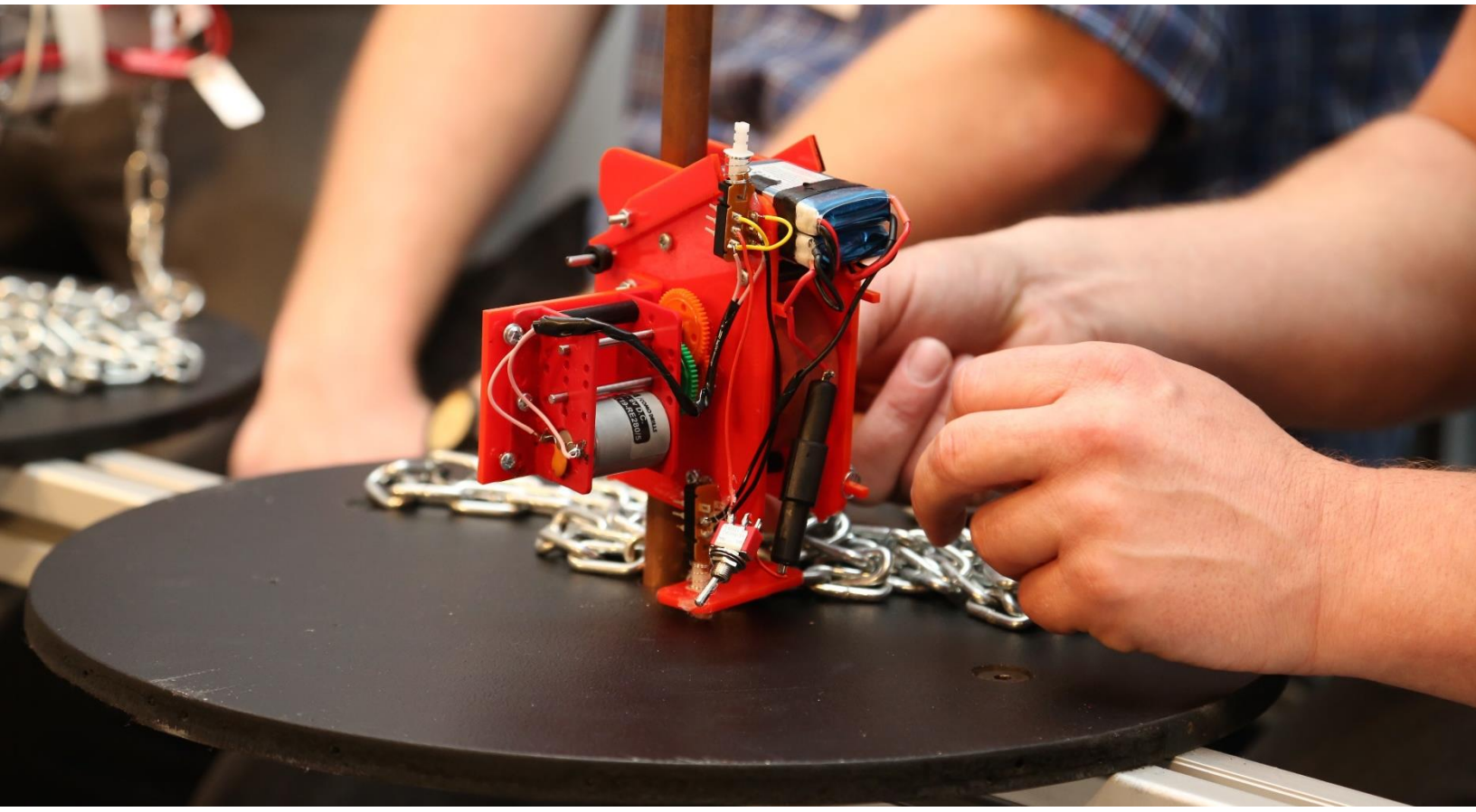
DESIGN CHALLENGE GENERAL SPECIFICATION AND RULES.

Institution of MECHANICAL ENGINEERS

Regional Competitions – UNITED KINGDOM



The 2nd Year Undergraduate Engineers Regional Competition

To be held at universities in the regions.

This guide is meant for regional leads/hosting universities but may also be used by participating universities as a generic guide where relevant.

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This Specification must be read in Conjunction with the Appropriate Project Specification – (2018 Internal Pipe Climber Project)

Contents

1. Introduction and purpose of the Design Challenge

This specification and rules of engagement are to be used in conjunction with the specific project specification adopted at the time.

