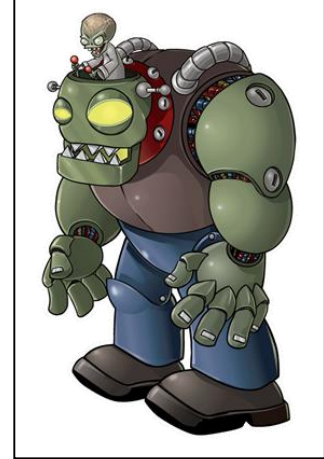


2015 Robocup challenge – Objective, requirements, and rules

Note – these rules are subject to change or modification

Scenario: This year's Robocup search and rescue challenge takes place after a zombie apocalypse in which a 'city' has been overrun. There are a number of packages of much needed food distributed throughout the city, but the environment and the zombies are hostile, and your autonomous robot is the only means to gather this food for your band of survivors (potential zombie food), in a limited time before it goes off.

To add to the challenge, there are two groups simultaneously competing for the food in this city. Thus, you need to gather as much food as possible, but the group with the most food will survive (and win!).



Objective: You have **5 minutes** to gather the **greatest cumulative weight** of food using your mobile robot.

Competition: Two robots will be in the arena at the same time, gathering food for their band. Food packages are considered rescued, and thus contributes to your final weight, if they are either:

- a. Onboard your robot.
- b. Have been gathered by your robot and delivered to your 'band HQ'

At the end of the 5 minutes, the band with the greatest cumulative weight of food will be the winner of that round. If two bands finish with the exact same weight, the band with the least number of packages will be the winner.

Now, we all know that survival ignores no opening in the food chain. So, if you win, you will face a bigger, meaner band in the next round. Similarly, losing bands that are chased off will need to compete with others to survive. These knockout rounds will continue until the entire class is "sorted" from well fed to zombie bait!

In a horrible twist of fate, limited material resources mean that your robot can only **carry a maximum of 3 packages at a time** (onboard). This constraint will likely mean that your robot will need some way of navigating back to your HQ and unloading, before going out on subsequent missions.

The competition draw will be determined and circulated prior to the competition.

Environment: The 'ruined city' from which the food must be rescued is defined by a 2.4 x 4.9m meter arena with 400mm high walls in the Mechatronics Design Lab C212. The arena will contain a number of obstacles that your robot will need to avoid or negotiate. The position of the obstacles for the final competition will not be revealed until the day of competition, so your robot must be able to deal with these unknowns.

Within the arena, there will be 11 food packages. All packages will outwardly look identical (i.e A steel cylinder of diameter 50mm and height 70mm with an annular groove to facilitate gripping) but vary in weight from **0.5-1.0kg each**.

Within the arena will be two areas designated as band HQ's. These areas will be coloured green and blue, different from the surrounding arena (black) and obstacles (red). These HQ's will measure 400mm x 400 mm and be surrounded by a low rim to prevent weights rolling out. The HQ's will be located in diagonally opposite corners of the arena.

Hardware: You must construct your robot using:

Controller: Arduino Mega ADK (Atmel ATmega 2560 8-bit microcontroller). You cannot use other boards/controllers.

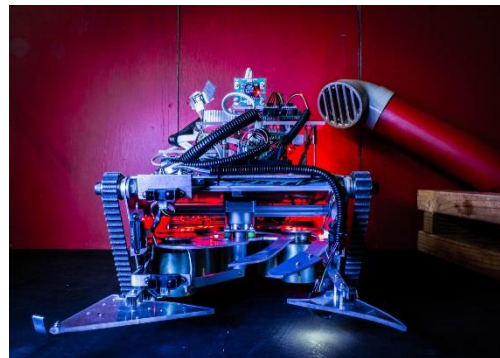
Chassis: You have the choice of using a supplied tracked chassis, or building your own custom chassis from scratch.

Sensors/actuators/structure: You will be provided with:

- i. A box of goodies including various sensors, actuators, and structural elements such as aluminium plate, rods, Perspex etc.
- ii. A budget of \$50 which you can use to order additional components.
- iii. 200g of material for 3D printing. Additional material will come out of your \$50 budget at 5c/g.

Circuit board: Each group member must design, draw, and manufacture at least one printed circuit board that is used on the final robot. You will be allowed a further \$5/person budget to purchase components for this PCB.

