

ASME STUDENT DESIGN COMPETITION

ASME Student Design Competition – 2023-2024 Rules Robot Mini Golf

The 2024 Student Design Competition (SDC) presents the challenge to design and fabricate a robot that can play a round of mini golf – 9 obstacles!

The 2024 SDC requires teams to design and build a remotely controlled device with the following goals:

- The device should be as small as possible, fitting within a rigid sizing box with maximum internal measurements of 50 cm by 50 cm by 50 cm (a Sizing Box bonus is awarded, see rule 2).
- If device operation is powered by batteries, the batteries must be rechargeable.
- The device will have 10 minutes to navigate a mini golf course to nine designated tees from which the device will “tee-off”. Up to 5 strokes are allowed when attempting to complete a mini golf obstacle. Once an obstacle has been completed, the device must navigate the field and align itself with the golf ball at the next tee.
- Proper design practices and time management for fabrication and testing are valued. A bonus is awarded for optional design and initial operation videos submitted prior to the competition.
- These rules were developed with the spirit of the game in mind. Any necessary judgement not captured explicitly in the rules will rule in favor of the spirit of the game. The spirit of this game is to provide a golf game that is an appropriate challenge for all engineering teams participating. The golf ball is to traverse through a set of obstacles only propelled by the built robot itself.

The validation of your design is intended to take place at an in-person ASME EFX® event(s). Not all EFX events will have every competition available. Check that SDC is available at that event before registering.

General Rules: team eligibility, overall design setup and constraints:

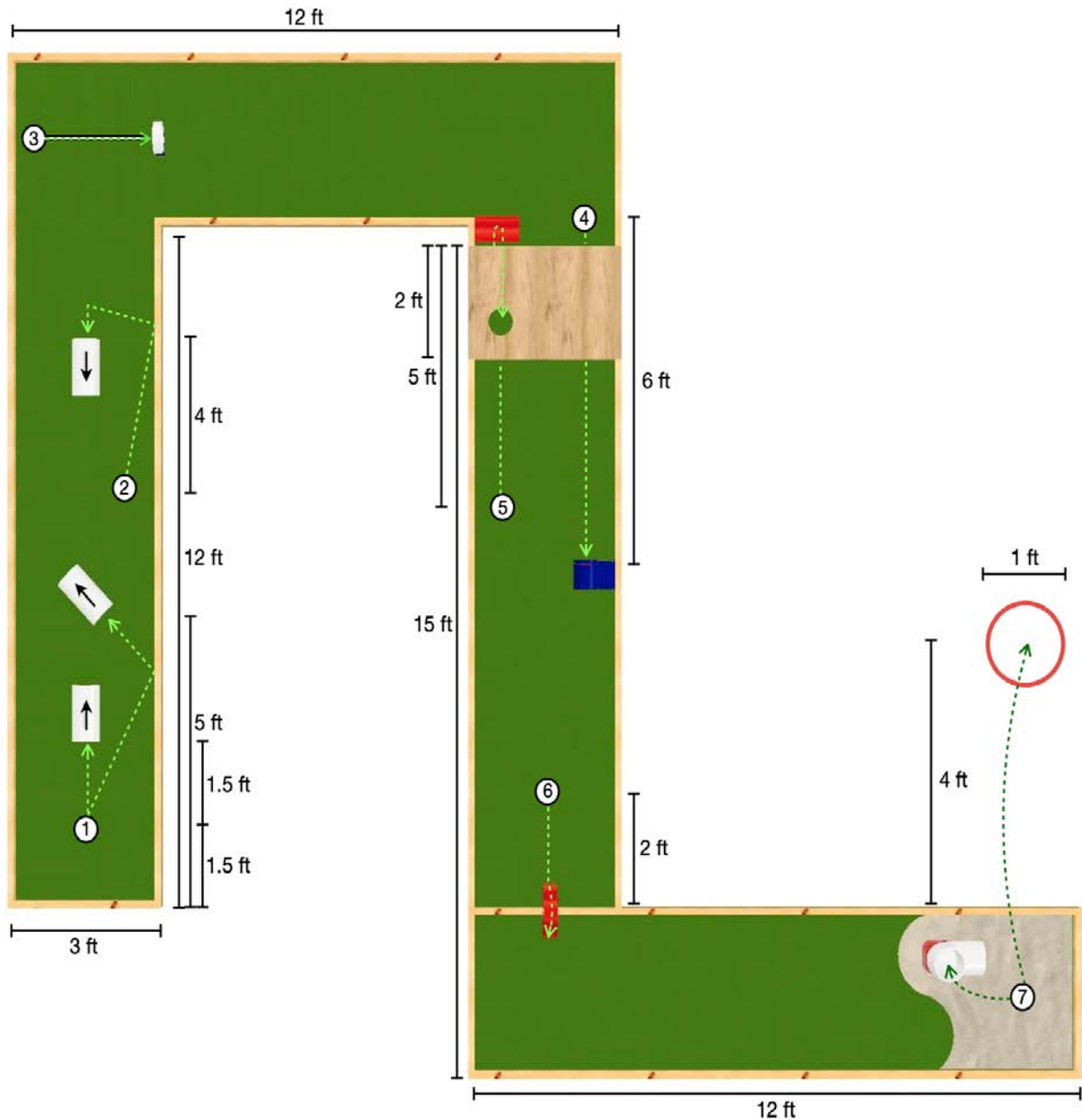
1. Students participating in the competition must be undergraduate engineering students, including community college students and students in associate degree programs (any engineering discipline is allowed) and must be ASME student members. There is no limit on the number of students on a team or the number of teams from a school. Each student may only participate on one team (contribute to one device) – participants from schools fielding more than one team will be asked to affirm this at the competition.
2. Teams **must provide a completely enclosed rigid sizing box with a top lid that will be measured for competition scoring. You will not be able to compete without this.** The device, controls, and all other materials to be used during the competition must fit within the box, which must be less than 50 cm x 50 cm x 50 cm (as measured from the interior walls). Teams should further minimize the box dimensions if possible. Starting each round of the competition, the device will be brought to the playing area within the sizing box. *Teams showing up at the competition without a legal sizing box face disqualification!*

