

DESIGN COMPETITION DESCRIPTION – Suck It Up!

Each team will be given clearly defined tasks to achieve using an autonomous device of their own design and will participate in a head-to-head, double-elimination, tournament-style class competition. This semester, you will race to pick up and store as much debris as possible. The competition fixture (a.k.a., arena) with sundry debris will be made available to you as soon as possible. Upon access, you can take dimensions, make design decisions, strategize, test, etc.

Competition Race

1. Each race will have **two autonomously competing devices within one arena**.
2. When your team is called to race, you will have **60 seconds to check in with the race referee**, or you will **forfeit** the round. The race referee will **inspect** your device's **debris bin** to confirm there is no debris present before the race begins.
3. A coin toss will determine your designated start location. You **must manually place your device in the start location within 60 seconds** of the "Place your devices" announcement from the race referee, or you will **forfeit** the round.
4. When the race referee says, "Start!", you may take **one action** (press button, flip switch, etc.) to **initialize** the **device**. This action may be manual or remote, but you cannot have any further contact with your device after initialization.
5. Each race will last **2 minutes**. During the race, your device must **autonomously move around the arena to pick up and store debris**. You will **forfeit** the round if your device travels outside of the arena.
6. The race is **over** only after the **race referee declares it so**. You **may not touch your device** until after this declaration, or you will **forfeit** the round.
7. The **winner** of a race is the **team** to safely pick up and store **the most debris, by mass, within their device's debris bin**. One by one, the teams must empty their device's debris bin into the scale bin for weighing. **Only the debris contained within the debris bin shall be weighed**. Debris elsewhere on or within the device shall not be added to the scale bin. Doing so will result in **forfeiting** the round. In the unlikely scenario that both devices collect an equal mass of debris, no winner will be declared, and a rematch will occur.
8. If neither device **picks up debris**, then no winner will be declared and both devices will compete against each other in a **rematch**.
 - a. The teams will be allowed 5 minutes to repair and prepare their devices.
 - b. If, during the rematch, neither device picks up debris, then the device that is farthest from its start location, **measured in a straight line at the end of the race**, will be declared the winner. If neither device moved from their start location, then a coin toss will determine the "winner".

Competition Fixture

The competition fixture (arena) will be a square space walled in by conjoined 2x4 lumber and will provide the space for two autonomous devices to compete head-to-head. The arena **walls** will be 3.5 inches (~9 cm) high, and the arena **area** will be 64 square feet. The two competing devices will be separated at the beginning of the race at designated **start locations**. Once the race begins, the two competing devices may interfere with each other, as there is no further separation between devices within the arena. The floor of the arena will be hard and relatively smooth, but could be made of any number of materials, including concrete, linoleum, tile, or wood. “Debris” will be randomly distributed throughout the competition fixture. Debris will vary in size, shape, density, and hardness. Note that **irregularities** and **variation** will exist within the competition fixture setup. As you will learn in this course, *a quality design in one that is robust enough to be indifferent to such variation.*

Competition Rules

1. The **competition** will be **head-to-head** and **double elimination**, meaning each team will compete against only one team at a time and will race twice before potentially being eliminated. The chart of **scheduled races** and rounds will be **available** for viewing the **day of the competition**.
2. Your team **must check in** at the **registration** table during the designated check-in time. If your team is **late** to the point of delaying the competition, your team will **forfeit its first round**.
3. The **device’s initial size** (at the start of the race) **must not exceed 30 cm (~12 inches) in length nor in width**. There is **no restriction on height**. These dimensions are defined by the **starting position** of your device. Length and width are the dimensions parallel to the floor. Height is the dimension perpendicular to the floor.
4. The device may be **started remotely or manually** but **cannot be touched or remotely controlled** once the race starts.
5. After movement has been initialized, the device **size may change** (increase or decrease) but **cannot exceed a 2.5-cm (~1-inch) increase** in any dimension (length, width, height). Note that *size* is not *orientation*.
6. The **device must be** and remain a **completely self-contained unit** during the race, meaning no tethers, loss of material, nor physical separation of components is allowed.
7. The **entire device must remain within the arena** boundaries throughout the race.
8. The **device must** always **have at least one contact point** with the floor during the race (no jumping, flying, etc.).
9. With one exception, **no electronic or physical contact** with the device is **allowed** at any time **after the start** of the race. **Human interaction** with the device can only occur **after a winner is officially declared**.
 - a. If, **during a race**, your **device is failing** and could damage itself beyond repair, you are **allowed to stop** your device and **forfeit the round**. For double-elimination

tournaments, this could allow your team to compete in the second round with a functional device.