Technical support: Julian Murphy



The fine print:

1. Robots

- 1.1. **Robots must be autonomous.** There can be no human intervention in the robots operation, either physically or via software during the competition
- 1.2. Robots must have a defined *front end* that will be used for aligning the start direction
- 1.3. The arena walls cannot be used as part of the robot. The robot must be able to move independently of the arena walls
- 1.4. Robots must be controlled by the supplied Arduino Mega ADK (Atmel ATmega 2560 8-bit microcontroller). You cannot use other boards/controllers – unless you build one from discrete components
- 1.5. You have the choice of using a supplied tracked chassis, or building your own custom chassis from scratch.
- 1.6. In addition to the Arduino and the tracked chassis, you will be provided with:
 - 1.6.1. A box of goodies including various sensors, actuators, and structural elements such as aluminium plate, rods, Perspex etc.
 - 1.6.2. A budget of \$50 which you can use to order additional components. (see Procurement)
 - 1.6.3. 200g of material for 3D printing. Additional material will come out of your \$50 (1.6.2) at 5c/g
 - 1.6.4. \$5/person for purchasing components for the printed circuit board
- 1.7. Each group member must design, draw, and manufacture at least one printed circuit board that is used on the final robot.
- 1.8. All robots need to meet general safety standards, including:
 - 1.8.1. Lasers must be below 5mW.
 - 1.8.2. Spinning devices must travel at under 200rpm, unless adequate guarding is in place.
 - 1.8.3. It is compulsory to use the power cut-off module, in between the battery and any electronics.
 - 1.8.4. No naked flames allowed, this includes any form of flame thrower.
 - 1.8.5. No chemically explosive devices.
 - 1.8.6. Voltage within your device should not exceed 100v DC.
 - 1.8.7. Use of EMP weaponry is not allowed.

2. Environment

- 2.1. The competition will take place in a 2.4 x 4.9m meter arena with 400mm high walls. The walls and floor of the arena will be coloured black
- 2.2. Within the arena will be two areas designated as band HQ's
 - 2.2.1. These areas will be coloured blue and green.
 - 2.2.2. There will be a low 'rim' attached to the floor around each band HQ (~10mm high) to prevent packages rolling outside of the designated area
 - 2.2.3. The band HQ's will be located in diagonally opposite corners of the arena
 - 2.2.4. The Band HQ area is defined as the 400 x 400 mm space within the rim.
 - 2.2.5. There will be an additional 200mm of colour outside the rim to facilitate detection.
- 2.3. The arena will contain a number of obstacles that your robot will need to negotiate. Obstacles include walls, ramps and 'speed-bumps'
 - 2.3.1. All gaps between walls (including arena walls) will be greater than 0.5m
 - 2.3.2. Vertical obstacles (e.g. walls and pipes) will be coloured red
 - 2.3.3. Horizontal obstacles (e.g. speed bumps and ramps) will be the same colour as the arena floor
 - 2.3.4. Speed-bumps will be rectangular in profile and up to 25mm high

3. Packages

- 3.1. Within the arena, there will be 11 food packages.
- 3.2. All packages will outwardly look identical:
 - 3.2.1. Steel cylinder of diameter 50mm and height 70mm with an annular groove to facilitate gripping
- 3.3. Packages will be either 0.5, 0.75, or 1.0 kg in weight
- 3.4. Location of packages will vary between rounds

- 3.5. No packages will be placed on top of obstacle walls
- 3.6. Packages may be placed against arena or obstacle walls
- 3.7. If a package is knocked over during a round, it will be left on its side for the remainder of the round