$$\text{Sizing Box Factor} = \sqrt[3]{\frac{(50)^3}{\text{width} \cdot \text{length} \cdot \text{height}}}$$

**note: the Sizing Box Factor is calculated using interior dimensions (all dimensions in cm).*

3. Teams are also requested to submit a design validation video in advance of the competition. This is not required, but a bonus factor based on the judges score of the design validation video will be used in the competition scoring.
4. Devices must use rechargeable batteries to power the device and control system. The use of mechanical energy is allowed, however, any stored potential energy at the start of the device's duty cycle must be returned to the original state under its own power by the end of each run.
5. A remote controller operated by one team member will control the device. The remote controller may have its own rechargeable battery.
6. Devices must completely fit within the closed sizing box at the start of each round and must only touch the ground within the mini golf course. Team members may only remove the device and place it on the mini golf course. Devices may expand beyond their initial size after being taken from the sizing box, but may not at any time become larger than 100 cm in any orientation when operating at full reach. Device expansion must occur under its own power, not manually.
7. Each demonstration will begin with the device in the rigid sizing box near the first tee of the mini golf course. One team member may remove the device and place it anywhere on the mini golf field and power it up. Once the device is set up for the first tee off, it may not be touched again until the nine obstacles of the mini golf course have been completed or the 10 minute time limit is reached (whichever happens first). The only exception to this rule is if the team opts to switch out batteries on the clock (the device may not be moved from its position on the field to accomplish this). Batteries may be switched out only once during the run.

Figure 1: Playing Field Overview



Mini Golf Field Obstacles

- Obstacle A & B: Golf ball starts at tee #1 and must completely pass through a tunnel in the specified direction.
- Obstacle C: Golf ball starts at tee #2 and must completely pass through a tunnel in the specified direction.
- Obstacle D: Golf ball starts at any point along the line indicated at tee #3 and must completely pass through the elevated hoop in either direction.
- Obstacle E: Golf ball starts at tee #4 and must pass through the toll booth arm (which raises and lowers at variable, moderate speed) and exit the tunnel.
- Obstacle F: Golf ball starts at tee #5 and must pass through a hole in either direction in the elevated platform.
- Obstacle G: Golf ball starts at tee #6 and must fully traverse the bridge and pass under both archways.
- Obstacle H: Golf ball starts at tee #7 and must pass through a vertical elbow tunnel in the specified direction.
- Obstacle I: Golf ball starts where it exited Obstacle H and must land within the target beyond the field boundaries.

Expected Device Functionality

Devices can be expected to perform most or all of the following operations:

- Putt a golf ball (transport the golf ball along the ground to a target)
 - A legal “putt” or “stroke” is defined as follows:
 - The device must first come to a complete stop. The travel function must not be in operation when “putting” (i.e. the device cannot travel while in contact with the golf ball unless it is specifically to transport the golf ball to a tee).
 - The device then makes contact with the golf ball in such a way that the golf ball is delivered to a new location.
 - The device ends contact with the golf ball.
 - Examples of “illegal” putts are:
 - Driving the device to the ball and then “bulldozing” it into/through an obstacle.
 - Driving the device into the golf ball with intent to transfer momentum.
- Chip a golf ball (transport the golf ball to an elevated target)
- Traverse the field (device must move about the field between obstacles, over walls, and potentially under a low platform)

