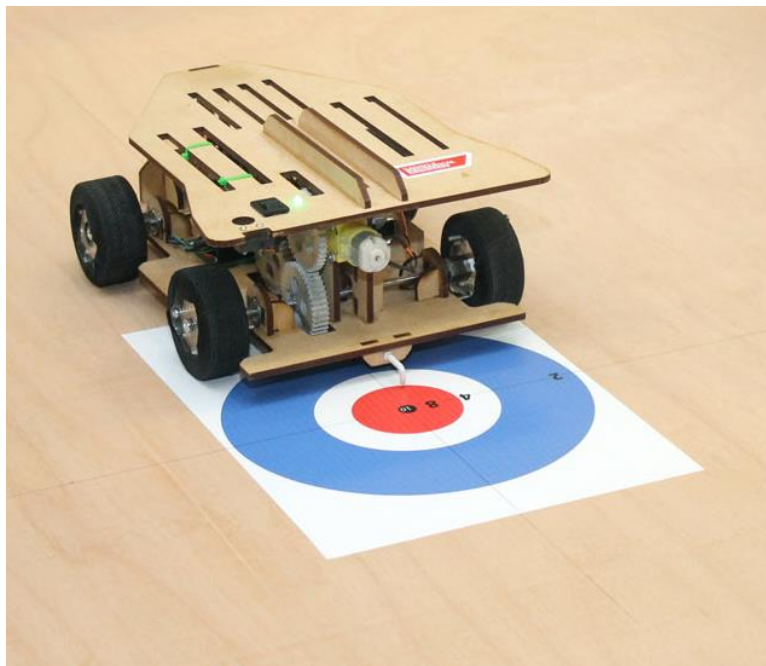


DESIGN CHALLENGE 1st & 2nd YEAR COVID-19 AMENDMENTS 2021

IMechE DESIGN CHALLENGE

REPEATABLE DEVICE



**COVID-19 Amendments
for the 2021
Repeatable Vehicle
1st and 2nd Year Undergraduate
Design Challenge**

Key HQ Contact: Jelena Gacesa, Operations Manager – Education Programme

Jelena.Gacesa@IMECHE.org

designchallenge@imeche.org

Tel: 020 7304 6867

Please Note: these amendments will be updated as the COVID-19 guidance from the UK Government changes.

Please check the IMechE Design Challenge website for updates.

Contents

List of Amendments:	3
1. Introduction.....	4
2. Physical Competition – Team Attends Final	5
3. Remote Competition – Team Competes Remotely	5
4. Virtual Simulation	6
5. Simulation App.....	6
6. Virtual Simulation Conditions	6
7. Technical Regulations for the Virtual Simulation	7
8. Rules for the Virtual Simulation	7
9. Virtual Simulation Run Procedure	8
10. Scoring for the Virtual Simulation	8
11. Extended Presentation	9
12. National Final.....	9
13. Spirit of the Competition	9
14. Amendment to the Rules for 3D Printing.....	9
15. Laser Cutting and 3D Printing Bureau Service	9

List of Amendments:

Version	Page	Details	Date
1.0	-	Full Release (no changes from DRAFT V0.4)	28-10-2020

1. Introduction

The Design Challenge will be running a full programme for first- and second-year students in the coming year. The format of designing a working device will remain the overriding principle. Students may not know when they will be returning to campus or may face the prospect of having no access to workshop facilities for the foreseeable future. As a result, the competition will introduce novel initiatives. For teams that manage to build a physical device, the regional and national finals will include the facility to run live competitions for teams that cannot attend in person. The new format will also allow teams that cannot build a physical device to compete. They will have the choice to either deliver an Extended Presentation to discuss manufacturing techniques and assembly, or enter a Virtual Simulation run. To achieve the latter, the IMechE has developed an app that will simulate performance based on the physical characteristics of a device. Teams with virtual devices will have access to the app to aid development of their designs. Entering the Virtual Simulation, or using the app, does not require any special skills outside those required for the Design Challenge.

