

**Design Challenge for Undergraduate Engineers.**

**Template for Introduction.**

**Target Competitors** – First Year Undergraduate Engineering Students.

**Number of Volunteers Required** –

- One Committee Chairman from the IMechE
- Support volunteers
- Local Business Development manager
- Commitment of several Universities to participate in the Challenge and to put forward teams of two to four Undergraduates to compete.

**Budget** - Prize money, and a trophy to be kept until the next Challenge Competition.

Note – The greater Manchester Area / North West Region offer prize money of £1200.

**Resources Required** – A University to host the event, provide the venue and the competition rig etc.

**Learning Outcomes** – Undergraduates will be exposed to the real world of Engineering whereby they are given a project objective and a precise specification from which they have to design a solution, make the product and test it. They will then compete with teams from other universities at the Design Challenge Competition.

The competition is split into three sections.

- 1) The Poster Competition
- 2) The Presentation Competition
- 3) The main Challenge Competition

Each of these sections is judged independently of each other and prize money and a certificate is awarded to the winners of each.

There should be one judge from each of the participating Universities.

Some Universities have an internal competition so that they can select the two teams to be entered into the IMechE competition.

The winning team in the Challenge Competition have won the order (so to speak) because they have met the objectives and beaten their competitors, which is what Engineers do in the real world.

**IMechE Objective of Working Closer to the Universities** - The competition brings the Universities and the Institution closer together, and some of the Universities in the North Western Region (NWR) have added the Design Challenge to the curriculum of the first year students so that it is mandatory carrying marks for their qualification. Other Universities such as the University of Manchester have included the Challenge as an option whereby students can chose between a University project and IMechE's Design Challenge, again marks are awarded for their qualifications.

When a new University joins the Challenge Competition the students enter purely on a voluntary basis, but the prize money is a good incentive.

In the NWR it has certainly achieved IMechE's objective of bringing the Universities and the Institution closer together.

**How the Design Challenge is Determined** – A committee is formed consisting of a Chairman from the IMechE, an IMechE Business Development Manager, and representatives from each of the participating Universities. They would meet about once per month initially to determine Challenge Project (numerous options are considered and during a process of elimination the challenge project for the next competition is determined), and then to agree a specification together with the rules of engagement.

Each of the participating universities will host the competition in turn so that the costs are kept as even as possible.

**Overview Sample Event Based Upon the Engineering Design Challenge Competition held at the Manchester Metropolitan University on Wednesday the 8<sup>th</sup> December 2010.**

## **1. Introduction**

Welcome to the 4th annual design competition organised by the Institution of Mechanical Engineers and universities of North West England. This year the student Design Challenge is set in the context of pumping equipment.

In a nutshell, the challenge is to design, build and test a water pumping device to convey approximately 3L of water from a reservoir into a cylinder as fast as possible.

The general spirit of the challenge is to provide students with the opportunity to experience the solving of an engineering problem in a commercial situation, which describes the phases of the engineer's task.

### **DESIGN – BUILD – TEST – COMPETE**

#### **DESIGN**

Use creativity and analytical methods to produce a workable solution to a defined problem or challenge, using new or proven technology in a novel way.

**Improving the world through engineering**

## **BUILD**

Realise the design in a physical embodiment using efficient and appropriate manufacturing methods.

## **TEST**

Subject the built embodiment of the design to measurement against defined performance criteria.

