Faculty of SEC
School of Mechanical and Automotive Engineering

Module No	**Module title**	**Module leader**
ME4013	Engineering Design, Materials and Manufacture	J Garcia
Assignment Title:	DMT: IMechE Design Challenge – Group Report and Logbook	

Group Name	C6

"Include device image here (solid model in shaded, isometric view)"

Group Members

KU ID	**Name**	**KU ID**	**Name**
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Contents

Abstract

Group Structure & Individual Contributions

Aliya Foster	Group Leader Research & Development Calculations Initial Ideas Manufacturing
Binaya Rai	Research & Development Initial Ideas Manufacturing Planning & Gantt Chart
Brandon Mongo Mboyo	CAD designs Research & Development Manufacturing Initial Ideas
Morsy Alaa	Initial Ideas

In order to be as productive as possible we endeavoured to play to our individual strengths as much as possible, i.e. by assigning roles to the relevant persons such as 'CAD designer'. We made sure that we took advantage of the timetabled group sessions for planning and discussions as well as keeping in contact with each other outside of class times by exchanging telephone numbers. All decisions made were carefully deliberated amongst group, but to ensure that there were no arguments, a group leader was elected who would have the final say. We distributed the work load as evenly as possible for maximum efficiency, especially since we have a small group in comparison to some others.

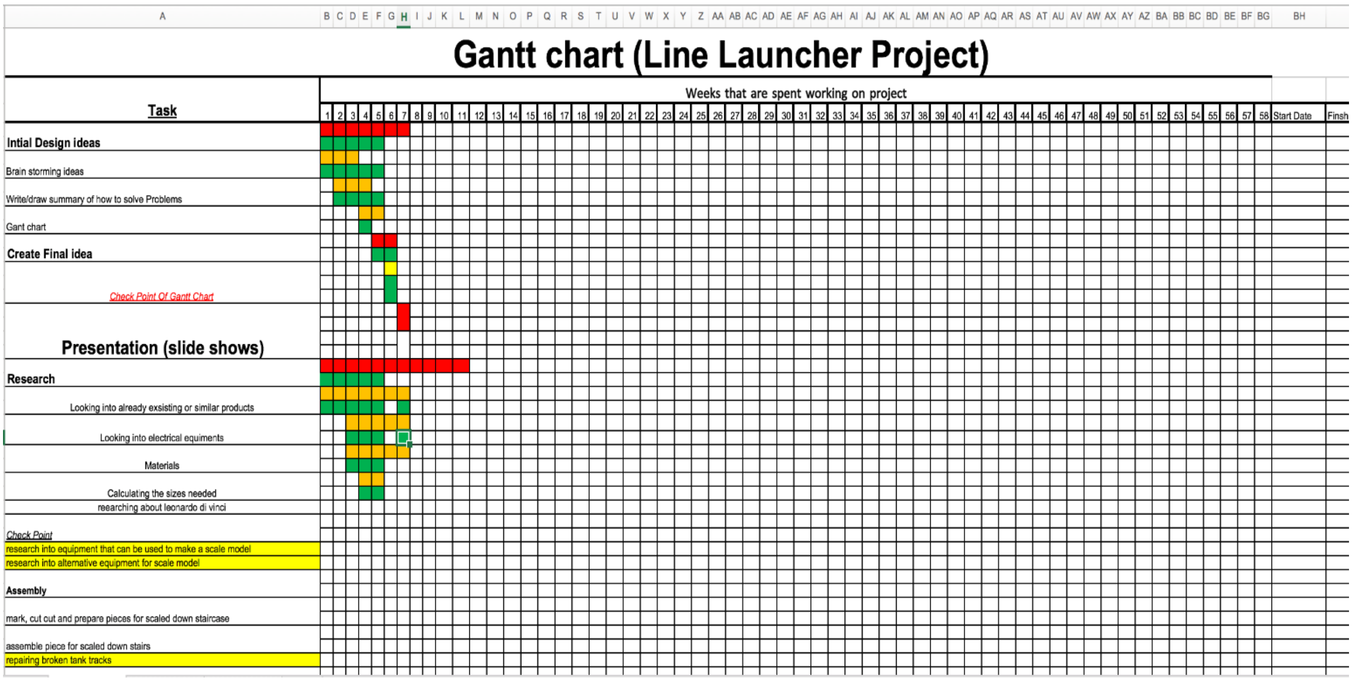
Introduction – Objectives

The task set for us to complete was to design, build and test a line launcher. Our project would have to be able to fire a yellow dot squash ball attached to a fishing line at a target which could be placed anywhere from 2 – 6m away from the firing line. Since the target could be moved to any distance within this range we would need to have some means of adjusting our device to hit the target at any distance. The specified target is a 600 x 600mm square 3x3 grid elevated 450mm above the table.

The device had to be mounted to a base measuring 400 x 200 x 20mm so that it could slide freely between the guide rails.

