First Year Undergraduate Design Challenge 2020

Project 3: LINE LAUNCHER

Note:- This Specification must be read in conjunction with the General Specification

Contents

1 Introduction

The Undergraduate Design Challenge, organised by the Institution of Mechanical Engineers is an annual competition for students in their first year of study on an undergraduate engineering degree programme. The challenge will be in four parts:

1 Work in teams of up to five students to design, build and test a device to compete with other teams.

2 Produce a poster to publicise the teams' work. The poster is a demonstration of the team's ability to sell their design solution.

3 Give a short presentation explaining the design and development of the device.

4 Submit a peer review where all students have the chance to vote for the best engineered solution to the problem.

In the spirit of the competition it is expected that the device be designed, developed and manufactured by students within the facilities of their university. Each member of the team should have good understanding of the design principles, theories, manufacturing methods and materials used.

The format of the Regional Competition and National Final is as follows:

Regional Competition	National Final
Poster	Poster
Presentation	Presentation
Peer Review	Design Excellence
Line Launcher Competition	Line Launcher Competition

Points will be awarded for the heats and other modules of the Line Launcher Competition.

In the event of a tie of overall points after the competition final, the team with the highest points in the Line Launcher Competition will be the champion.

In addition to the above rules and regulations please refer to the "General Specification" for further requirements.

2 Line Launcher

A Line Launcher is a device used to fire a rope from one ship to another at sea or for various rescue scenarios. The challenge is for teams to design, build and test a small-scale device to fire a squash ball attached to a line indoors over various distances. A target will determine which device delivers consistent accuracy and precision.

The design will principally deal with energy storage and projectile trajectory from a fixed point. There are many methods of firing projectiles; such devices require a controlled and safe method of energy storage, line storage and with a reliable release mechanism.

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3 Competition Conditions

To simulate a rescue line launch, a firing range (figure 1) will be set up in an indoor space i.e. lecture theatre (minimum ceiling height 3 m), with a launch location pin and designated target area. Range is the distance from the device launch location pin to the centre of the target. The launch location pin is mounted 100 mm in from the rear most edge of a 600 x 600 mm small table. The target area (figure 2) is a series of circular concentric rings mounted over a circular container. Scoring will be judged by the ring space the ball first passes through on the target.

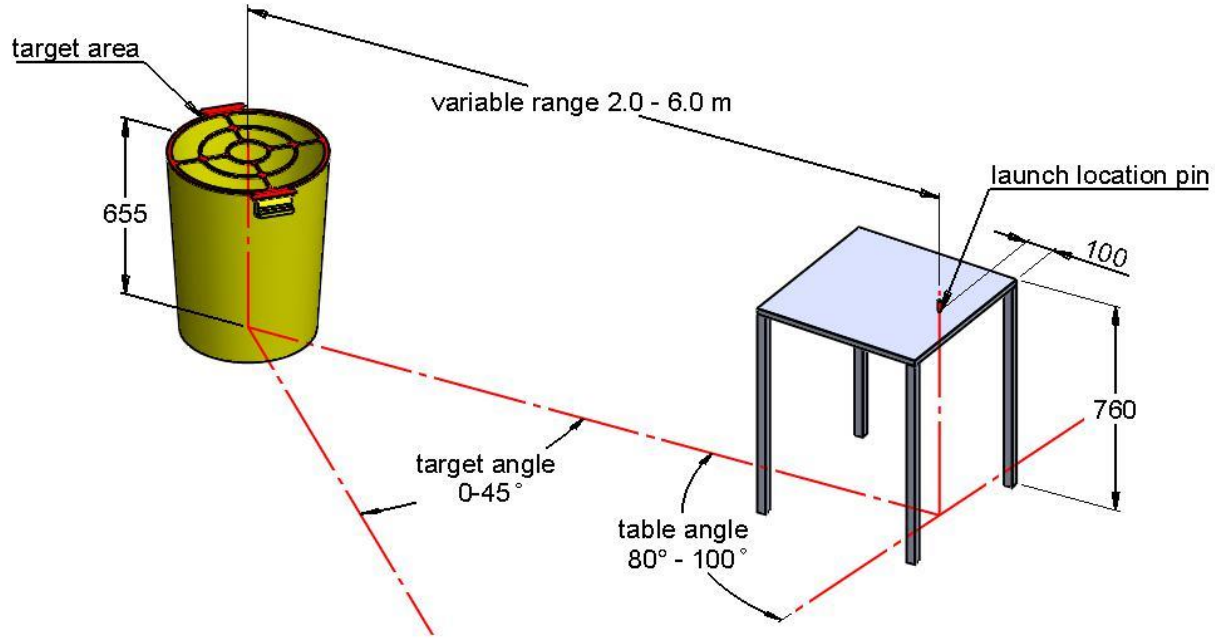


Figure 1 – Layout of simulated firing range[1].