SELECTION OF TEAMS WITHIN INDIVIDUAL UNIVERSITIES FOR REGIONAL FINALS

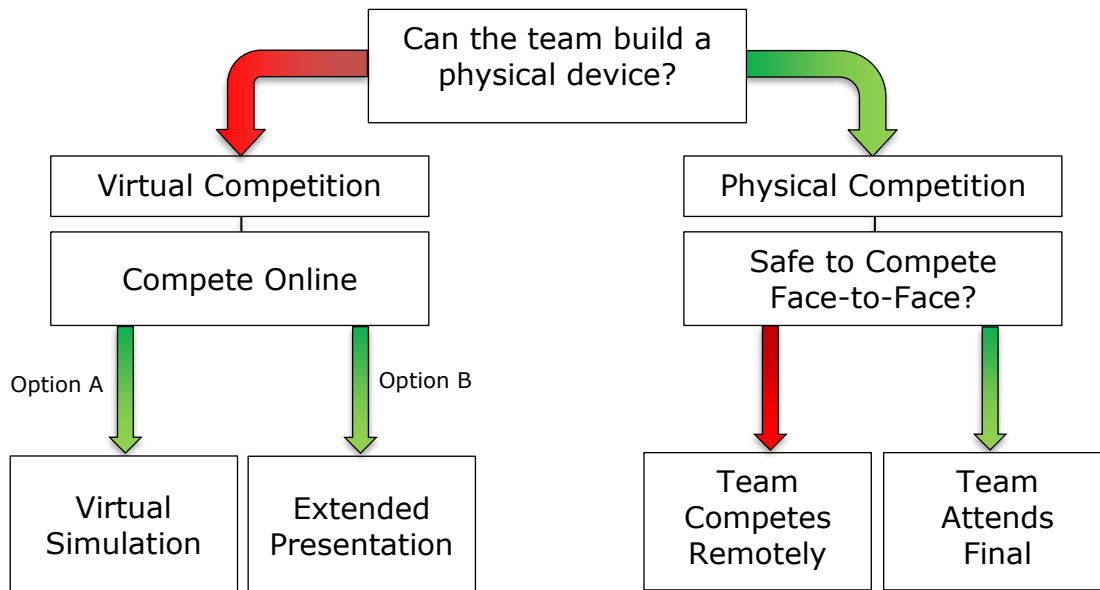
There is no substitute for practical engineering and the IMechE encourages all universities to maintain access to workshops if at all possible. Many universities are allowing some lab/workshop facilities to be available during the year for groups of up to five students. It may not be possible for all teams at a university to build a device, in which case the university may have to prioritise. Universities are free to choose whatever means they deem appropriate for selecting their internal teams to enter the regional competition. As part of this selection process university staff should assess the design solution of each of the teams together with the CAD data and the poster so that they can determine their two winning teams. The IMechE recommends that if workshop access is limited, these two teams should be given access to the facilities to produce a physical device for competition.

FORMAT FOR REGIONAL FINALS

Each region is free to choose the format of their Regional Final in agreement with the IMechE and all universities in the region. Regions are advised to choose a format based on the options detailed later in this document.

On Regional Finals day, the preferred option is for teams to compete in person with physical devices. If this is not possible, then the IMechE can assist with running either a live, remote competition, or a virtual competition. Both alternatives will allow teams to compete live against each other.

FORMAT OPTIONS FOR THE REGIONAL FINAL



Teams may enter either the physical or virtual competition, but not both.

For the Virtual Competition, it is recommended that first year teams choose either Option A or Option B. Second year teams are encouraged to do both Options A & B. The decision rests with the universities and regions to agree the most appropriate format for their Regional Final. See further details later in this document.

2. Physical Competition – Team Attends Final

Face-to-face competition will depend on restrictions in place at the time of the Regional and National Finals. The intention will be to run finals in person, as long as it is safe to do so. The IMechE will issue further guidance, depending on how the situation evolves in the coming months.

3. Remote Competition – Team Competes Remotely

Even if the finals take place in person, it may not be possible for all the teams to attend. In this situation, teams will be able to compete remotely via a live link. Teams will not have to build their own competition lane if competing remotely! They will be able to run their vehicle in a suitable space, such as the floor of a hall, corridor, or any space with at least 4m of length and a suitable vertical wall to reverse from. This will be where the nominated device controller will operate from. Other team members will not need to be all together during the live runs. The only stipulation will be to have a nominated person alongside the device controller, who will act as an independent adjudicator, to set the target distances and score each run, and to act as timekeeper. The adjudicator will also be required to film the device as it completes a run.

4. Virtual Simulation – Option A

With the introduction of the Design Competition element to this year's challenge, all teams will have the chance to enter the Virtual Simulation if they are unable to build a physical device. The IMechE will release a Simulation App in January 2021, which will allow teams to compete with a virtual model of their device.

Teams will run the virtual model that they submit for the Design Competition. It will not be possible to judge these designs on their ability to accurately hit the target zone in the same way as a physical device in the Main Competition. As an alternative, devices will be judged on a combination of the time taken to complete the challenge and the amount of energy used.

