

# ASME Student Design Competition 2019 Contest

## The Pick-and-Place Race

### Design Problem Setup

The 2019 Student Design Competition challenges your imagination and technical design skills to create a device that can quickly but carefully secure a variety of different balls that will be balancing on tube stands in the middle of a flat playing surface. You must construct a single remotely controlled device to collect as many balls as possible, and place them in a collection area – you must do this quickly, but avoid having balls fall off their stand and hit the ground. The competition will have an initial round where your device will run without competition, and then devices will compete against each other in a knockout format.

The constraints and competition procedures for all devices are as follows:

#### *Pre-Game Rules*

1. Students participating in the competition must be undergraduate engineering students (any engineering discipline is allowed) and must be ASME members. There is no limit on the number of students on a team.
2. At the start of the competition, teams **must provide a sizing box for your device** and any tools your team would use to make minor repairs during the competition. Throughout the competition, your device, controls, any extra batteries, and any tools must fit within your rigid sizing box. This box must be no more than 50 cm x 50 cm x 50 cm (internal dimensions), but *teams should minimize actual box size, volume is a tie-breaker in the competition.*
3. Your device will be stored inside your sizing box throughout all of the rounds of the competition. Teams will have one minute to remove your device from the box to compete in each round. No modifications to the device are permitted during this setup.
4. All energy for the device must be provided by rechargeable batteries. No other forms of stored energy (such as pre-compressed springs or gas) are allowed unless the stored energy of this component is returned to the initial state (for example an initially compressed spring must be re-compressed using the energy from the battery).
5. Teams may replace batteries between rounds, however replacement batteries must be identical to the original, mounted in the same way to the device, and stored in the sizing box throughout the competition.
6. Your device must be controlled via remote control through a transmitter/receiver radio link. Transmitter/receiver radio links may be any commercially available model controller. Radio transmitter batteries **do not** have to be rechargeable. All radio controllers will be shut off/stored within the team's box during the competition unless the team is competing.
7. Communication between controller and device must be able to be secured to allow for at least 3 other teams simultaneously using live controllers at other games taking place in the same auditorium area.

8. Flying devices are not allowed. Devices must remain intact throughout the game – for example, the device may not split and retrieve multiple balls at once.

### *Game Rules*

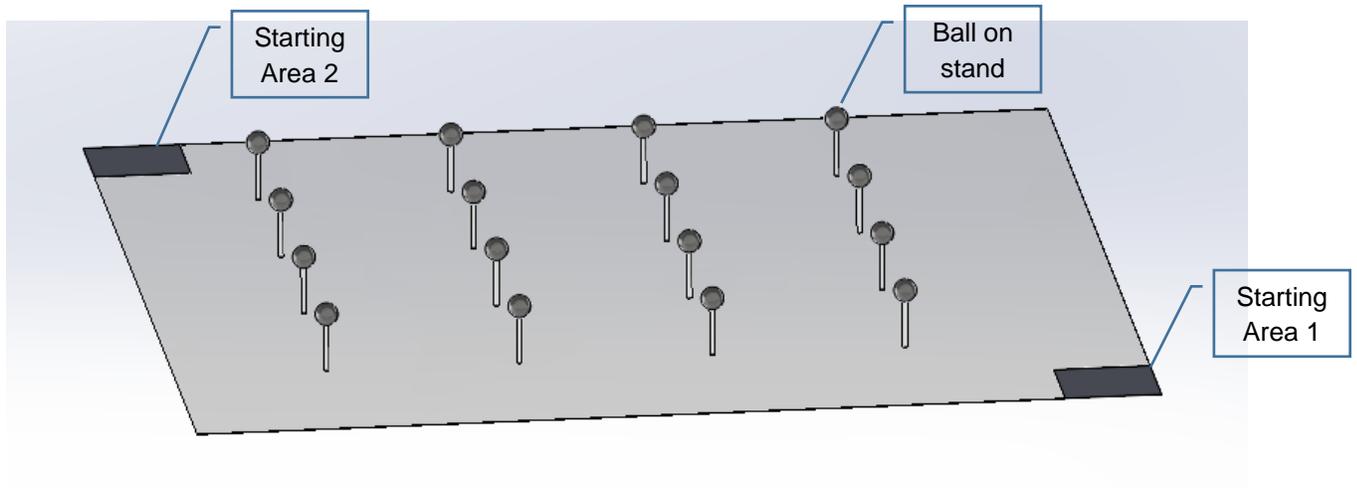
9. The playing surface dimensions are 5 meters x 5 meters, with boundaries marked by tape on the floor. The device will start each game in a 50 cm x 50 cm area in one corner of the playing surface, also marked by tape on the ground. See Figure 1 below with comments.
10. There will be sixteen balls each resting on top of a cylindrical stand at the start of each game. The balls will be at least 2.7 grams and 40 mm in diameter (a table tennis ball) and no larger than 650 grams and 250 mm in diameter (a basketball). Teams will not know the exact details of the balls (sizes or distribution of types of balls) until the competition – designs need to be flexible.
11. The sixteen cylinders will be approximately 3 – 5 cm in diameter (*probably PVC pipe*) and will be 20 cm tall. Judges may create a small base for each cylinder, but teams should expect that the stands will be easy to knock over if a device runs into them.
12. The playing surface will be level, and may be either hard surface or carpet typically found in public areas.
13. Just prior to the start of each game, judges will randomly place all the balls on the cylinders and immediately start the game. All games will last **5 minutes**.
14. Teams will earn/lose points as follows:
  - Plus two points for **collecting** a ball from its stand and securing it on their device
  - Plus three points for **placing** a ball in the team's starting area
  - Minus one point for every ball that is **knocked off** its stand and hits the ground
15. Once a ball has been scored (either secured, secured and placed, or knocked off stand) it can no longer be played during the rest of the game. Balls knocked off their stand will remain on the playing surface floor for the remainder of the game.
16. Teams earn two collecting points when a ball is secure within their device *for at least two seconds*; if the ball subsequently falls to the ground this does not change the scoring but placement points in the starting area cannot be earned for that ball.
17. Rules for earning the additional three placement points are as follows:
  - Only balls first secured within the device are eligible for placement points
  - Teams may either secure and then place one ball at a time, or may secure multiple balls and place them simultaneously
  - Placing points are earned when a ball is placed and remains stationary inside the starting area; if the ball is subsequently displaced this does not change the scoring.
  - The placed ball must rest on the ground within the scoring area, not touching the device
  - Balls that have been secured may be pushed on the ground into the scoring area, however any ball that leaves the 5m x 5m playing surface becomes ineligible.
18. If all sixteen balls are scored in less than 5 minutes, the game will end.
19. All teams will complete in one initial game with no other device present. The team score earned will be used to seed the first knockout round of the competition.