Project Plan & Gantt Charts

First and foremost we created a Gantt chart which has numerous benefits. It enables us to minimise confusion as it gives us a visual representation of our time scale and what has to be done at each stage. This therefore makes it easier to keep on track because even if we fall behind schedule, we can see how much more work we have to do to get back on track. It also acts as one of our techniques for helping with communication; if each and every group member has a copy of the Gantt chart then there is less confusion with what is required of them.



The project plan is the governing document that establishes the means to execute, monitor and control the whole project. The plans purpose is to ensure that all the group members has the knowledge and the idea of what this projects objectives are and how they will be accomplished. Project plan had been made before carrying any physical work. All the group members were happy and came to an agreement with the plan. However, along the way few changes were made because of errors and flaws in the plan.
(Logbook)

Before starting the project, we had to sit down in groups brainstorm different ideas on making the line launchers. The internet was the first source we used to get all the information about it.
Gantt chart was one of the first thing we made for us to keep track of the project timing (see above). The Red colour is an estimation of Overall tasks, the yellow colour is and estimation of the sub tasks and the Green colour is actual time we achieved the individual tasks.
We estimated how long it will take us to complete certain tasks and would fill in every time we came to checkpoint and by doing that we were not focusing on one thing more than we should for e.g. we estimated that brainstorming ideas would take us about 6-7 weeks as we thought that there might be faults in the first few designs and would have to keep changing. Surely enough we were

right and we did make few adjustments on the design along the way but we were aware of how long till we came to an agreement with the final design.

Initial Ideas

- We began by **first** focusing on the launching mechanism itself and all made a mutual agreement on using a spring after a series of brainstorms. We started with the idea of having the spring inside cylinder closed at one end and pushing the ball downwards to compress the spring. Complications arose when trying to decide on how to lock the spring into place and connecting it to out release mechanism.
- Other design concept that we has was to put two compression springs outside the cylinder tube thinking that the compression springs outside will give us more force and will be easier to compress but find a compression spring that we though could have the desired effect proved quite problematic.

  (Add rough drawing if we have any)

Pros & Cons of All Ideas

Development

- Several design attempts later we realised that placing our spring externally meant that we would be able to compress the spring and change the level of compression more easily when needed.
- We then decided that the best way to change the angle was to actually develop an adjustable base and then mount our launcher to the base.
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Detailed CAD Drawings

The Parts/Components

Required Materials, Parts, Weight Prediction & Costings

Calculations

The main purpose of doing calculations was to give us a reference point to start from. We began by calculating the initial velocity that the projectile would need to be fired to reach the maximum distance of 6m at its optimum angle of 45°.

Distance $D = \frac{V_0{}^2 \sin 2\theta}{g} \rightarrow when\ D = 6,\ \ V_0 = \sqrt{\frac{6\times 9.81}{\sin\,(2\times 45)}} = 7.67m/s$

From this we were then able to work out the expected flight time:

Time of flight $T = \frac{2\,V_0 \sin\theta}{g} = \frac{2\times 7.67\times sin45}{9.81} = 1.11s$

Using the velocity we were also able to work out the maximum expected height which is very important since we do not want the projectile to hit the ceiling during its flight.

Maximum height $H = \frac{V_0{}^2 \sin^2 \theta}{2g} = \frac{7.67^2 \times sin(45^2)}{2 \times 9.81}$=1.50m

We used the idea of energy conservation to work out the stored energy in the spring from the kinetic energy and potential energy of the spring when the ball is released:

$\frac{1}{2}mv^2 + mgh = kx^2$ $\left(\frac{1}{2} \times 24 \times 7.67^2\right) + (24 \times 9.81 \times 247) = 58974 = kx^2$

Rearranging this enable us to work out the displacement of the spring necessary for us to be able to achieve this:

k =27.9 $kx^2 = 58974 \rightarrow x = 25mm$

In these calculations things like air resistance and friction have been considered negligible which is one of the reasons testing are amendments are necessary.

Details of Manufacturing Process with Photos

1) **Making the base:** We cut a piece of 17mm plywood into two pieces of length 250mm and width 150mm. The two pieces were then joined together using hinges. (Tools used: hacksaw, disc sander, Phillips head screw driver)	
2) **Making the angle adjuster:** We cut out a quarter of a circle from the same material and marked out the increasing angles from the corner using a protractor. Near the edge of the circle we drilled holes big enough for a 6mm threaded steel rod at each of our angle increments. This was then attached to the base using two long screws. (Tools used: junior hack saw for the curve, disc sander to smooth edges and a pillar drill for the holes).	
3) **The projectile launching tube:** Starting with a PVC tube with a length of 195mm and outer diameter of 50mm we cut a slot on either side using the milling machine. The slot also had to be wide enough for a	