10. **Upon request**, teams will be **allowed 5 minutes between races** to repair and/or prepare their device. You must make this request *before* your next race is started.
11. You may **protest a judge's decision**, but you **must do so immediately** after the decision is announced by verbally notifying the judge. Protests may be supported by video evidence and/or the competition rulebook (this document). The course instructor will be the final judge of all protests.
12. **Safety** is our **number one priority** throughout this project. There are multiple important and necessary safety rules for the competition:
 - a. During **competition check-in**, your device will be **measured and examined for compliance**.
 - i. You **must disclose** any **changes** made to the device since it was last approved by the TAs/instructor.
 - ii. Devices that are **deemed hazardous** will **not be allowed to compete**.
 - b. During the **competition races**, you and your device will be **monitored for compliance**. Your team will be disqualified if:
 - i. Your device intentionally or unintentionally damages the competition fixture *in a way that could impact the integrity of the competition*, including (but not limited to) breaking, gouging, melting, or polluting any part of the fixture.
 - ii. Your device is deemed hazardous after sustaining damage or after alterations are made. Device dimensions may be rechecked if a device is modified.
 - iii. Team member(s) violate any commonsense safety rules, including (but not limited to) damaging (or altering) the fixture (e.g., use of adhesives or heat on the fixture) or intentionally damaging another team's device.
 - c. The **race referee** is the primary person to observe and **judge any safety or rules violations**.
13. This competition is a lot of fun and an opportunity to cheer for and encourage everyone. **Feel free to invite your friends and family!**

Device Rules

1. You are allowed a **maximum total budget of \$100** for this project. This **monetary limit** is an **out-of-pocket expense** for the team. However, there is no requirement to buy additional materials - that is up to you as a team. To defray costs, you can seek **donations** or use **items you already have**, but the value of those items **must be factored into** the specified **monetary limit**. The following items are available **for free** to the whole class and **do not** count towards the specified monetary limit:
 - a. Many **parts** are available to you via Steve Johnson (Steve.Johnson@colostate.edu).

- b. **Arduinos** will also be **provided** to every student and can be used for this competition.
 - c. If your team has a **request for general-use items**, such as tooling or wiring for mechatronics, **contact Steve Johnson** about making the purchases. There are certain items he can purchase that will be **made available to everyone** in the class.
2. The **device** can be made from any **materials** you choose, with some exceptions:
- a. You **may not use** any potentially **hazardous energy** production or storage methods. Examples of hazardous energy devices include, but are not limited to:
 - i. Explosives, combustion processes, or highly exothermic reactions (such as model rockets)
 - ii. Compressed fluids that might release too quickly
 - iii. Alternating electric currents
 - iv. Mechanically stored energy at extreme levels (crossbows, springs with high spring constants)
 - b. You **may not use** any biological materials. Examples of **biologics** include, but are not limited to:
 - i. Plants and algae
 - ii. A trained hamster or very small dog
3. The device **may not** be designed to **intentionally interfere** with or **damage a competing device**. However, interference between competing device is possible during a race, which should be considered in your design. Think bumper cars, not battle bots.

Judge's Decisions Disclaimer

In a competition of this nature, it is hard to anticipate all the interpretations of the rules and situations that will arise during the competition. Therefore, the judges will decide anything not covered by these rules and the interpretations of these rules. These rules are subject to optimization and may be altered by the course instructor to preserve the “spirit” of the competition.

Competition Prizes

- 1. The 1st place team will receive a **1.5-point increase** to *each* team member's final **course grade**.
- 2. The 2nd place team will receive a **1.0-point increase** to *each* team member's final **course grade**.
- 3. The 3rd place team will receive a **0.5-point increase** to *each* team member's final **course grade**.

Sharing the Experience

After the competition, we would like to keep your device until after next semester's competition. We have a display area where devices can be seen by anyone. Device display is voluntary. Please see the course instructor if you would like to display your device.

Design Confidentiality

The TAs, and instructor agree to hold discussions about device design and competitive strategies confidential. If the discussion leads to items of general interest (e.g., rules, competition, or grading clarifications), the design group agrees to allow the publication of those items of general interest. Otherwise, any discussion of a competitive nature leading to a competitive advantage for the group will be held confidential.

Required Design Reviews

To ensure that your team is on track to compete, there will be two required meetings with the TAs/instructor before the competition. The first is a 10-minute prototype demonstration meeting where your team will present a mostly or fully functioning prototype of your device. The second 10-minute meeting will be to test your prototype on the competition fixture and demonstrate to the TAs/instructor that your device is nearly or entirely ready for competition. These meetings will indicate whether your team is adequately meeting the minimum expectations of this course. Demonstrating a "good faith" effort is our minimum expectation and note that outcomes of these meetings are part of the team's report grade. These meetings will also serve to determine the safety of your device. Any features deemed unsafe must be changed prior to the competition.