## **COMPETE**

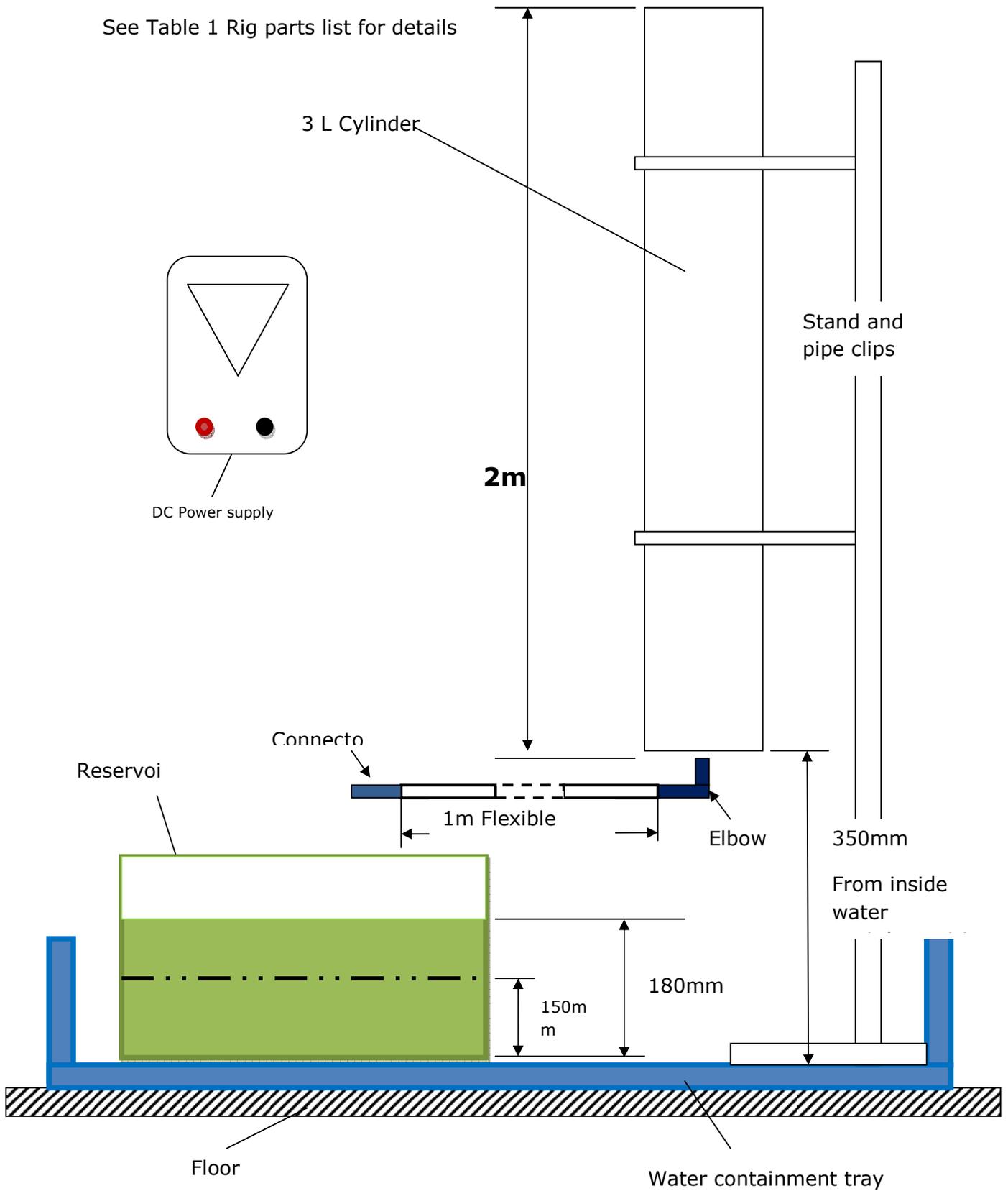
Release the solution into the open market to compete against other designers' solutions to the same or similar problems or challenges.

There are many engineering applications of such devices, for example the fire service are, more and more frequently, called on to pump water from the basements of flooded buildings.

A schematic of the equipment to be used in the Design Challenge is shown in Figure 1. It shows the platform, containment tray, reservoir, cylinder (where the water is pumped to)

**Figure 1: Schematic of equipment**

See Table 1 Rig parts list for details



**Note \*** at start of each race setup - measured from inside reservoir.

The challenge has 4 constituent parts:

1. Work in teams of 2 or 4 to design and build and test a water pumping device.
2. Compete against other teams, using standardised test methods and equipment to demonstrate the performance of the device.
3. Produce a poster to present the team's work.
4. Give a short presentation and explain the rationale for the team's design.

### **Competition Regulations**

1. The competition is to be a race.
2. Each university is allowed to enter two teams.
3. Teams entering the competition must produce a device which will pump water into a tube. When the water overflows the exercise is completed, or after 5 minutes when the levels will be measured to determine the winners.
4. There will be heats followed by a final.
5. The first three teams to overflow the tube in the final will receive prizes.
6. Each team must produce a poster and give a presentation.

### **Competition Rules**

1. Each team will receive a kit of parts:
  - 1 x DC motor MFA457-RE280
  - 1 x toggle switch Part No. RE2HO with 1m flying lead
2. Proprietary items may be used as part of the design scheme, provided that their combined value per design scheme does not exceed £10. Receipts must be made available for scrutiny.
3. The energy source will be a 6Volt Lead-Acid DC battery
4. Only the electric motor provided can be used as the prime mover to drive the pump.
5. The device must be able to be started by means of a toggle switch via a 1m flying lead.
6. The device cannot be placed inside the cylinder.
7. The device must be within the footprint of the water reservoir (0.4x0.3m) but may protrude into and or any distance above the container. The top edge of the reservoir may be used to support the device.
8. It is not permissible to purchase a proprietary pump.

### **Kit available at competition venue**

- reservoir for each tube (storage container 400x300x235mmhigh 20L capacity<sup>1</sup>)
- 6 x 3L - 2m long 44mm Inside diameter transparent cylinder with 1m of flexible tube<sup>2</sup> connector<sup>3</sup> and elbow<sup>4</sup> attached.
- 1 x water containment tray incorporating the water reservoirs and cylinders.
- 6Volt Lead-Acid DC battery<sup>5</sup> for each device.

## **2. General Guidelines**

- a. Each team shall produce a single pumping device.