20. During the knockout stage, two teams will compete, attempting to earn the most points in the game. The team with the most points will advance to the next round. The following rules apply to team interactions during the knockout stage:
- Only minimal, incidental contact between devices will be allowed. Reckless behavior will result in a time penalty. Devices should be robust to survive minor collisions.
  - When one team's device is attempting to secure a ball, the other team must not interfere. Striking another device while it is in the process of securing a ball will earn the interfering team the one point penalty if the ball falls to the ground.
  - If judges are not able to determine which device causes a ball to fall off the stand, then no penalty will be awarded either team.
  - Teams are allowed to play defense and block the other device from returning to their starting area or moving to a desired location, as long as there is no intentional contact.
  - Devices must stay within the outside boundaries of the 5m x 5m playing surface. If a device **entirely leaves** the playing surface (all device contact with the ground is outside the boundary lines) the team will receive an **official caution** – the team must then remain motionless for 30 seconds before being allowed to resume competing
  - Intentional *fouls* and overly aggressive behavior will be stopped by the judges. Excessive contact with the other device may result in an **official caution** – the team must then remain motionless for 30 seconds before being allowed to resume competing.

### *Competition Scoring Rules*

21. Teams will receive a score for their initial individual round – points for all balls collected/placed, minus deductions for balls knocked off stands.
22. The initial round score will be used to seed the knockout round. In the knockout round, highest scoring team will compete against lowest scoring team, 2<sup>nd</sup> highest against 2<sup>nd</sup> lowest, etc. For teams with the same score, the tiebreaker will be the volume of the team sizing box (smallest volume is best).
23. If there is an odd number of teams in any round, the two lowest scoring teams will compete against each other, and that winner will then compete against the highest scoring team in the prior round.
24. For all subsequent knockout rounds, each winning team's score earned will be used to seed the subsequent round. If necessary, the tiebreaker will be total number of points scored in the initial solo round (if still tied, box volume will be used). Again, highest score will compete against lowest score, 2<sup>nd</sup> highest against 2<sup>nd</sup> lowest, etc.
25. Knockout rounds will continue until the final match between the top two devices. The team with the most points is the champion. If the two teams are tied after 5 minutes, the course will be reset and the teams will compete in a one minute shootout. If still tied, shootouts will be repeated until there is a winner.

**Figure 1: Overview of the Playing Surface**



*At the start of the 5 minute game, a team's device will begin in their designated starting area, a 50 cm x 50 cm square shown in two corners of the 5 m x 5 m playing surface. Teams will score points by collecting any of the 16 balls on stands, and attempt to bring the balls back to their own starting area. Teams are also trying to avoid knocking balls off the stands onto the ground.*

*The sixteen stands and balls are equally spaced 1 meter apart from each other and the overall game boundaries. The balls shown in Figure 1 are all the same size, this will not be the case for the actual competition. See the rules for the range of ball sizes. Distribution of the balls used will change throughout the competition.*