Figure 2: Playing Field Angled Views

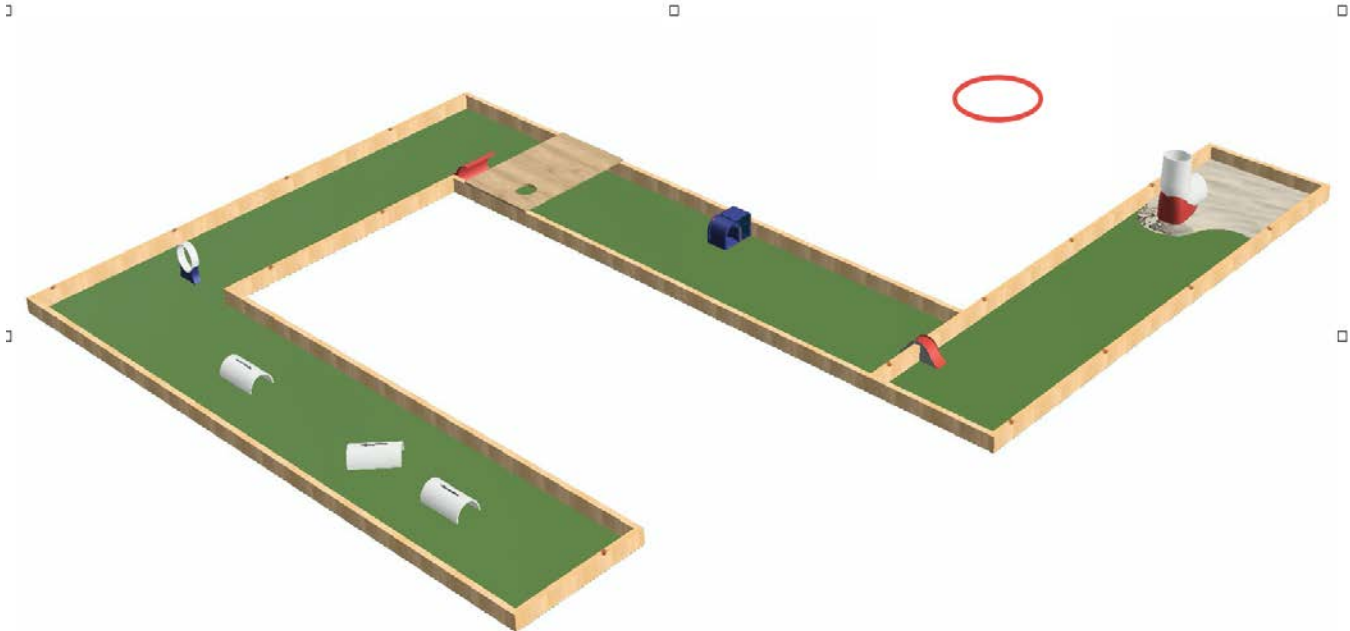
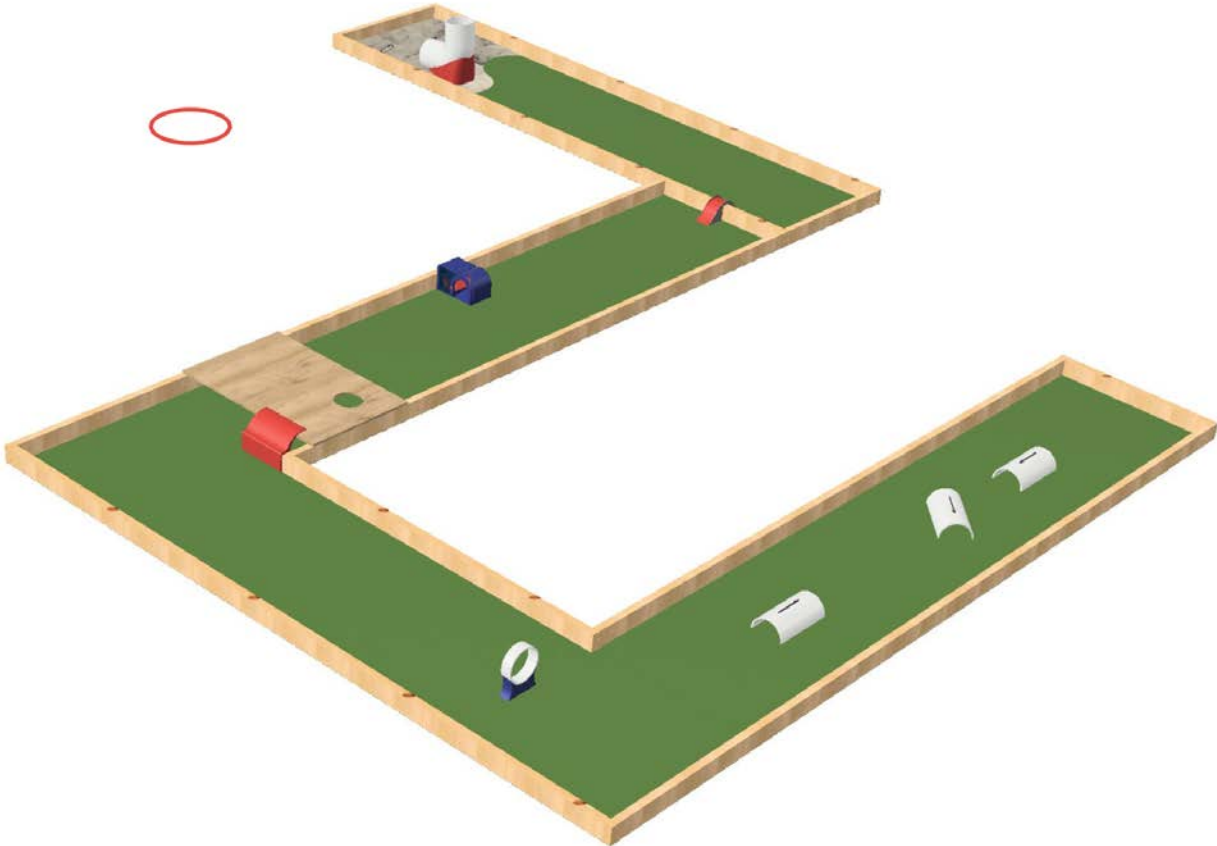