- b. Each device must allow for fitting to the standard test rig via the hose connector and flying leads provided by the Manchester Metropolitan University, and be ready for the race in no more than ten minutes.

### **3. Materials**

The devices shall be made using generally-available facilities and processes that students can themselves work with under minimal or no supervision. It is accepted that some Layered Manufacturing (Rapid Prototyping) and CNC machining is permissible together with technician support at the discretion of the Universities. There should be an emphasis on assembly rather than manufacture for components designed by students.

### **4. Authority and Arbitration**

- a. On matters relating to test equipment and procedure, the authority will be the chairman of the Institution of Mechanical Engineering Design Challenge organising committee or their delegated representative(s).
- b. The students' responses to the design challenge will be compared at a Final Event at Manchester Metropolitan University. A panel of judges will appraise the performance of the designs and the quality of the teams' communications skills. There will be one judge from each participating institution.
- c. The decision(s) of the Panel of Judges on the day of the Final Event will be final.
- d. In the event of a tie in the race, the tied teams will compete in a race-off until a winner is declared.

### **5. Final Day Competition Format**

Elements of the event will include:

- Scrutineering
- Lunch and refreshments
- Introductions from MMU and Keynote speech from IMechE
- Judging of presentations and posters
- Competitive races
- Presentation of prizes and trophy

### **6. Teams**

Each participating institution shall be permitted to enter up to 2 teams of between 2 and 4 students for the event.

- a. Institutions are encouraged to arrange internal qualifying events within their organisations and to apply their own criteria to select the teams with the best chance of winning.
- b. Teams must consist entirely of students on the first year of an undergraduate course.

## 7. The Test Equipment and Procedure

### General

Inter-team competitive tests shall be carried out on Wed 8 December 2010 at Manchester Metropolitan University using a standardised piece of test equipment, as shown in figure 1, to a defined procedure.

Participants are free to visit Manchester Metropolitan University by arrangement to see and/or use the definitive test equipment, and each university may have their own rig.

### The Procedure

All designs shall be subject to eligibility checks by the judges during the scrutinising session and before testing and racing. The race procedure shall be as follows:

1. Within ten minutes duration:
  - a. Couple to the DC power supply
  - b. Mount test and prime (if required) the pump device
  - c. Securely fix any feed tubing between the device and flying tube's connector
2. Switch device on when given the order "GO" at start of the race
3. The race will be deemed to be finished for each team when water overflows from the tube

## 8. The Poster

Each team **must** produce an A1 paper poster. The poster shall concisely describe the operating principles of the team's pump device and shall include:

- CAD or other drawings in 2D and/or 3D describing the pump device
- Bulleted text to expand on the drawings
- Illustrated explanation of the operational principles of the device and the key engineering science that underpins its workings
- Brief details of the team's members
- The University name and reference to the IMechE Undergraduate Design Challenge and inclusion of the IMechE logo

The poster shall be assessed according to its visual impact, graphical quality and the extent to which it demonstrates the team's understanding of the design's working principles.

A team's performance in the Poster Competition is independent of, and shall not influence, judgement in the pump device competition.

## 9. The Presentation

Each team **must** give a presentation, lasting no more than five minutes including questions, about their device and answer specific questions fielded by a panel of judges. The purpose of the presentation is to allow each team to demonstrate that their device is the result of conscious design, not random chance.

The presentation should address the following five areas:

1. The principal features of the design
2. The rationale for the design – why the design is the way it is, and what engineering science underpins it
3. What steps the team used to arrive at this design – any experiments or improvements that were made as a result of testing
4. **One** example of a calculation that was used during the design of the device
5. Outline costing

A team's performance in the Presentation Competition is independent of, and shall not influence, judgement in the pump device competition.

## 10. Prizes

- a. Cash prizes will be awarded by the Institution of Mechanical Engineers to the three teams achieving the fastest overflow of water in the final. There will be a separate prize for the poster element of the Challenge and also for the presentation element. Team prize values shall be:

1<sup>st</sup> prize: £500

2<sup>nd</sup> prize: £300

3<sup>rd</sup> prize: £200

- b. The winning team's institution shall be awarded a trophy by the Institution of Mechanical Engineers, for safe keeping for one year (or until the next Challenge, whichever comes first)
- c. The team judged to have produced the best poster shall be awarded a further cash prize of £100. The "poster prize" shall be awarded independently of a team's performance in the Challenge
- d. The team judged to have given the best presentation shall be awarded a further cash prize of £100. The "presentation prize" shall be awarded independently of a team's performance in the Challenge
- e. Certificates will be awarded to all winning students and the winning institute following the competition

**Table 1 Rig Parts list**

Ref	Part no	Description	Supplier
1	219S080N1	Container (Reservoir)	Key Industrial
2	RS293-2151	Flexible PVC Hose 6mmID 1.5 Thick	RS
3	RS 795-348	Connector	RS
4	RS 795-231	Elbow	RS
5	RS537-5438	6V Lead-acid battery 10Ah	RS

David Ball – North Western Region. December 2010.