The purpose of the Design Challenge competition is to simulate the requirements of a professional engineer so that students are exposed to the real world of engineering where they have to think for themselves and apply a systematic approach to solve an engineering requirement.
The competition is open to teams of two to five engineering degree students at the appropriate level.

Each university can complete a registration form and by paying in the stipulated university registration fee (£100 in 2017), can register to participate in the competition annually and enter up to two teams in the regional competition. Each team can use just one device at the competition but all students who work on the challenge will benefit from the learning experience of applying their engineering knowledge.

The Challenge consists of four elements which are.

1) 1a - Work in teams to design, build and test a self-contained device from a precise specification. From this specification they have to produce a design solution, make it, test it and compete to win a place in the IMechE Regional Competition.
   1b - Compete with other teams in the regional competition to achieve the fastest or most accurate device.
2) Produce a "poster" to demonstrate pictorial and graphical skills and the team's ability to sell their design solution.
3) Deliver a "presentation" to demonstrate verbal and presentational skills.
4) Carry out a "peer review" of the devices produced by all of the other teams and rate them so that a winner can be determined.

The above covers the general requirements of a professional engineer.

All teams must compete in the main competition and the peer review. However in some regions where there are a large number of teams it is permissible for each university to enter one team in the poster competition and one team in the presentation competition (this is due to time restraints). Under these circumstances if a university enters only one team they must compete in both the poster and the presentation competitions. In the spirit of the competition all teams within each university should make a presentation and produce a poster even if they do not get a place in the regional competition and if they do they may not necessarily have to present one of them due to time restraints.

The amount of time spent on the challenge at each university is different unfortunately but this should not affect the fairness of the competition.

Most universities have embedded the Design Challenge into their learning programme either initially or after a pilot year and it is said to be beneficial to both the university and the students.

Each region should form a committee chaired by a member of the IMechE regional committee and with a representative from each of the participating universities. The committee should coordinate and monitor the progress of the challenge, deal with any problems, communicate with the IMechE HQ as required, and keep everyone informed.

The date of the regional competition is determined by the committee but it is based upon the best time of the academic year for the universities involved.
The competitions are normally held in March or April but this is not prescriptive because it can be at any time to suit the universities in the region during the academic year.

The National Design Challenge Competition is held in October of each year at the IMechE HQ

The four sections of the regional DC competition are as follows.

1) Main challenge competition.
2) Presentation competition.
3) Poster competition.
4) Peer review.

Each of these sections will be treated separately in the regions, and they will be judged independently of each other but collectively in the national competition.

2. The four adopted Design Challenge projects.

Four suitable projects have been determined for the Design Challenge and they will be introduced consecutively in each region over a four year period.
Each year one of the selected projects is adopted and applied in each region and the same specification and rules of engagement are used so that the regional competitions are identical to each other and subsequently the winning team in the National competition is the true winner of the challenge.

Each of the four projects has a detailed specification for the device requirements, but in each case this general specification will apply for the competition and the rules of engagement.

Each of the four adopted challenge projects represents a real life application so that the students can see a reason for developing such a project

In each case there is a budget of £100 for the 2nd year competition

The four Design Challenge projects are as follows and they are shown in the order they will be adopted over the 4 year period.

1 Repeatable vehicle.

2 Internal pipe climbing device.

3 Line launcher.

4 External pipe climbing device.

3. Competition Rules for all Projects.

3.1 Rules for the design, make, test competition.

The run order should be projected onto the screen. See Appendix A – Sample chart for the run order in main competition in the Heats to be displayed prior to the start of the main competition.

