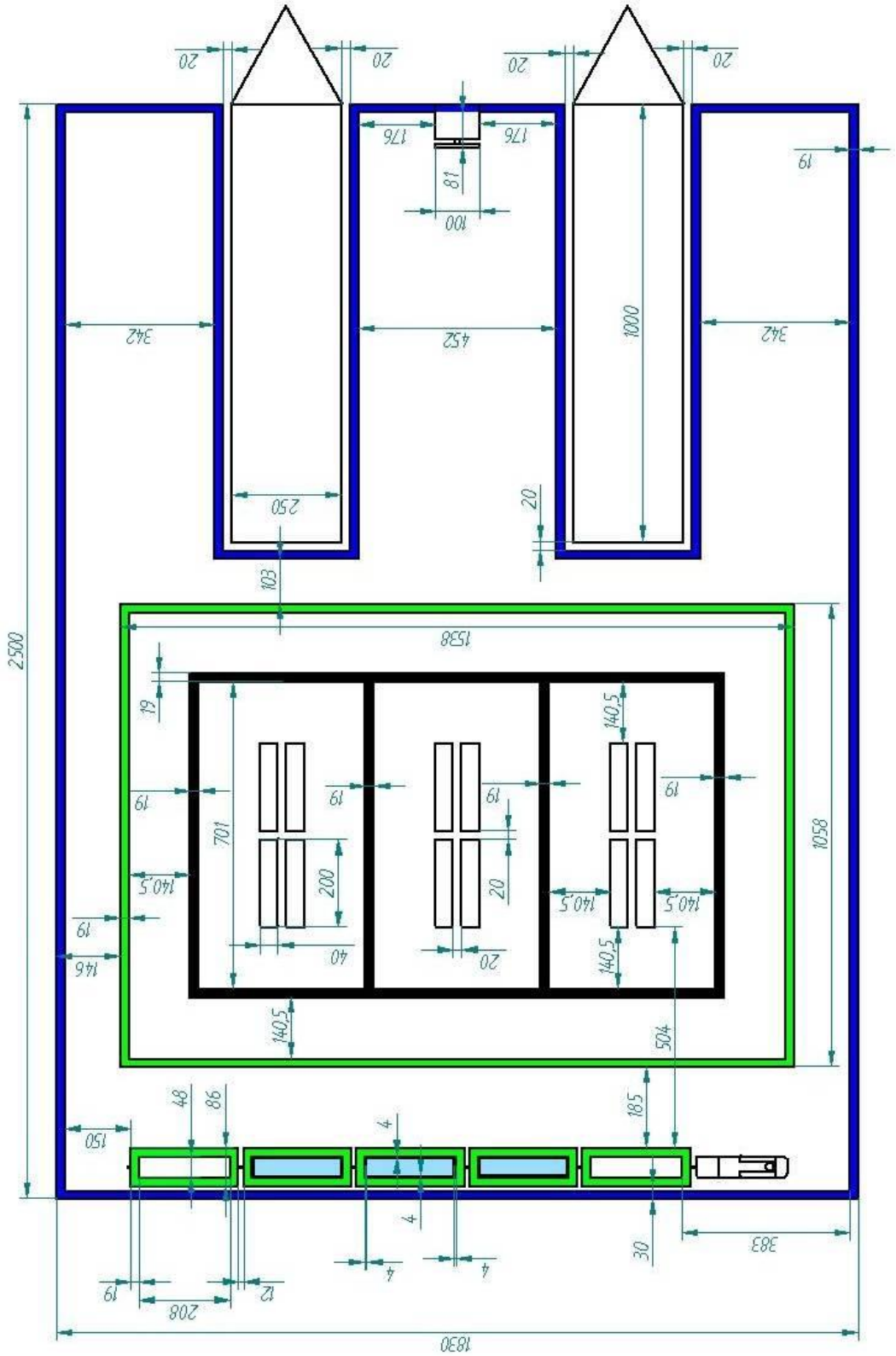
The Jury

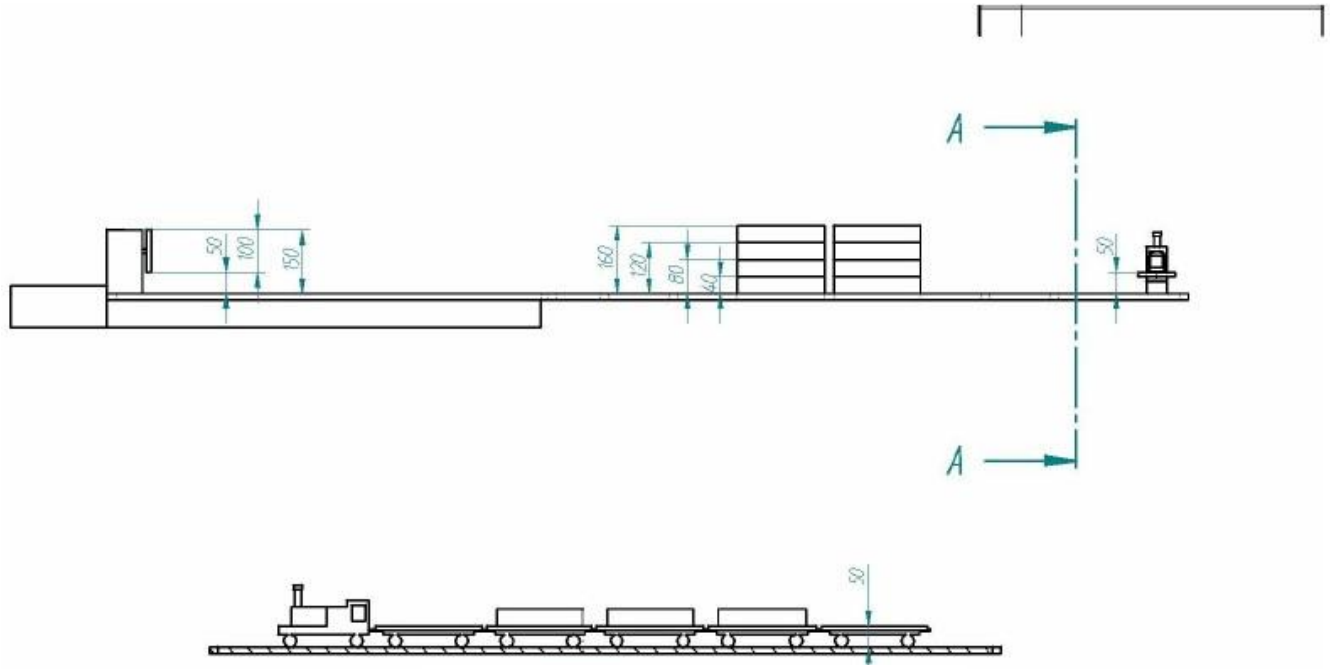
The JURY is composed by a member of organizing chairs, an auxiliary of the organization and a member of other team that is not competing in the match, chosen before the match starts.

Extraordinary Situations During the Competition

If there is any situation not covered under the above mentioned rules, or any doubt about the score, it will be up to the judges and the organizers of the competition to consider the case in the greatest possible impartiality and make a decision. It is important to mention that any fact that it is not explicit in the rules cannot be automatically considered as allowable in the competition. Missing facts will always be treated as **extraordinary situation** and it must be judged as allowable or not by the judges and organization