Figure 3: Obstacle F Closer View



Figure 4: Obstacle E & F Closer View

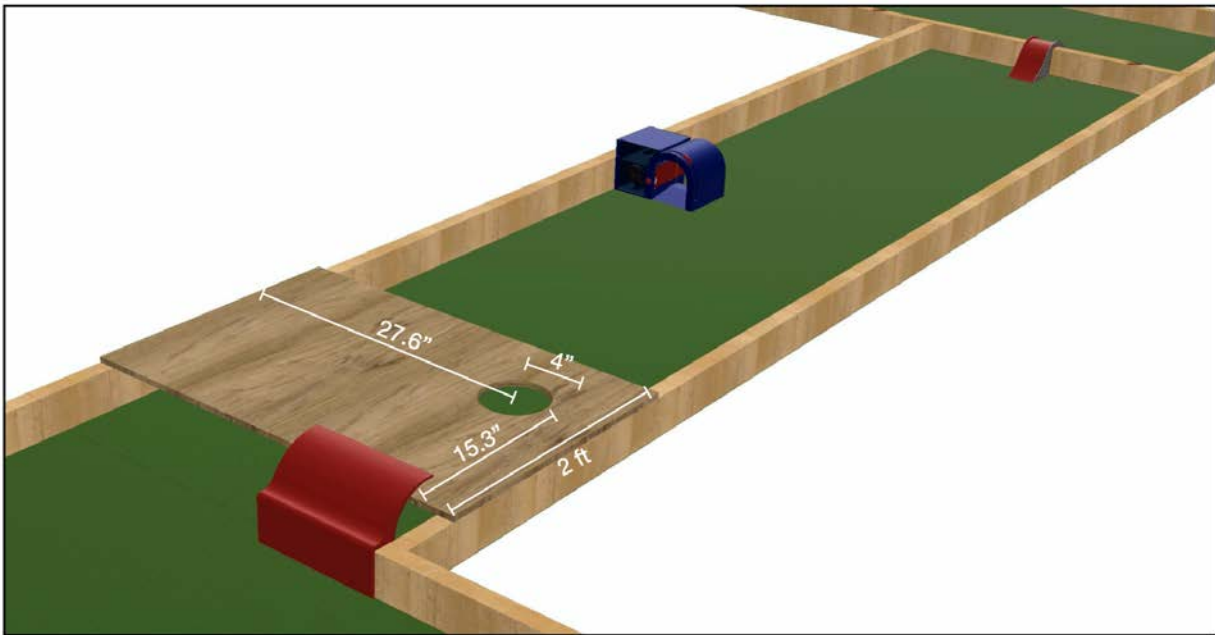


Figure 5: Obstacle E Front View



Figure 6: Obstacle E Detailed View