6mm threaded rod to be able to slide freely up and down. This tube was then glued down to the top of the base. (Tools used: Milling machine, glue gun)	
4) The internal support for the squash ball: From another piece of plywood we cut out a circle with a diameter of 38mm and drill a 6mm hole through the thickness. We cut a piece of the 6mm rod to a length of 85mm; this was then slotted through the hole and secured by screwing an end nut on either end. (Tools used: pillar drill with hole saw bit, pillar drill with regular twist bit, junior hacksaw to cut rod) This step originally only contained the metal rod however, when amending our design after the initial testing stage we decided to add the circle of plywood to improve the support of the squash ball *please see testing procedure details*.	
5) Support beams for bungee cords: We cut two pieces of the plywood a length of 300mm and a width of 50mm and then drilled two 6mm holes 55mm from the top end. We screwed them to the top of the base, either side of the PVC tube. (Tools used: band saw, disc sander, pillar drill with twist bit, screws, Phillips head screw driver)	
6) Mounts for the bungee cords: We slotted two short pieces of the threaded metal rod through the holes and fixed them into place using two end nuts. (Tools used: junior hacksaw to cut rods).	
7) Preparing the bungee cords: We used one bungee cord and cut into two equal pieces. We then tied a not at the cut end of the cord to secure the hooks that come already attached to the cord. (Tools used: scissors)	
8) Fastening the bungee cords: We attached one end of the bungee cord to the support beam by screwing it into place, 35mm from the bottom.	

We then curved the bungee cord around the end nuts that we previously attached to the top of the support beam. Next we curved the hooks around the metal rod that goes through the PVC tube. We repeated this on both sides. After the initial testing phase we realised that the reason our ball did not travel as far as we would have liked was due to the fact that the bungee cords were still very slack so we screwed a second screw near the bottom of the support beam to wrap the cord around and tighten it. This was also repeated on both sides. (Tools used: screw driver, pliers)	
9) **Attaching the device to the main base:** We glued three pieces of pine wood that was stacked on top of each other onto the standard Imeche base that was given to us. (tools used: glue gun)	

The Electronics

Test Procedure

After all our hard work we felt that we were finally ready to test our device. Testing took place with three group members present over several hours. It took longer than anticipated because although we thought that we were ready, after the initial testing, several changes had to be made and then retested. This made the testing a two phase procedure: The trial and improvement phase followed by the final tests which would then be approved by the relevant people.

We brought out device up to the firing line and secured it in placed. We then pulled the bungee cords firmly back which brought the squash ball down the tube. Upon releasing the cords nothing happened, unfortunately the ball was stuck. We realised that this was due to fact that the only thing we had behind the ball was the metal rod designed to slide up and down the tube, so ball would become lodge in between the side of the tube and the rod. It was now time to head back to the drawing board.

In an attempt to fix our problem we added a small circle of plywood for added support inside the tube. This helped a great deal and when retesting, the ball was then about to actually exit the tube. Much to our dismay this only worked sometimes, it was still getting stuck. There was too much friction between the ball and the inside of the tube because of the texture of the ball. We managed to get around this problem by inserting a tube with a smaller diameter that had been cut in half so that it would act as a ledge for the ball to rest on but its smoothness enabled it to slide up and down inside the tube. Using a glue gun we glued the end of it to the wooden block inside the tube.

We then retested and the ball was able to exit the launcher with great ease however we were very disappointed with the range since it was only able to travel approximately 1.5m. After noticing that the tighter the bungee cords were, the further the ball was able to travel, we realised that our bungee cables were far too slack to be able to deliver the force and propulsion we were certain they were capable of. To overcome this obstacle we decided to add a second screw to the base of each of the bungee support beams that we could wrap the bungee cords around to tighten them. To our delight, after retesting we saw that our projectile was able to travel to 6m.

Results & Discussion Conclusion

Even that when our Project launched the ball and the ball reached 6 metres but after a few tests fires the PVC tube broke meaning that our product lifespan of the line launcher wasn't that long. The reason the PVC broke is that the force from the rod hitting on the slots that stop the rod from fly off was too much and to get our desired distance is that we wanted we had to release the bungee with that much force. So if we was to build it again we would use something strong than PVC like for example a metal cylinder that's not magnetic so it don't interfere with the electromagnet. So it can withstand the force that the bungee exerts of the end of the slots which were close to the edge of the PVC or something stronger that our PVC tube.

In conclusion since our line launcher reached 6 metres within three shots the overall goal of the Imeche challenge was achieved but I failed to focus on the health and safety aspect side of the Imeche challenge which was to put a safety pin or mechanism to make sure that it wouldn't fire accidently that was due to constant problems that arises from manufacturing which needed more attention than our group anticipated therefore taking up more time which coincidentally resulted in there no time to work on the health and safety aspect.

But for our whole group this Imeche challenge was a great learning experience for all our members where skills that we already had like our maths skills and what we knew about projectiles were used but for a real application that was relevant to us and our CAD skills were expanded to greater depths and other important skill like time management and organisation we put to the test and if we were to do it again our time management and organisation would be better and now we are better equipped to deal with similar projects. Plus the experience of getting hands on with the machines in the labs was really good getting use the machine the components that you created on CAD

Appendix 1 – Log Book

Appendix 2 – Lab Pack