1. The device can be of any safe design, but it must be self-contained and at all times during the competition fit within the maximum dimensions stated for the particular project.
2. The Device Controller is the only person who is allowed to attend to the device during the preparation and start of each heat. The teams competing in a heat will be required to start their devices simultaneously. Once started there can be no outside interference from the Device Controller who must step away from the apparatus.
3. The device must have a means of satisfactorily attaching any external member if required (such as a chain or line etc.)
4. A full parts list must be produced. Receipts, or verification, must be provided ahead of the competition for inspection by the judges. The total cost of the device (including VAT at 20%) is to be under £100 for the 2nd year competition.
5. All parts must be listed with the as-new normal retail purchase price from established suppliers (including VAT, but excluding carriage). Invoices and receipts, or verification, are required to be included with the parts list.
6. Parts with a value of less than £0.20 should be included on the parts list but do not need to be included in the total price (considered free). Components in-kind or provided by the university must be included in the parts list, and costed as appropriate.
7. The cost must include all parts and materials on or over £0.20 used to make the device and any replacement or substitute parts used during the regional events. However spare sets of batteries for example to be changed during the heats need not be counted towards the £100.
8. While the cost of generic tools (drills, saws, files, etc.) need not be included, specialised and unique tools need to be accounted for. For example, a machined wooden former costing £5 used to vacuum form a part during construction must be included as it is bespoke to this item. However the milling cutters used to make the former need not be included. Likewise a battery charger or air compressor can be excluded as they are considered general-use workshop items.
9. Standard sheet/bar materials should be charged as a proportion used per device, within reason. For example if the purchase of a 6m length of steel bar cost £18 and 200 mm were used, the cost recorded would be £0.60 (£18 x 0.2 / 6.0). Purchase of 600 m of bar would be deemed unreasonable.
10. The costed parts list and invoices, or verification, must be clearly displayed by all teams during static judging and scrutineering. Teams may be expected to justify the purchase price of any item of the device, whether on the parts list or not. All devices must be 'signed off' by the academic staff member of the individual universities to say that their teams' device meet all of the scrutineering rules, before the final competition. On the day of the competition and after successfully completing the scrutineering process teams will be given a sticker, this must be attached to the device as proof of scrutineering. Any team which tries to enter a heat without this sticker will not be allowed to compete.
11. Rapid prototyping or additive manufacture is permitted for individual parts but not for the whole assembly (costed at 10p per gram).
12. Teams are encouraged to think very carefully about the safety. All devices must be 'signed off' by the academic staff member of the individual universities to say that their student's devices are deemed safe to operate in a lecture theatre or sports hall environment at the regional competition.

13. The main challenge competitions will consist of several heats for all teams after which the appropriate number of teams will go forward into the regional competition final. All teams must compete in each heat to qualify for the final.
14. There is a time limit for the heats and the final and time will start from the end of the timekeepers starting countdown.
15. It is permissible to replenish the device's energy source between heats. Competitors should consider this during their design process so as to minimise disruption to the smooth running of the event. Any team not ready to compete within the allocated time will be disqualified from the heat.
16. Lithium batteries are not permitted due to the risk of fire and explosion, but other types of safe rechargeable batteries may be used.
17. All teams must display an A4 sheet detailing the team name and university whilst they are competing, and this must be clearly visible during any run in which the team is taking part, so that the audience knows which teams are competing.

If a device does not meet these requirements, and modification cannot be made within the allocated time period to allow it to comply, then it will be deemed withdrawn from the heat.

3.2 Rules for the poster competition.

See the poster judging criteria in appendix - B

1. The poster should be A0 size in portrait format. It should clearly display the logos of the team's university and of the IMechE.
2. The poster should concisely describe the device, how it operates and the engineering principles it is based on. It should include, but is not limited to:
    - 2a - Sketch, 3D visualisation or 2D technical drawings representing the device,
    - 2b - text to explain important features shown in the drawings,
    - 2c - details of how and why the device works, using diagrams if necessary, and
    - 2d - brief details of the team's members.
3. Detailed costing of the device is not required in the poster but a summary should be included.
4. The poster will be assessed and judged by the appointed judges. In accordance with the marking scheme in appendix "B"
5. The poster is a demonstration of the team's ability to sell their design solution.

3.3 Rules for the presentation competition.

See the presentation judging criteria in appendix – C

The run order of the presentations should be projected onto the screen
1. Presentations should be submitted (on a memory stick) on arrival at the regional competition.
2. The maximum length of the presentation is five minutes plus typically two minutes for questions (for the Regional competitions). It can be delivered by any number of team members, from one person to all members of the team. Computer and projector facilities with common software will be available.
3. The presentation should include, but is not limited to;
    - 3a the principal features of the final design,
    - 3b the engineering science that underpins the device,

3c the steps the team followed to arrive at the design, and
3d the cost of the final design and if/how costs influenced the final design

4. The team will be required to answer questions on their design.
5. The presentation will be assessed by the judges according with the marking criteria in the "Judges procedure appendix C, and will be judged by the appointed judges.
6. The presentation is a demonstration of the team's ability to verbally present their design solution.