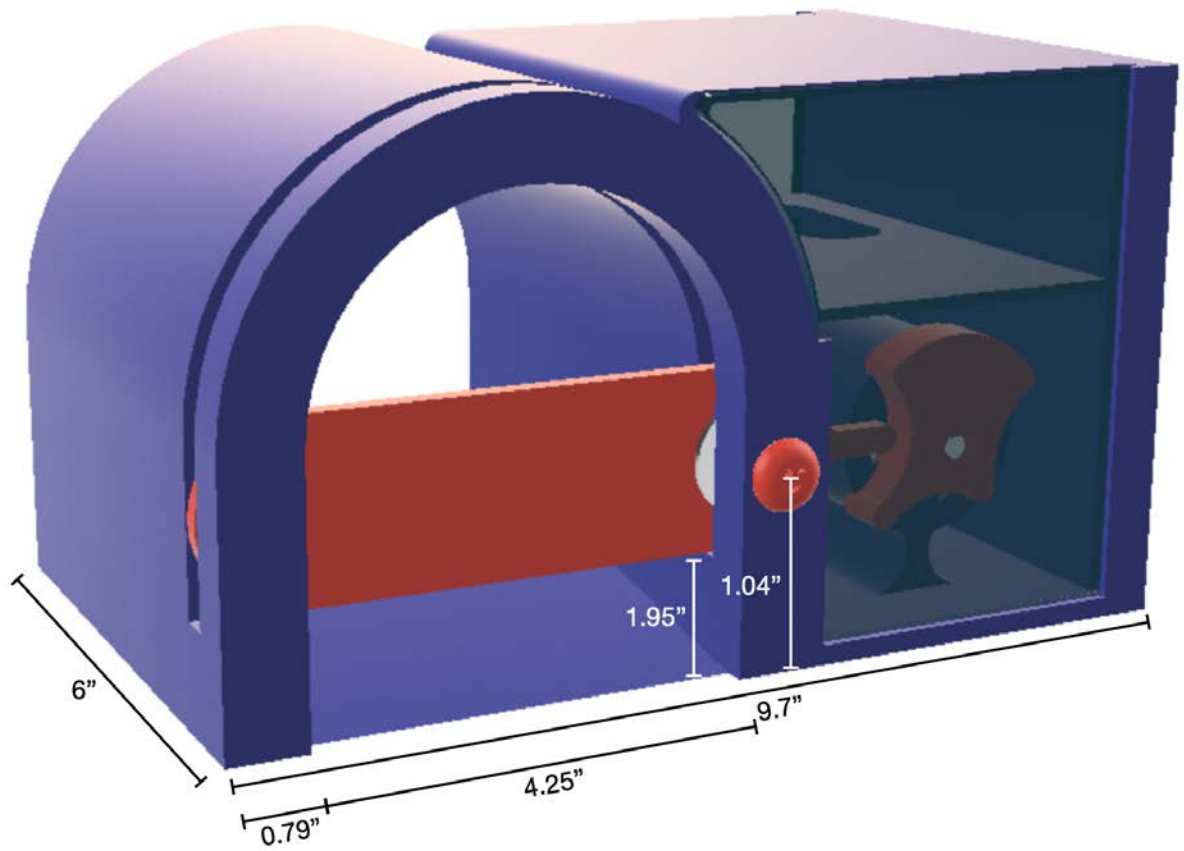


Figure 7: Obstacle #A-C Detailed View

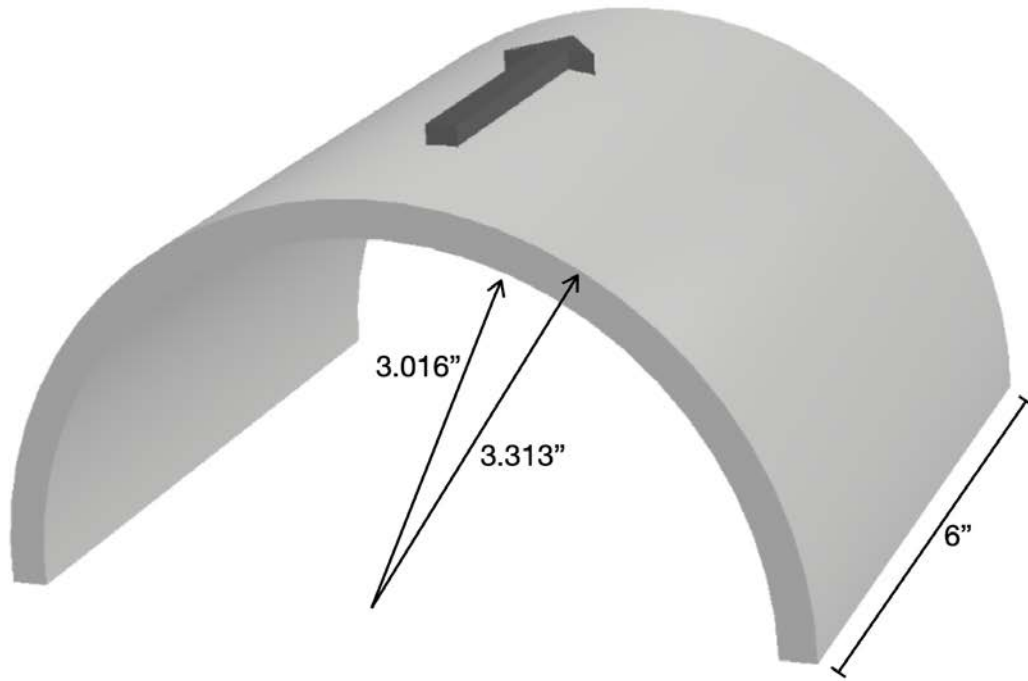


Figure 8: Obstacle D Detailed View