Full details of the virtual simulation format will be published in January 2021, but questions are welcomed in the meantime. Please see the FAQs forum on the IMechE Design Challenge website.

5. Simulation App

The performance of devices in the Virtual Simulation will be assessed by using a real-world physics app developed by the IMechE for the Design Challenge. The simulation will work by calculating the movement of a device based on its mass, and the inertia of any rotating parts. Acceleration will be calculated from the motor characteristic of the device, the gear ratios used, and the size of the drive wheels. Aerodynamic resistance will be neglected, but tyre friction will be accounted for. The app will simulate the device travelling from the start point, to the wall, and back again. The app will track the time taken and the energy used to complete a run.

6. Virtual Simulation Conditions

The virtual layout will be exactly the same as the Main Competition, except for one major difference. To add a further variable to the problem of optimising the design for the Virtual Competition, the lane will no longer be level, but will be angled at $\pm 10^\circ$ to the horizontal longitudinally. The lane will remain level from side to side.

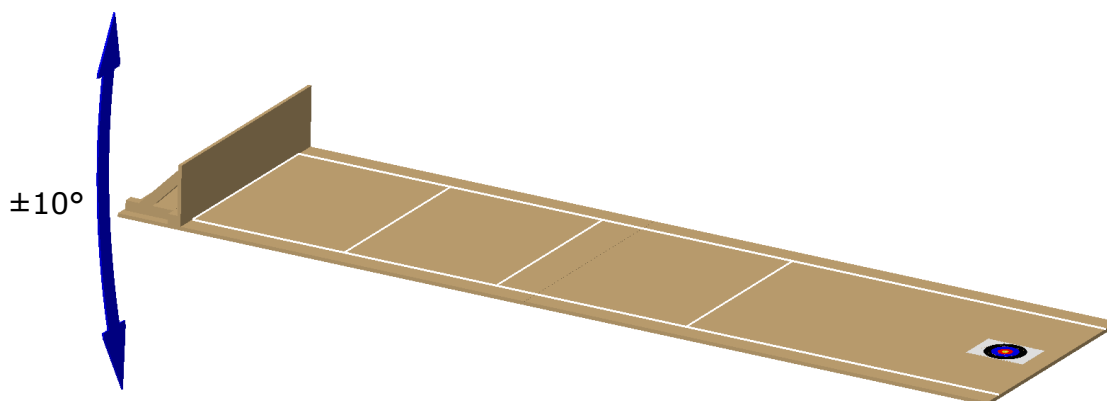


Figure 1. Virtual lane set-up with the wall set at the maximum range distance.

- 6.1 Range distances will be chosen on the day along with the angle of inclination for each run.

7. Technical Regulations for the Virtual Simulation

- 7.1 The virtual prototype must comply fully with the Design Challenge regulations.
- 7.2 Teams must submit a complete virtual prototype of their design in accordance with Section 8. of the "IMechE 1st Year Design Challenge - Project Specification 2021".
- 7.3 To enter the Virtual Simulation, devices must be powered by a DC electric motor for the purposes of the simulation app. The motor choice is free, but it must be a commercially available item and comply with the Design Challenge regulations.
- 7.4 Teams must submit the speed vs. torque characteristics of their chosen motor using an Excel spreadsheet template that will be provided.
- 7.5 Teams will be required to specify the details of the drivetrain used. A spreadsheet will be supplied for this purpose. Gear ratios will be entered into this template along with masses and inertias.
- 7.6 The virtual device must be fitted with a commercially available spring, or springs, fitted to the front of the device, to act as a buffer when the device hits the wall. Teams will need to choose the spring stiffness such that the peak deceleration does not exceed 10g.
- 7.7 Details of the spring used must be included in the Design Competition BOM.
- 7.8 Frictional properties of the interface between the lane surface and the wheels will be published when the Simulation App is released. Coefficients will be assigned based on the tyre or wheel material. Apart from rubber tyres, the options will include plastic, wood and aluminium for devices with solid wheels.
- 7.9 Other physical parameters of the device will be specified in a similar way for running the Simulation App. Further details will be released with the app.