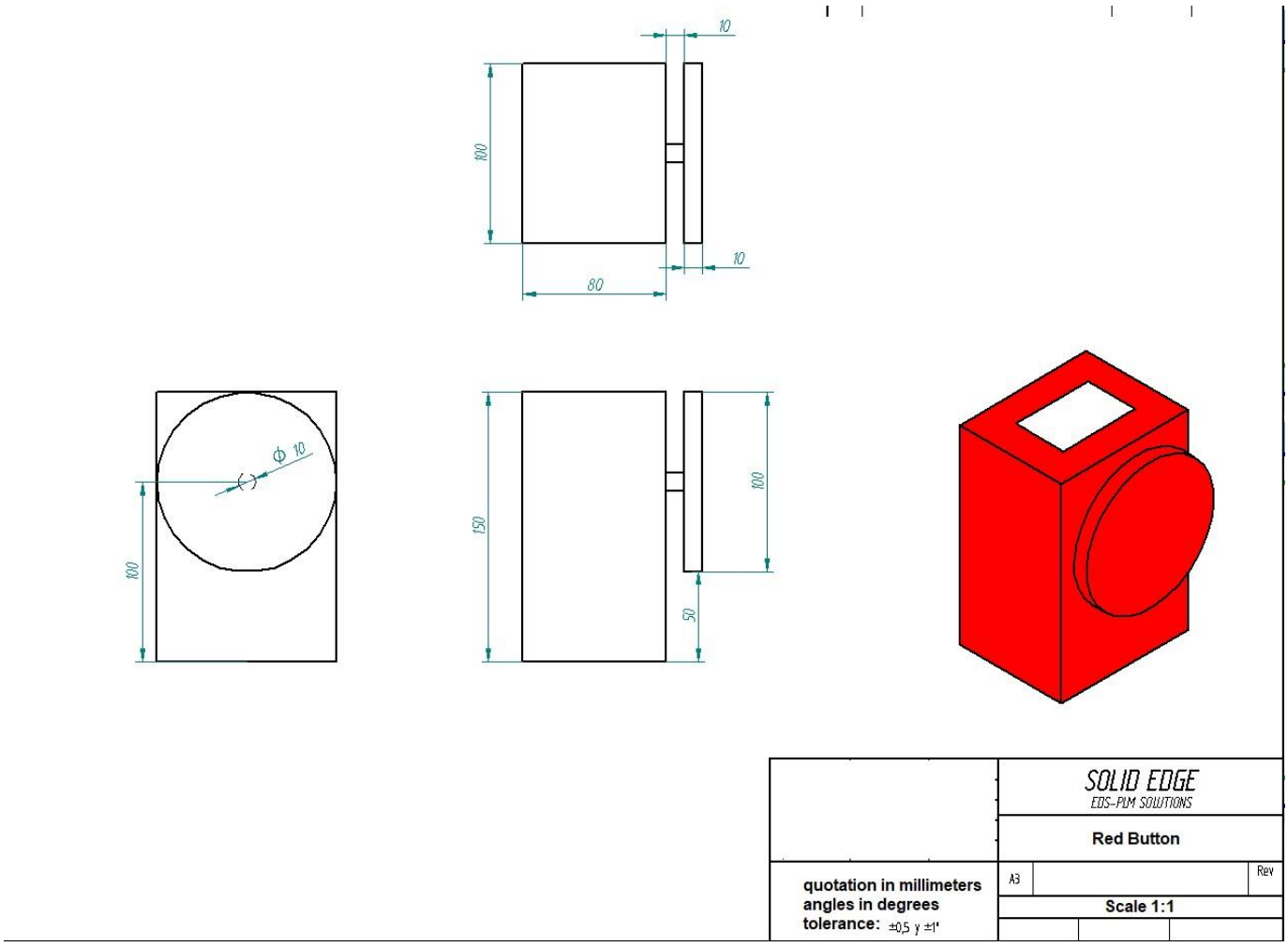
APPENDIX – ARENA DIMMENSIONS IN MILIMETERS (mm)



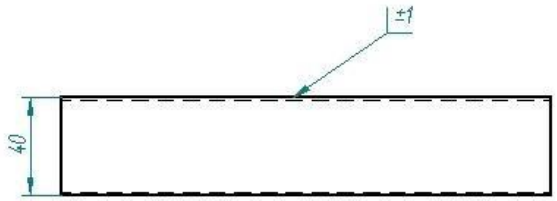


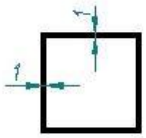
View A-A

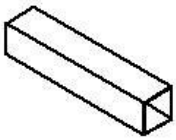
TRAIN ZONE



BUTTON DIMMENSIONS







Physical Properties Report .
Material= structural steel / SAE1010
Density= 7,833000 [g/cm³]
Volume= 31200,000000 [mm³]
Mass= 0,244390 [kg]
Surface Area= 62712,000000 □ [mm²]

With respect to the Global Coordinate System :
Center Of Mass :
X= 20,000000 [mm]
Y= 100,000000 [mm]
Z= 30,000000 [mm]

	SOLID EDGE EDS-PLM SOLUTIONS
	Container
quotation in millimeters **angles in degrees** **tolerance:** ±0,5 y ±1'	A4 **scale 1:1** Rev

CONTAINERS