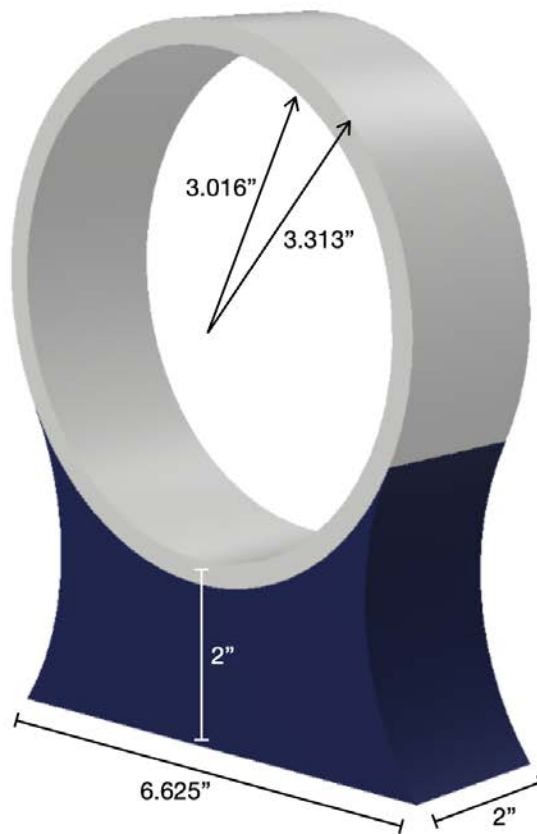


Figure 9: Obstacle G Detailed View

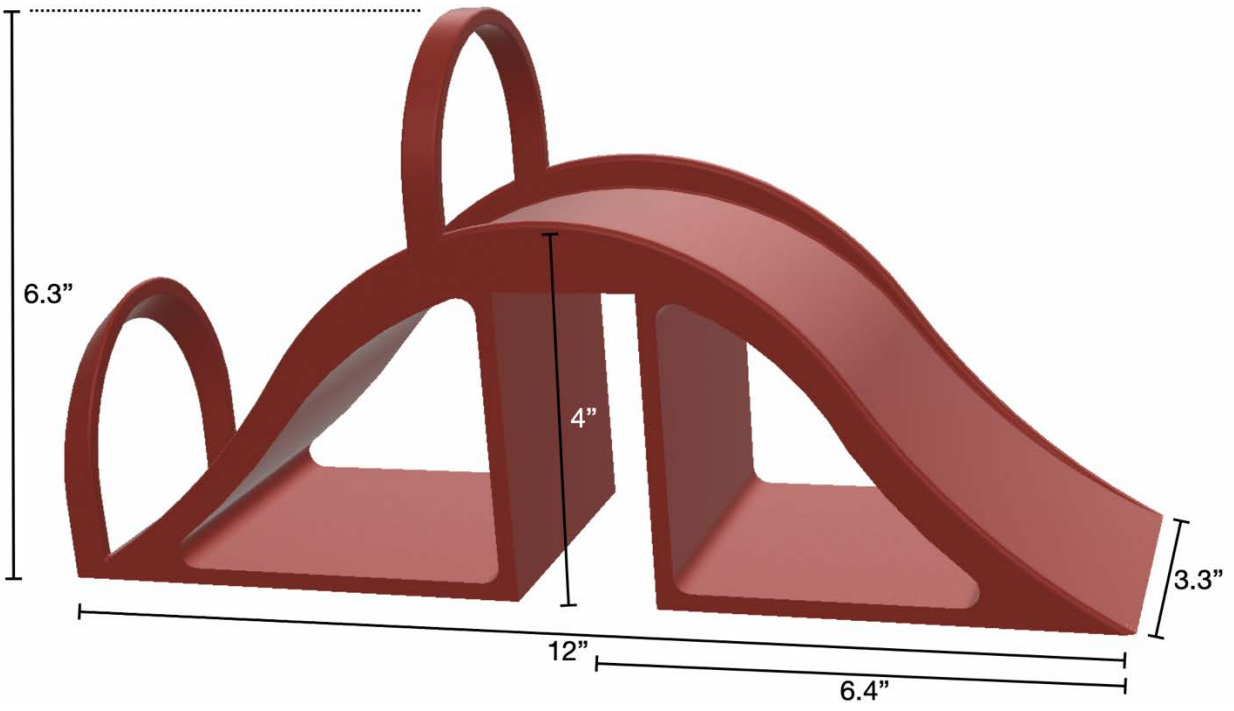
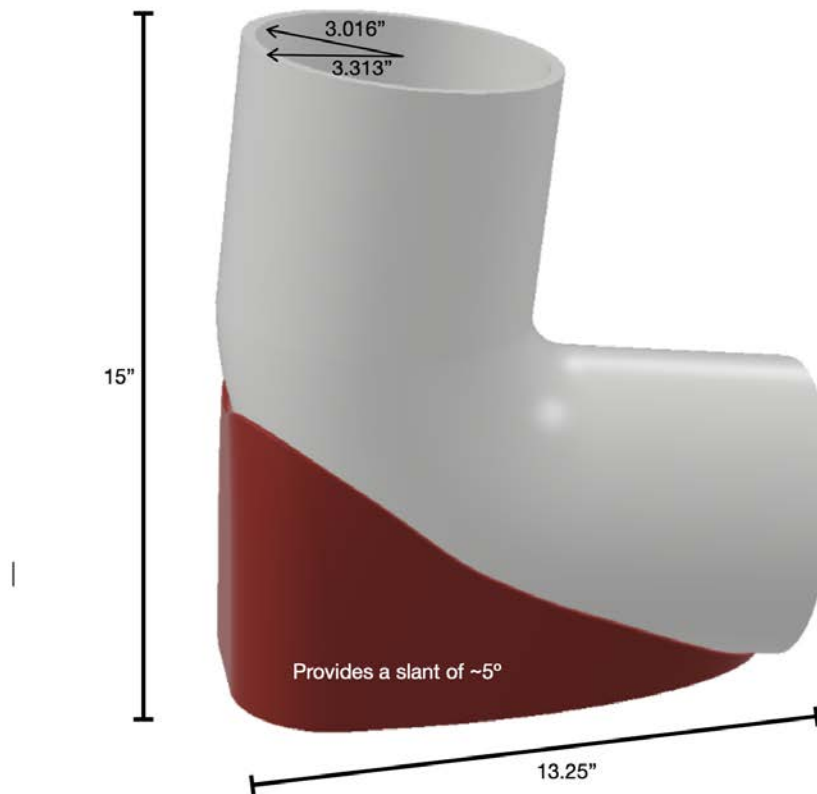