3.4 Rules for the peer review competition.

See the peer review voting slips in appendix - D

1. Each team should examine the device design from each of the other teams without handling them.
2. Whist the peer review is being carried out there must be at least one member of each team present to answer questions etc.
3. During the examination teams should be looking for the following;
   3a design principles used,
   3b the simplicity of the design,
   3c the robustness of the design,
   3d the manufacturing excellence, and
   3e the general appearance.
4. The competition judges should cast a cursory eye over the procedure during the peer review.

4. Enforcement of the Rules.

1. On matters relating to test equipment and procedure, the authority will be the chair of the Institution of Mechanical Engineering Design Challenge organising committee or his/her delegated representative(s).
2. The panel of judges consists of IMechE and university representatives.
3. The decisions of the panel of judges will be final.
4. In addition to the rules for the regional competition outlined above, universities are responsible for internally ensuring that the spirit of the competition is adhered to during the design and make stages.
5. Appeals: If a team wishes to lodge a complaint to query a procedure or rule infringement they must do so through the chair of the institution of Mechanical Engineering Design Challenge organising committee or his/her delegated representative(s). Any complaint will be investigated immediately with at least two judges and a response will be issued within a reasonable time. This decision will be final and not subject to further appeal.

5. Judges procedure and scoring.

Judges will be appointed from the participating universities; these would normally be the representatives from the regional Design Challenge Committee and from the IMechE.

Note – The judging panel are allowed to vary the rules slightly if it is deemed necessary to maintain the smooth running of the competition.

The Judge's decision will be final.

5.1 Judging requirement - Main Challenge Competition

Judges required.

One judge is required for each lane of the competition heats to ensure that everything conforms to the rules and to record times/scores etc.

A further judge is required to oversee the entire competition rig and to record the winner of the heats and the final. This judge will position themselves so that they can see the entire competition apparatus.

A starter /timekeeper are required to ensure the starting and timing is correct.

The results are to be passed to the administrator for the score. If there is a dispute about who won the video will be replayed to determine the winner

Plus an administrator or administrators for the scores and the certificates so that the scores of the main competition are projected onto a screen showing everyone the progress of the results also to complete the certificates as the competition progresses

5.2 Judging Requirement – Presentation Competition.

The presentation run order is chosen at random and should be displayed. A minimum of three Judges will judge each presentation in accordance with the procedure in appendix C and after determining the results pass the points for each team to the administrator for the score.
A further judge will be the "Timekeeper" who will time each presentation and stop them after 5 minutes.

After each presentation there will be about two minutes of questions from the keynote speaker and the chairman of the Design Challenge organising committee or his or her representative.

5.3 Judging requirement – Poster Competition.

A judge or judges will judge the posters in accordance with the procedure in appendix B and after determining the results pass the points for each team to the Administrator for the score. However due to time restraints it is permissible to appoint a senior judge only to judge the posters. (This procedure has been used at several regional competitions successfully where Dr Colin Brown Engineering Director of the IMechE has been the single judge).
It is normal to carry out the judging during the lunch break.

5.4 Judging requirement - Scrutinising the devices for conformity.

The scrutineering is normally carried out during the lunch break.
Collectively the judges will scrutinise the devices for conformity in accordance with the procedure below and if corrective action can't be made, point out the deviations to the chair of the Institution of Mechanical Engineering Design Challenge organising committee or his/her delegated representative(s) for a final decision.

1) – Any specific principle requirements in the specification must be adhered to.

- The size gauge should be used to ensure that the device fits within the permitted dimensions under all conditions.

2) - The total cost must be under £100 for the 2nd year competition projects.

When the device has passed the scrutineering test the team will be given a sticker to attach to their device to show that it conforms to the rules.

The judging will be carried out as per the rules for the competition, which are outlined in section 3.

5.5 Judging requirement – Peer Review.

Judging by the teams should be generally in accordance with the rules for the peer review (repeated below) and the competition judges should cast a cursory eye over this review whilst it is taking place.

1) Each team should examine the device design from each of the other teams without handling them.
2) Whist the peer review is being carried out there must be at least one member of each team present to answer questions etc.
3) During the examination teams should be looking for the following.
   - 3a design principles used.
   - 3b the simplicity of the design.
   - 3c the robustness of the design.
   - 3d the manufacturing excellence.
   - 3e the general appearance.

5.6 Certificate and score administrator.

The "Certificate & Score Administrator" will record the results on the score chart as each section of the competition is completed as per the following

1) As each section of the competition is completed the results should be collected from the judges and recorded on the total score table and the names should be entered onto the certificates.