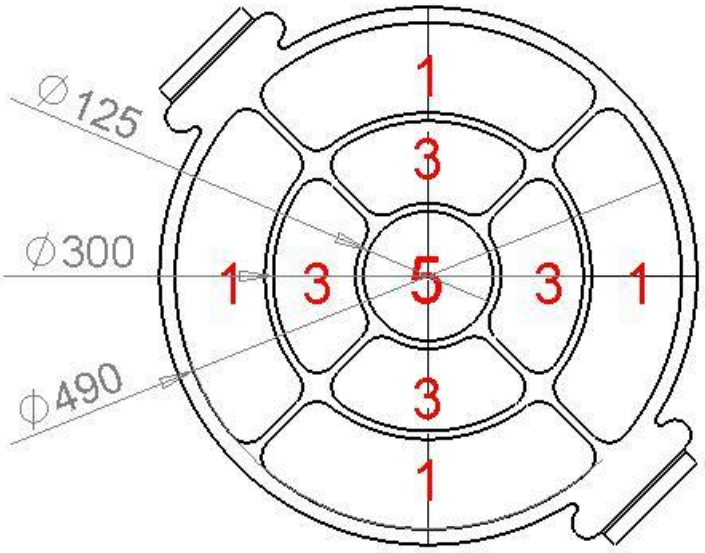


Figure 2 – Target size and scoring.

[1] Surfaces will be flat and level within normal building tolerances. Dimensions indicated ± 2 mm. The table and target angles may vary and it will be down to competitors to align the launch device to the centre of the target. Consistency amongst heats will be maintained within the spirit of the competition.

The launch location pin (figure 3) is an M10 bolt, 50 mm long glued in place with approximately 30 mm of thread exposed. Devices are to be secured to the location pin using the 10 mm washer and wing nut provided. Clear access to the wing nut is required to enable the launcher to be easily secured/removed without disassembly.

Figure 3 - Launch location pin with securing washer and wing nut.

The launcher must fire a yellow dot squash ball[2] which is attached through its approximate centre to a line[3] by the method shown in figure 4. A similar loop at the opposite end must be used to attach the line securely to the device. Balls and lines will be given at the event with the length of line approximately 9.5 m, sufficient to prevent the line length becoming taut and thus controlling range. Excess line cannot be cut-off or tied to a specific length.

Figure 4 - Line attachment to yellow dot squash ball (loop slackened for clarity)

[2] Single Yellow Dot Squash Ball (Dunlop Competition)

[3] Line: Times Spectra Extreme Braided Fishing Line Yellow (30 LB, 0.26 mm)

4 Device Regulations

4.1 Devices must be regarded as safe and reasonable as judged by the member/s of staff responsible for the team/s, consideration should be given to guarding if there is risk of entanglement or entrapment.

4.2 All devices must be fitted with a safety mechanism which prevents the device being accidentally fired once armed.

4.3 The device must fit within a maximum working envelope of 600 x 600 x 600mm at all times during competition, even during firing.

4.4 The device must sit above and cannot overhang the edge of the launch table at any point during a heat.

4.5 Devices shall be fixed securely by use of the launch location pin, washer and wing nut to the launch table. Any device or part of device that 'breaks free' during a competing heat or final will not receive any points for that attempt.

4.6 Each device must have a quick and simple method of attaching and detaching the line, which should not require the use of tools. It is up to individual teams as to how this is achieved, but any coupling must not cause the device to violate the control volume dimensions.

4.7 Teams are advised to pay particular attention to line-management during a launch sequence. Line management devices can be reloaded, reused or replaced during a heat or final.

4.8 Devices must be fired remotely via a low voltage electrical switch with a minimum cable length of 2 m. The firing switch and wiring are the only components excluded from the working envelope.

4.9 Parts from existing firing devices (i.e. triggers, barrels, breaches) are not permitted.

Please note: As detailed in the General Specification the device budget is £30.

5 Competition Procedure

5.1 All devices must be available for scrutineering prior to commencement of the competition.

5.2 Safety glasses must be worn by the Device Controller just prior to arming and at all times during the heats/final where a device may fire.