4. Competition

- 4.1. The competition consists of a number of rounds in which two robots are present in the arena simultaneously.
 - 4.1.1. Robots will begin each round on their respective band HQ, facing a specified direction
 - 4.1.2. Each round lasts for 3 minutes
 - 4.1.3. The robot possessing the greatest cumulative weight at the end of the round will be declared the winner
 - 4.1.4. If two robots finish with exactly the same weight, the band with the least number of packages will be declared the winner
 - 4.1.5. In the unlikely event that two robots finish the round tied according to 4.1.3 and 4.1.4, the robot that is furthest from its band HQ (in a straight line) will be declared the (dubious) winner.
 - 4.1.6. Packages are considered possessed, and thus contributes to your final weight, if they are either:
 - 4.1.6.1. Onboard your robot.
 - 4.1.6.2. Have been gathered by your robot and delivered to your 'band HQ'
 - 4.1.7. A weight will be considered **onboard** a robot when it is off the ground and completely under the control of the robot e.g. resting on the body of the robot, or gripped and lifted by a manipulator.
 - 4.1.8. A robot can have **a maximum of 3 weights onboard** at any point in time while moving.
 - 4.1.8.1. Only 3 onboard weights will contribute to the final cumulative weight for the round
 - 4.1.9. If a robot moves with more than 3 weights onboard, a penalty will be applied.
 - 4.1.9.1. Movement is defined as translation or rotation resulting from the primary drive mechanism
 - 4.1.9.2. For every additional weight (>3) onboard, the value of the heaviest weight onboard at the end of the round will be subtracted from the total cumulative weight at the end of the round.
 - 4.1.9.3. Penalties will be limited so that the minimum cumulative weight is 0kg.
 - 4.1.10. The competition draw will be determined and circulated prior to the competition
- 4.2. Packages that have been successfully delivered to the band HQ are considered 'safe' and cannot be stolen by the opposing robot.
- 4.3. If one or more packages is stolen from a band HQ, those packages will still contribute to the final weight of the band which originally gathered them and a penalty equivalent to this weight will be subtracted from the thieving band.
- 4.4. Packages *onboard* a robot are not considered safe and can therefore be pilfered by the opposing band, provided that no deliberate damage is inflicted during the raid (as per previous clause about damage).
- 4.5. There will be no restarts of robots. If a robot malfunctions or is damaged accidentally, it must continue to the end of the round without intervention.
- 4.6. Robots can be repaired between rounds. However, they must be ready in time for their next round.
- 4.7. If a robot is late to its round, it will be disqualified. This decision will be made at the discretion of the competition judge. There will be no discussion or appeal
- 4.8. Both robots must remain inside the arena at all times. If a robot ventures outside the arena, **whichever robot was responsible will be disqualified** (i.e. if a robot takes itself outside the arena, it will be disqualified. If one robot is placed outside the arena by the opposition, the opposition will be disqualified).
 - 4.8.1. A robot will be considered outside the arena when either the top of the arena wall, or the ground outside the arena support some or all of the robots weight.
- 4.9. Any deliberate damage to the other robot during a knockout round will result in **immediate disqualification**. This is not Robot Wars! However, cunning methods to inhibit your competition that do not result in damage will be permitted. The decision on whether any damage is accidental or

deliberate will be made by the judge on the competition day – there will be no discussion or appeal, so be careful!

4.10. In the event that one robot is *captured* by another, any packages onboard the captured robot will be considered property of the captor.

4.10.1. A robot is considered ***captured*** if no part of it is touching the ground and its movements are completely under the control of the captor – ie the captor must be able to move the captive robot at will and without restriction.

4.11. If a robot is passing through the opposition band HQ under its own control (not captive), the onboard weights still *belong* to it.

4.12. When the competition is completed, the design will be stripped down to the original components by the team and all parts returned to Julian – unless your robot is so damned awesome that you are requested to return the robot in one piece for a victory parade.

5. Procurement

5.1. When spending your budget, **items must be ordered through Julian** and be able to be purchased using a credit card. If you buy any items yourself, or bring them from home, you **will not be reimbursed**.

5.2. Any items not ordered through Julian will be assessed for value (either on production of a receipt, or Julian's experience) and that amount deducted from your budget. This is not an all-out robot-beauty pageant, there are cost and hardware constraints, just like in the real-world.

5.2.1. Second-hand items will be valued at their current 'new' price (if you were to buy that item today)

5.3. Procurement requests should be submitted to Julian via email and procurement will take place fortnightly, unless agreed in advance.

5.4. All materials used from the supplied parts kit or additional procurement shall be identified in a bill of materials in the design document.

5.5. No budget credit will be given for unused items in the supplied parts kit.

5.6. Arrangements to print your circuit boards must be made with Julian prior to 01 October 2015.

5.6.1. Failure to meet this deadline may result in printing being refused and associated loss of marks

Things to consider: There are a number of different strategies that could win this competition, along with a number of other aspects that you may want to put some thought into:

1. You are only be able to fit three packages on your robot at any one time – should you collect them indiscriminately and as fast as possible, or weigh them and optimise your collection?
2. Are you better to do many short, fast sorties from your HQ in which you collect only one or two packages, or fewer, longer ones where you weigh many packages and collect three?
3. The dynamics of your robot will change dramatically with several kilograms of payload, you will need to devise a control strategy to account for this. Especially if your competitors for food “accidentally” run into you (always bad in a zombie infiltrated zone (ZIZ)). Thus, ...
4. How will you avoid the other robot in the arena?
5. Is it really worth risking disqualification to inhibit the other robot?

Reporting:

We have produced guidelines for each of the three reports that are required for this project. These guideline documents will be available on Learn. Basically, the structure of the three reports is:

1. Conceptual design report – present and evaluate several possible concepts and select one to take forward
2. Detailed design report – present the detailed design of your selected concept to a level that a competent engineer (or mechatronics student) could assemble a working version of your design.
3. Design evaluation report - critically evaluate the performance of your final design and compare it against competing designs in the context of this competition.

These reports have strict page limits to ensure that you present only relevant and important information. Several examples of each type from last year's class will be made available on Learn.