2) When the overall winning team is known to complete the certificates for the winning university and the members of the winning team.

3) If time permits to complete the certificates for all the members of the other teams so that there is the minimum of delay between the completion of the competition and the

prize giving ceremony. Alternatively the certificates for all competing students that are not in the winning teams can be forwarded after the competition.

6. Prizes and Certificates.

The IMechE will provide a trophy, and certificates to each of the appropriate regional competitions as follows.

1. The certificates required for each regional competition are as follows.

5 – Certificates for the winners of the main competition.
5 – Certificates for the runners up in the main competition.
5 – Certificates for the third placed team of the main competition.
5 – Certificates for the winners of the poster competition.
5 – Certificates for the winners of the presentation competition.
5 – Certificates for the winners of the peer review competition.
1 – Certificate for the winning university.
No's to be determined – Certificates for all other team members that have not won any part of the competition will be awarded.

7. Host University and Facilities Required for the Competition.

It is proposed that each University in the Region hosts the competition in turn so that the costs etc. are spread evenly.

7.1 The Requirements for the Host University.

1. Appoint a champion who will work together with the representative from the IMechE to ensure that the preparation for the competition is carried out in a timely manner and that the competition runs smoothly on the day.
2. Produce the competition rig (or borrow it from a University that has already hosted that particular competition project) in accordance with the requirements in the project specification.
3. Provide a lecture theatre or sports hall on the competition day and set up the competition rig in an appropriate position at the front of the room so that everyone can see it.
4. Provide facilities for projecting the presentations onto a screen as appropriate.
5. Provide facilities to video the competition.
6. Appoint someone to assist with the scoring of the main competition so that the results can be projected onto the screen as the competition progresses.
7. Make sure that all ancillary equipment is available to support the competition apparatus such as the chain or the line etc.
8. Ensure there is an appropriate place to display the team names against each of the competition tracks
9. Provide stands for the posters together with tables beneath them for the devices for the scrutineering process.
10. Ensure that the gauge is available to ensure that all devices conform to the maximum size limitations.

11. Provide refreshments at the start of the competition day and lunch as appropriate during the day.
12. Provide a periodic facility for the Regional Design Challenge Committee to meet together with refreshments (tea coffee etc.).
13. Attend to any other facility requirements that may be necessary.

8. General Agenda for the Competition Day.

The following is a typical agenda from a regional competition held. The appropriate agenda should be projected onto the screen at the start of the competition.

10-00 Arrival and refreshments. Teams to supply media files for presentations and posters to be displayed.

10-15 Judges Briefing.

10-30 Formal opening and health & safety announcement – Chair

10-35 Opening Remarks – Dignitary from the University

10-50 Outline of the days event – Chair

10-55 Keynote Speakers – IMechE Staff Rep

11-15 Presentation Competition

12-30 Lunch, during which time scrutinising of devices and judging of the posters will take place

13-40 Main Challenge competition runs

14-55 Judges Deliberation

15-00 Grand final

15-10 The purpose of the Design Challenge – Founder – Dr D Ball

15-25 Presentation of the prizes – Guest/IMechE Staff

15-40 Presentation of Trophy – Dr D Ball

15-45 Hand out Questionnaires for all team members to fill in

15-50 vent summary and closing remarks – IMechE Staff

16-00 Event finish

9. Chairman and Speeches at the Competition.

A chairman should be appointed to run the competition and to announce the various sections of the competition processes, but it would be appropriate for the chairman of the regional committee or the regional DC committee to carry out this role. This will include outlining the various stages of the proceedings before they take place. This has been the chairman of the Design Challenge Dr David Ball.

The purpose of the speeches at the competition is to inspire the students and to give them enthusiasm for their future as a professional engineer.

1. Dignitary from the University – It is preferable to have the "Vice Chancellor" if possible so that he or she can emphasise the commitment to the Design Challenge and the benefits it provides for the students.
2. Keynote Speaker – This speech should demonstrate the Design Challenge principle on a non-related topical subject. This speech has been delivered very successfully by Dr Colin Brown the Engineering Director of the IMechE or similar from the Institution.
3. Purpose of the Design Challenge – This should relate to the Challenge itself and how it will help students to prepare for their future as a professional engineer. This speech has been delivered by Dr David Ball the Chairman of the Design Challenge
4. Event Summary and Closing Remarks – the summary speech can be delivered by the keynote speaker or the chairman of the regional committee or the DC committee etc.