Figure 10: Obstacle H Detailed View



Pre-Competition Deliverables (Optional): Design Evaluation and Initial Operation

8. **Four weeks before a competition**, teams may submit a 10-minute (maximum) design validation video. This is not required, but a bonus factor based on the judges score of the design validation video will be used in the competition scoring. This video or PowerPoint presentation with voice over should describe the team design and cover:
 - the design process and decisions made during the project
 - a description of the final design and its unique qualities
 - the procedures that the team is taking during fabrication and testing of the device to validate and improve operation for the competition
 - Judges Design Score will be out of a maximum of 30 points – 10 points are possible for each of the above bullet points.
9. **Two weeks before a competition**, teams may submit a device operation video. This is not required, but a bonus factor based on the judges score of the operation video will be used in the competition scoring. This video should clearly show the device is capable of “putting a golf ball”, traveling to where the golf ball landed, and “putting” the golf ball a second time.
 - Teams that submit an operation video will be scored from 0 to 10 for completing a run on a Playing Field that matches the competition rules
10. Judging scores will be incorporated into a Pre-Competition Factor used in the Elimination Testing Round of the competition as follows:

$$\text{Pre-Competition Factor} = 1 + (\text{Judges Design Score} + \text{Operation Video Score})/100$$

11. All videos are optional. Teams may submit both videos, only the design or the operation video, or neither video and still compete. Instructions and video submission forms will be provided by ASME after teams/team members are registered.

On-site Demonstration Rules: Preparing for Testing, Operator/Device Operation

12. Team devices must be brought to the testing area in the team sizing box.
13. One person from the team will remove the device from the sizing box and prepare the device to operate. Other than connecting power to the device and setting it up to operate, no modifications are permitted during this setup time. The device may expand under its own power as it is taken from the sizing box, but may not at any time become larger than 100 cm in any orientation when operating at full reach.
14. The testing area surface will be reasonably level and may be either smooth or non-smooth (e.g. hard surfaces, carpet, or other flooring typically found in public areas).
15. Only one team member will be allowed to control the device when the clock is started. A second teammate may serve as “caddy” who may retrieve, switch out batteries on the device, and return it to the first tee if it becomes stranded. The “caddy” will also be responsible for manipulating the golf ball under specific circumstances during gameplay. All other team members must remain away from the playing surface area.
16. The duration of each device test is given in the following sections; if the device or devices are not able to continue, the testing round will be stopped.
17. Multiple devices may be operating simultaneously, and multiple competitions may be conducted in parallel. Each team must be responsible for ensuring that the communication between their wireless controller and the device is not affected by another team’s controller.

Initial Testing Rules: Initial Demonstration of Performance

18. All devices will initially be tested one time without another competitor on the Playing Field. Multiple teams may operate their devices at the same time on different Playing Fields to expedite running the competition if necessary.

19. For the **Initial** testing round, each team will have 10 minutes to play through the mini golf field and complete as many obstacles as possible using as few strokes as can be managed.
20. For the **Initial** testing round, teams may tackle the obstacles in any order and from any tee of their choice, *provided the first tee-off is made from the first tee.*
21. For the **Initial** testing round, teams may choose to play the golf ball where it lands or have the caddy transport it to a tee of their choice with the approval of the judges (see Rule 15). Transporting the golf ball back to a tee counts toward the scoring as one stroke.
22. If the golf ball lands against a wall (or vertical surface) such that the device cannot putt it, the Gamesmanship Rule may be activated for a 1 stroke penalty. The Gamesmanship Rule allows the golf ball to be moved by the caddy up to 6 inches away from the obstructing vertical surface—but no closer to the target obstacle.
23. If a device becomes stranded for any reason, but can continue to operate, the device may be returned to the first tee with a 30 second penalty. If a device becomes stranded for any reason, and cannot continue to operate without repairs, the initial testing round will be ended.
24. If the golf ball leaves the mini golf field boundaries at any point during the round, a four-stroke penalty will be applied, the golf ball will be returned to the first tee, and the device must remain stationary for 60 seconds.
25. The top 16 scoring teams based on the number of obstacles completed will advance to the elimination round testing. The bracket is shown below (Figure 11). **Any ties will be broken using the number of strokes required to complete the obstacles (the fewer the better).** *Secondary ties will be broken based on who has the smaller sizing box.*
 - a. $Score = (\# \text{ completed obstacles}) * (\text{Pre-Competition Factor})$
 - b. *The more obstacles completed, the higher the seed.*