8. Rules for the Virtual Simulation

- 8.1 The Virtual Simulation is reserved for teams that cannot participate with a physical device. Teams cannot enter the Virtual Simulation just because their physical device is not working properly.
- 8.2 University Supervisors will be required to endorse virtual entries and acknowledge that it has not been possible for a team to build their device, owing to restrictions in place.
- 8.3 Teams must express their desire to enter the Virtual Simulation by 28th February 2021.
- 8.4 Prior to the event, teams will use the IMechE Simulation App to generate a data file that must be submitted to the event organisers. This data will be used to run the device in the Virtual Simulation on the day of the final.
- 8.5 All virtual devices must be available for scrutineering prior to commencement of the competition.
- 8.6 Clear instruction on the running order for the heats and finals will be given online at the event.
- 8.7 There will be three competition lanes in the Virtual Simulation, set at different wall distances and inclinations.

- 8.8 The wall distances and inclinations will be the same for all teams, but will not be known in advance, and will be determined on the day.
- 8.9 Teams will compete head to head in heats for a place in the final. The relative performance will be determined by teams scoring points during a run.
- 8.10 A heat or final will involve running on each of the three lanes. Therefore, each team will have a single run at the wall in each of the three different wall distances.
- 8.11 A heat may consist of up to three teams' virtual devices running in parallel on different lanes. Scores will be recorded for each successful attempt.
- 8.12 The time limit for runs in the heats and final will be 2 minutes.

9. Virtual Simulation Run Procedure

- 9.1 Competitors will join the Regional or National Final via a live link.
- 9.2 The Virtual Simulation format will follow the same procedure as the main competition in terms of heats and finals, except that only one heat of three single runs will take place.
- 9.3 When it is their turn to run, the team's virtual prototype will be loaded into the Simulation App by the event organisers. The run will take place and the score recorded.
- 9.4 The run procedure is repeated on each of the three lanes to complete the heat.
- 9.5 For the final, the range distances and inclination will be changed.

10. Scoring for the Virtual Simulation

- 10.1 The fastest team in each run will be awarded 5 points. The slowest team to successfully complete a run will be awarded 1 point. Teams in between these times will be awarded their scores on a pro rata basis.
- 10.2 The team using the least amount of energy to complete a run will be awarded 5 points. The team using the most amount of energy to successfully complete a run will be awarded 1 point. Teams in between these limits will be awarded their scores on a pro rata basis, so long as they complete the challenge within the time limit.

Regional Finals

- 10.3 A maximum of 30 points is available in the heat. The top three teams in the heats returning the highest scores will progress to the final.
- 10.4 Points from the heats will not be carried forward. A maximum of 30 points is available in the Regional Final. The winner will be the team achieving the highest score in the final.
- 10.5 In the event of a tie in the Regional Final, the team with the lowest accumulated energy use in the final will be the winner.
- 10.6 In the event of a further tie on energy use, the team with the fastest accumulated time in the final will be the winner.

National Finals

- 10.7 A maximum of 30 points is available in the heat. The top three teams in the heats returning the highest scores will progress to the final.
- 10.8 Points from the heats will be carried forward to the final. 30 points are available in the final, meaning a maximum of 60 points is possible for the Virtual Simulation.
- 10.9 In the event of a tie of overall points in the National Final, the team with the lowest accumulated energy use in the final will be the winner.
- 10.10 In the event of a further tie on energy use, the team with the fastest accumulated time in the final will be the winner.

11. Extended Presentation – Option B

If universities in a region agree that the Virtual Simulation is not appropriate for their Regional Final, then teams should complete an Extended Presentation in its place. It is recommended that the presentation and questions should include details of the manufacture of the device, the materials used, and the method of assembly. For the second-year competition, regions should encourage teams to also include the Extended Presentation format, in addition to competing in the Virtual Competition. This will allow teams to explain the control systems used in their device. Whatever the format used, in either first or second year, it must be agreed and circulated to all competing universities well in advance of the Regional Final. Scoring for the Extended Presentation should be agreed at regional level.

12. National Final

The IMechE design Challenge committee will meet in January 2021 onwards to discuss the format of the National Final. The competition will be run in the physical format in October 2021 unless announced otherwise. This will require all competing teams to build a device, regardless of the format of their respective Regional Final.

13. Spirit of the Competition

All competitors and universities are reminded that this is a student competition. Given the unique and difficult conditions, staff and technicians must avoid stepping in to assist in designing or manufacturing the devices on behalf of the teams. All entries for the competition must be the students' work alone.

14. Amendment to the Rules for 3D Printing

There will be no restriction on the proportion of the device that is 3D printed, so long as it is within the cost limit.

15. Laser Cutting and 3D Printing Bureau Service

The IMechE is working with industry partners to offer teams the ability to make parts if they have no access to their university workshop. This service will be available to teams selected for the Regional Finals from early in 2021. Further details will be announced when available.