5.3 No person is to be between the device and target once armed.

5.4 No practice firing of any projectile is permitted, the device may however be tested for all other functionality.

5.5 A device that fires prematurely **at any time** during the competition will forfeit its next pending attempt.

5.6 Clear instruction on heats and finals will be given at the event.

5.7 Organisers will announce the target range **3 minutes** before a heat. Participating teams will have those **3 minutes** to position their device on the firing line and be armed but with safety device in place.

5.8 Operators will raise their hand clearly to show readiness within the 3 minute period, if all operators are ready to fire, a heat can commence.

5.9 A vertical pin will be placed at the centre of the target to assist in visual device alignment at the start of each heat/final but will be removed before firing commences.

5.10 Once ready, teams will be instructed to “RELEASE SAFETY” operators will release the safety mechanism and return to the safe firing position, then on a count of 3,2,1, FIRE ! Each team will fire their device.

5.11 If a device fails to fire within 10 seconds of the FIRE command, it will not score points for that pending shot.

5.12 Once all devices have fired (or been made safe if not fired) judges will record the scores and teams will be instructed to retrieve ball and line.

5.13 Teams will have **2 minutes** from a given signal to re-load and safely arm devices before the second shot.

5.14 Teams not ready within the allotted time will forfeit that attempt.

5.15 Breach of any rule during competition will forfeit that heat.

6 Heats

6.1 Teams will compete head to head in heats.

6.2 There will be three heats over three different ranges, all teams will fire over the same ranges set.

6.3 All teams will be allowed two shots per heat. Each firing can score points.

6.4 The highest cumulative score from all six shots will determine the final score.

6.5 The final will be three single shots over three different ranges. Each firing can score points.

6.6 If a ball fails to score by bouncing off the top of the target (as identified by the judge) another attempt will be allowed.

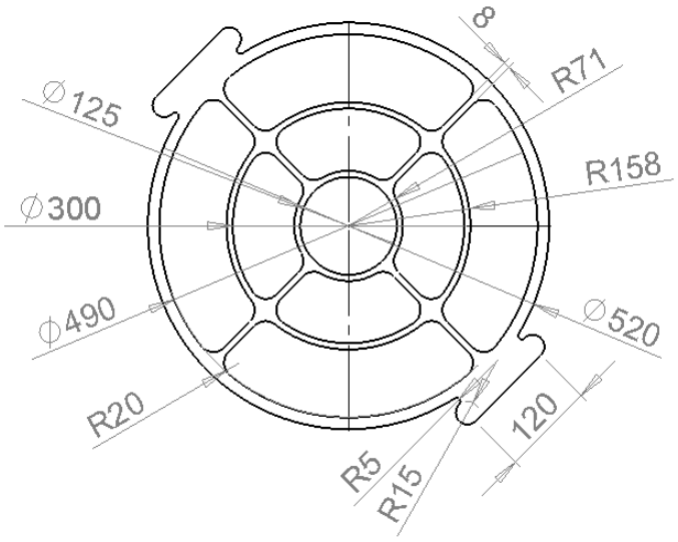
6.7 In the event of a drawn score the range will be re-set and a single shot run off will take place with a 20% smaller target. This will be repeated at a different range until one team outscores the other.

6.8 Judges reserve the right to modify these competition procedures to assist with the smooth running and timing of the event.

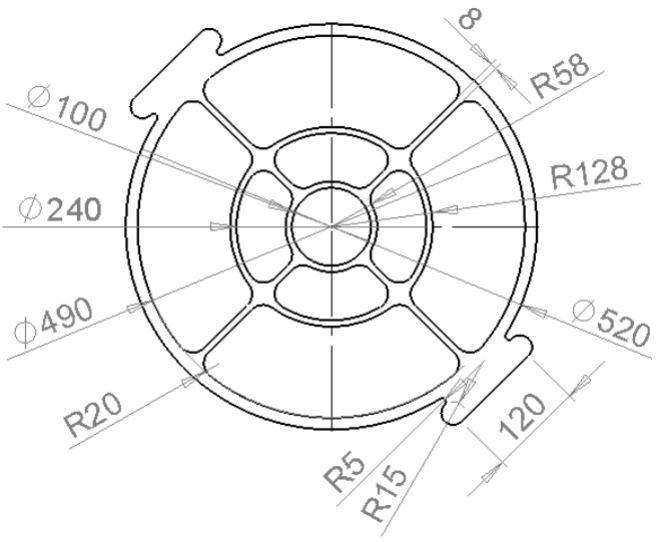
7 Appendix 1 – Simulated firing range components