Figure 11: Elimination Bracket (with seeding based on Initial Testing results)



Elimination Testing Rules: Final Demonstration of Performance

26. For the Elimination testing rounds, two teams will compete one-on-one on the mini-golf field based on the Competition Bracket set by Initial Testing results. Rounds will last a maximum of 10 minutes. The higher seeded team can select whether or not they tee off first.
27. During the Elimination testing rounds, teams may be required to complete the field obstacles in a different order than is presented for the Initial testing rounds. This will be consistent between teams competing at the same bracket level.
28. The team who will tee off first will attempt to complete the first obstacle with a maximum of 5 allowable strokes. The second team will then switch onto the mini golf field (devices will not be operating on the field at the same time) and attempt to complete the first obstacle with a maximum of 5 allowable strokes. If both teams complete the

first obstacle, they will both progress to the next one. If only one team completes the first obstacle, that team wins. This cycle will continue until the first occurrence of the following:

- a. All 9 obstacles have been played to completion (team with fewer cumulative strokes wins).
 - b. The 10-minute time limit is reached (winning team is the one who completed previous obstacles with the least number of cumulative strokes).
 - c. One team fails to complete an obstacle the other team successfully completes.
 - d. Both teams fail to complete an obstacle (Default to Lightning Round).
29. Note that game play must be continuous, and purposefully running out the clock is disallowed. If a team is taking too long, intentionally or otherwise, the judge may issue a warning to speed up the process. No device should take longer than 1 minute to perform a single putt. If a device takes longer than one minute to complete a putt, then a stroke is added to their score (which counts towards their 5 allowable strokes per obstacle). If the first team completes an obstacle when the 10 minute time limit is reached, the second team will be allowed a fair chance to complete that obstacle as well.
30. If a team ties in both completed obstacles and number of cumulative strokes, they default to a **Lighting Round**. The Lightning Round consists of each team competing to successfully complete an obstacle on the field selected at random by the judges. The first team to miss a shot does not advance.
31. During the **elimination rounds**, the teams must complete the obstacles in the judge-designated order and from the designated tees.
32. During the **elimination rounds**, the teams may choose to play the golf ball where it lies or have the caddy transport it back to the designated tee with approval from the judges (see Rule 15). Transporting the golf ball back to the tee counts toward the scoring as one stroke.
33. If a device becomes stranded for any reason, but can continue to operate, the device may be returned to the first tee with a 30 second penalty. If a device becomes stranded for any reason, and cannot continue to operate without repairs, the elimination round will be ended.
34. If the golf ball leaves the mini golf field boundaries at any point during the round, a four-stroke penalty will be applied, the golf ball will be returned to the first tee, and the device must remain stationary for 30 seconds.
35. Winning teams from each elimination game will advance and continue competing against each other until an overall champion is determined. A competition to determine 3rd place will be held between the two teams eliminated in the semi-final round.

General Device & Gameplay Rules:

36. Flying or airborne machines are not allowed.
37. Devices may not utilize fire, liquids, or corrosive materials that may escape the device and damage the field and/or spectators.
38. Devices may not use lasers on the device that will project higher than 3" from the ground. There must also be a safety mechanism to protect the spectators if/when the device traverses raised/uneven terrain.
39. The devices must be controlled either via remote control through a transmitter/receiver radio link or through an umbilical cord (tether). The machine may not be touched at any time during the proving trial except to replace batteries.
 - 39.1. Transmitter/receiver radio links may be any commercially available model controller, or may be a custom machine, or a custom modification of a commercial machine. Radio transmitters may have their own batteries and these batteries do not have to be carried onboard the machine.
 - 39.2. Mechanical forces on an umbilical cord may not be used to help propel or control the machine. An umbilical cord may not be a part of the supporting structure of the machine. An umbilical cord may only be used to transmit electrical commands between team-held control components and the machine.
40. The device may not pierce, score, cut indent, discolor, smudge, or otherwise damage: the putting green, the golf ball, the ceiling/lights, the windows, the room amenities/equipment, other students, etc., on pain of *disqualification* from the competition. Safety first!
41. The device may not touch the ground anywhere outside the mini golf field while in operation.
42. The device may not intentionally move the obstacles around the game field.

Video Submission(s) & EFX/SDC Registration

Advance EFX registration is required for team captains and ALL team members. Any associated registration fees will be published on the EFX website. Once your EFX competition registration is complete, team captains and team members will

be contacted about any video submissions. Not all EFX events will have every competition available. Check that SDC is available at that event before registering.

Prizes and Winners

- 1st place - \$500
- 2nd place - \$300
- 3rd place - \$150
- SDC competition winners will be announced at the local EFX event.

Questions?

Questions may be directed to sdc@asme.org

The SDC Q&A Forum will open in mid-September on the SDC Competition website: <https://bit.ly/ASME-SDCCompetition> .
The Q&A Forum will close by February 1, 2024.