

American Society of Mechanical Engineers Student Design Contest

Robots for Relief

2014-2015 Contest

Final version

Design Problem Description

Delivering aid, including clean water, food, fuel, and medical supplies to places, such as the Philippines after Typhoon Haiyan, is a difficult task, as transporting bulk materials over uneven and rough terrain, in tight spaces, and over long distances is often required to help those in need.

This year's challenge is to design and develop a scaled-down version of a transporter capable of delivering granular materials, which will be guided by, at most, one person.

The engineering design constraints and evaluation procedures for your device are as follows:

- In order to verify the feasibility of your design concept, you must build and test a prototype system which will be capable of efficiently transporting a variety of granular materials (e.g., rice, beans, etc.) through water and sand as well as up and down a stair setup, as shown in Figure 1, and empty as much of the granular material as deemed appropriate into a receiving container within a three-minute time limit.
- In the three-minute competition period, you may load your device and complete as many round trips as your team sees fit.
- You can only place the material in your device in the loading area and can only empty it into the receiving area from the discharge step.
- In order to make multiple trips, you must return to the loading area by traversing the entire course.
- The amount of material transported per trip is up to each team and the design of their transporter.

The competition course is designed to capture the various challenges that a vehicle might see in the real world. As such, the granular material delivered needs to be "edible" once delivered, and therefore neither damaged nor contaminated.

Design Specifications:

1. The device must be powered by rechargeable batteries. No other sources of energy are permitted. This precludes the use of preloaded springs, charged capacitors, compressed gas canisters, and related systems. Note that battery packs ARE allowable as long as they are made up of rechargeable batteries and that this is easily verified by the competition's judges.
2. All rechargeable batteries used must have clearly documented energy capacity – rated voltage and current capacity (milliamp-hours). Teams must be able to demonstrate this to the judges.
3. The device must be controlled either through a transmitter/receiver radio link or through an umbilical cord. An umbilical cord controller may not contain any batteries. As an exception to the battery rule, a radio transmitter may have its own batteries. These batteries do not have to be rechargeable and will not be included in the scoring calculation of energy capacity. The transmitter/receiver radio link may be any commercially available model controller. All radio controllers will be impounded and shut off at the competition, except during the team's run.
4. Mechanical forces on the umbilical cord may not be used to help propel or control the vehicle. The umbilical cord must be detachable from the vehicle using a commercial connector. The umbilical cord may not be a part of the supporting structure of the device. The umbilical cord may only be used to transmit the commands from the controller. Teams will be disqualified if, at any time, the umbilical cord is used to apply mechanical force to the device.
5. Before the trial begins, the device must fit inside a 25 cm x 25 cm x 30 cm rectangular box, which is provided by your team. If your box is part of your design, then the external dimensions must be no larger than the 25 cm x 25 cm x 30 cm rectangular box. The device must be fully assembled as it comes from the box. There is one allowable exception: antenna wires may "spring up" on their own, and remain upright, without penalty, even if they extend beyond the size constraint, as long as the device is controlled by a wireless radio transmitter/receiver pair.
6. You will begin in a square loading area measuring 40 cm on each side. Team members can load and interact with their device in this area only. Before the trial the entire device must be completely within this area (except for any control umbilical cable and controller or antenna). Teams will be provided 1 minute to set up their device, and then will have 3 additional minutes to fill their device with the granular material, and deliver as many loads as possible. Note that teams do not have to use the entire 3 minute competition period. The amount of time utilized will be a strong function of the team's strategy.
7. You must climb a ramp that is between 75 cm and 125 cm long with a rise of at most 10 cm. The ramp will touch the ground at the edge of the loading area and end at the water section. The ramp will be 40 cm wide, may be made of random construction materials (wood, metal, plastic etc.), and may have an uneven surface or some small holes.
8. You must pass through a water section 40 cm by 40 cm by at most 10 cm deep.

9. You must pass through a sand section 40 cm by 40cm by at most 10 cm deep. This sand may be uneven.
10. You must traverse three 40 cm by 40 cm steps of unequal height. The height of each step will be between 5 and 20 cm.
11. There will be a 10 cm diameter hole centered in the top step, into which your material must be delivered. Only material that falls through the hole will count towards the useable payload score.
12. If your material is wet or sandy (as determined by the judges), the material will not count as part of your score.
13. If you touch your device after it has left the loading area, your team will be disqualified.
14. During the trial, the device must be completely controlled via the radio or umbilical controller; no other contact, interaction, or influence is permitted. One team member must control the device (either via wireless or umbilical) throughout the trial. When umbilical cords are used, additional team members are permitted to use poles or rods to guide the umbilical cords during the trial.
15. Throughout the trial, no team member is permitted to touch the course or the receiving container. If the team wishes to repair their device, they must do so in the loading area.
16. The transporter is to climb the stairs by placing its weight successively on sequential stair treads. At any time after leaving the base surface (floor), the weight of the transporter may not be supported by more than two stair treads. The ramp, sand, water, and stairs may not be bypassed by going directly to the top platform or dumping directly into the receiving container.
17. There are no guard rails or curbs on the ramp, steps, or the top platform.
18. Practice runs will not be allowed on the actual contest stairs at the competition sites. The actual course at the competition site will be available for inspection at least one hour prior to device judging and impounding.