	Launch table: Scholar Crush Bent Square Tables by Office Furniture Online https://www.officefurnitureonline.co.uk/education-furniture/classroom-desks/square-rectangular-classroom-tables/scholar-crush-bent-square-tables.html# 760H - 14 – Adult 600 mm W x 600 mm D x 760 mm H.	£42 min 4 tables.
	Target Container: 110L – Yellow – Litre Plastic Colour Bin Garden Rubbish Waste Dustbin by OnlineDiscountStore https://www.amazon.co.uk/110L-Yellow-Plastic-Rubbish-Dustbin/dp/B00MK1TS4G Dia 600 mm, H 720 mm	£25.99
	Ball: Dunlop Competition Squash Ball 12 Pack Yellow by Dunlop https://www.amazon.co.uk/DUNLOP-Competition-Squash-Balls-Single/dp/B0002QVMHM/ref=sr_1_4?keywords=dunlop+competition+squash&qid=1564574958&s=gateway&sr=8-4	£25 for 12 approx.
	Line: Times Spectra Extreme Braided Fishing Line Yellow 30LB Test 100m https://www.amazon.co.uk/Spectra-Extreme-Braided-100m-2000m-109Yards/dp/B01BZN7SAA/ref=sr_1_19?dchild=1&keywords=braided%2Bfishing%2Bline&qid=1573036661&sr=8-19&th=1&psc=1	£5.12
	Launch Pin: Bolt – Screwfix 11372 Easyfix BZP Steel Set Screws M10 x 50 mm 50 pack Washer – Screwfix 14327 Easyfix Large Flat Washers M10 x 2.5 mm 10 pack Wing nut – Screwfix 5195T Easyfix Zinc-Plated Steel Wing Nuts M10 10 pack	£6.89 £0.49 £2.89

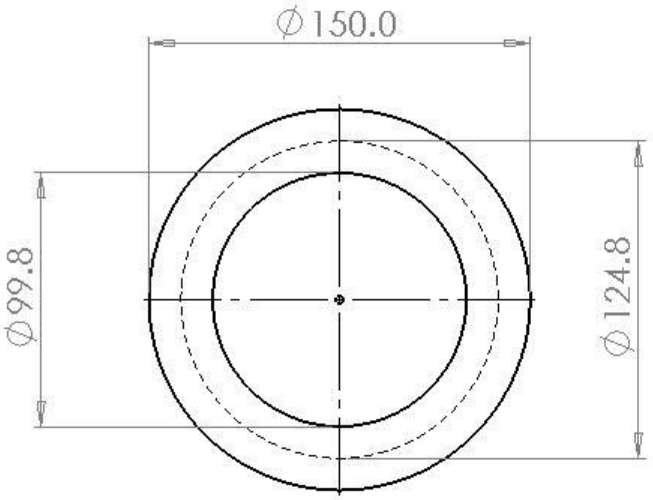
The targets are cut from 5 mm acrylic sheet, and secured to the bin using elastic bands looped around the handles. DXF files of the targets are available from the competition organisers.

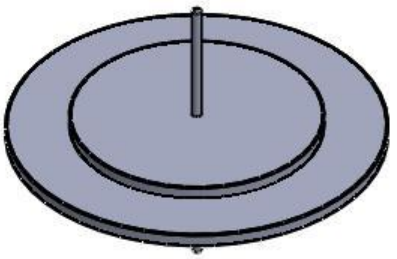


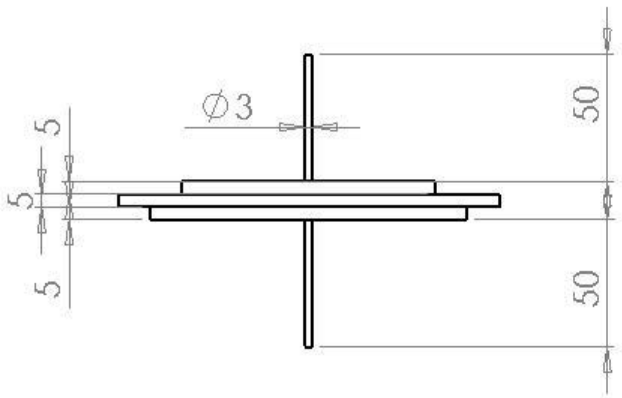
Main target



Tie-break target







Target alignment pin

It is suggested the centre of the two target cut-outs are used to make the upper and lower discs to ensure a precise fit.