10. Questionnaire to be filled in by the Students

The Regional Design Challenge Competition Questionnaire

	1	2	3	4	5	6	7
How difficult have you found the challenge? 1 = easy, 7 = hard							
How much do you think you have learnt from completing the challenge? 1 = a little, 7 = a lot							
Have you found the rules clear and easy to understand? 1 = unclear/ambiguous, 7 = very clear							
Have you found the event timing appropriate? 1 = too short, 7 = too long							
As an estimate how many hours have you spent on the challenge?	_____ Hours						

Please tick yes or no to the following statements and give reasons for any negative answers that you give

	Yes	No
Do you think the Poster is a valuable part of the competition?		
Do you think the Presentation is a valuable part of the competition?		
Do you think this competition has exposed you to the real world of engineering?		

If you selected 'no' to any of the above statements, please provide a short explanation as to why you don't think the competition achieved this objective:

What has been the best part of the day/event and why?

What has been the worst part of the day/event and why?

What could be improved for the future (you may write about any aspect of the competition including the event)?

Do you have any other comments?

11. Check List of requirements prior to each Competition.

1. Chairman appointed to run the competition.
2. Dignitary arranged for the opening remarks.
3. Arrange Keynote Speaker.
4. Venue facilities and refreshments.
5. Competition Rig.
6. Trophy for winning University to keep for about 12 months.
7. Certificates are available.
8. Judges appointed and available.
9. Agenda for the competition day printed and available.
10. Gauge for maximum size of the devices.
11. Arrangements to project the agenda onto the screen.
12. Project the run order for the Presentation competition.
13. Project the heats table onto the screen.
14. Print the judging sheets for each section of the competition.
15. Name cards for each team to display against their competition lane when they are competing.
16. The progression of the main competition results should be projected onto the screen whilst the competition is proceeding.
17. A certificate writer needs to be determined who will complete the certificates on completion of the competition (preferably typed and printed). This will be the Administrator.
18. Photographer filming the event and taking still shots of the competition sections.
19. Continuous fixed video to be directed at the whole of the competition rig so that it can be used for any disputes.
20. Ensure there is a fixed starting line or point on the apparatus as appropriate.
21. Tables for the devices directly adjacent to each individual poster display.
22. Briefing for the judged prior to the start of the competition. (by the IMechE Representative)
23. Teams to download their presentations prior to commencement.
24. Ensure that all teams have had their device signed off by their University for conformity, safety and maximum cost, so that the scrutineering is just a formality.
25. During the scrutineering ensure that all of the team is present
26. Questionnaires to be available for circulating.
27. Determine who will be asking the questions after each presentation.
28. Ensure the stickers are available after scrutineering.

Appendix A –Run Order

(Scores of Heats to be displayed prior to the start of the main competition).

	Heat 1	**Heat 2**	**Heat 3**	**Heat 4**	**Heat 5**	**Heat 6**	**Etc. etc.**
University							
University							
University							
University							

Appendix B - Poster Judging Criteria

		Weight (%)
Visual Impact	Compliance with rules – size (A0) and orientation (portrait)	15
	Obvious information on the university represented (logos) and the team members' names	15
	Good use of colour, layout, text and space to convey meaning	15
Technical Content	Clear but brief textual description of the competing device	15
	Clear diagram(s) – sketch, rendering or CAD model – of the device	15
	Evidence of the engineering science underpinning the device	15
	Summary costing of major components of the device	10
	Total	**100**

Appendix C - Presentation Marking Scheme

		Weight (%)
Presentation Style	Audience Engagement	15
	Quality of spoken presentation (well structured, fluent, clear etc.)	15
	Quality of visual aids (clear and easily readable, do not duplicate spoken presentation etc.)	15
Technical Content	Principal features of the final design	15
	Steps followed to reach the final design, including costing of the device	15
	Engineering science that underpins the final design	15
	Answer to judges questions	10
	Total	**100**

Appendix D – Peer review voting slips

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Team voting:

We have reviewed the other teams' designs and would rank the top three "best designs" as:

1st

2nd

3rd

.....

Team voting:

We have reviewed the other teams' designs and would rank the top three "best designs" as:

1st

2nd

3rd

.....

List of Amendments:

Iss	Page	Details	Date
2.1	-	Released for approval – updated from 2017 spec	28.08.2017