At the end of the trial, the granular material in the receiving container will be weighed and the team with the maximum total score will win.

Scoring is based on the following equation

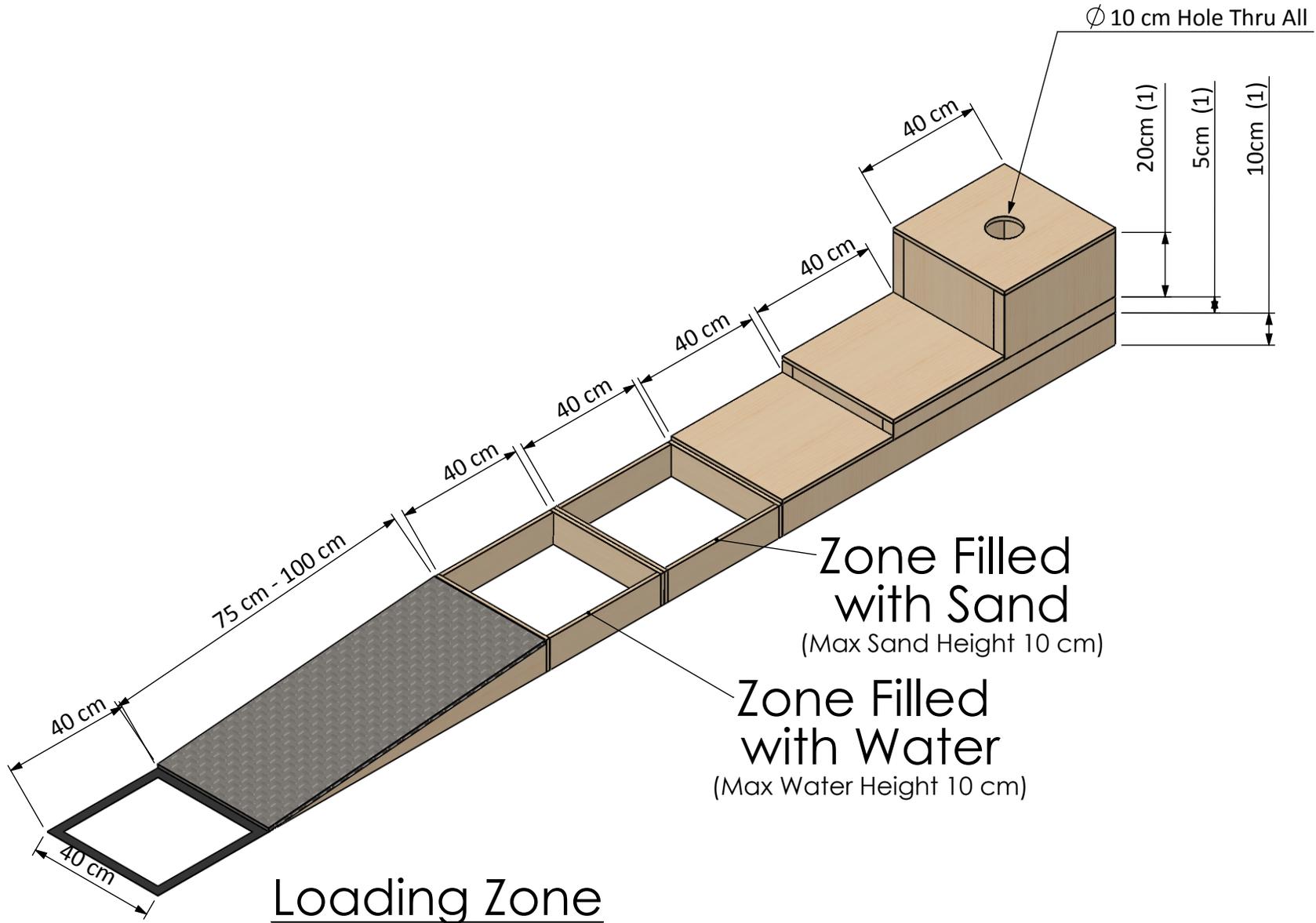
$$S = \frac{\textit{usable payload}}{\textit{time} * \textit{energy capacity}}$$

where:

- S is the team's total score
- Usable payload is measured in grams
- Competition time is measured in seconds (maximum: 180 sec.)
- Energy capacity is measured in Volts*milliAmpere-hours

There will be awards for the following:

- 1st place: Maximum Total Score
- Best Use of Advanced Manufacturing (judges' discretion)
 - A one page report is to be submitted when the team registers for the Student Professional Development Conference. The report will explain how the team used Advanced Manufacturing in the design of their vehicle.
- Best Use of Predictive Design and Simulation Tools (judges' discretion)
 - A one page report is to be submitted when the team registers for the Student Professional Development Conference. The report will explain how the team used Predictive Design and Simulation Tools in the design of their vehicle.



1. Heights Between 5 cm and 20 cm

Author: DCT

MATERIAL
Wood and Misc.

FINISH
SANDED/PAINTED

TITLE: 2015 ASME SDC
Playing Surface

Figure 1

DO NOT SCALE DRAWING

SCALE: 1:50

SHEET 1 OF 1