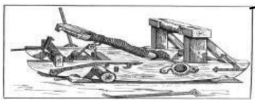


THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Group Project

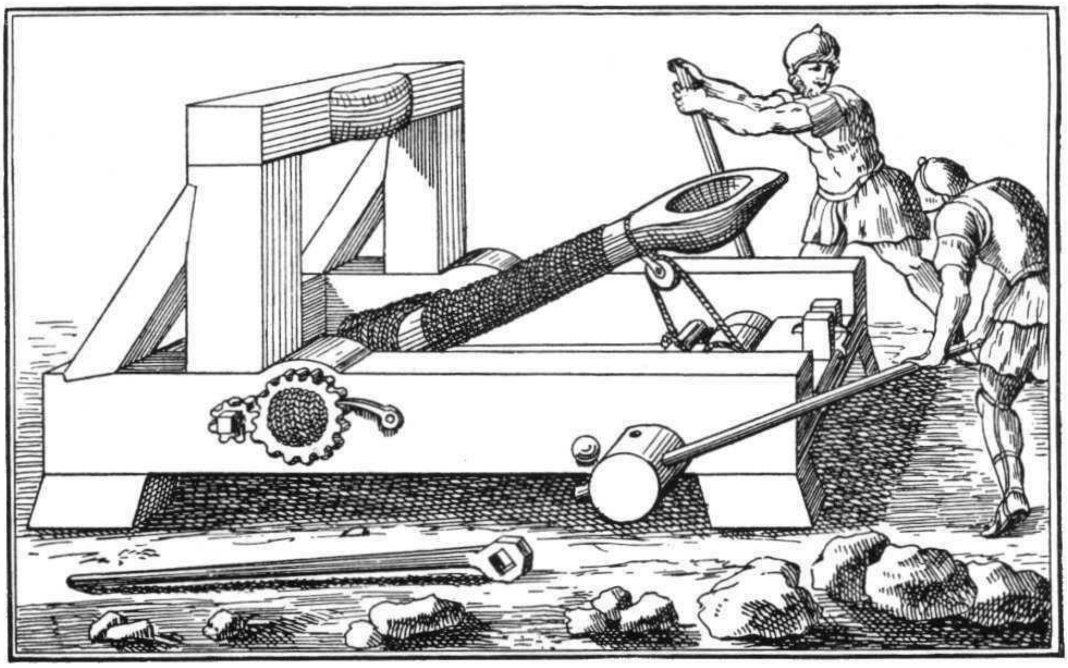
&

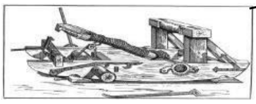
Poster presentation

On

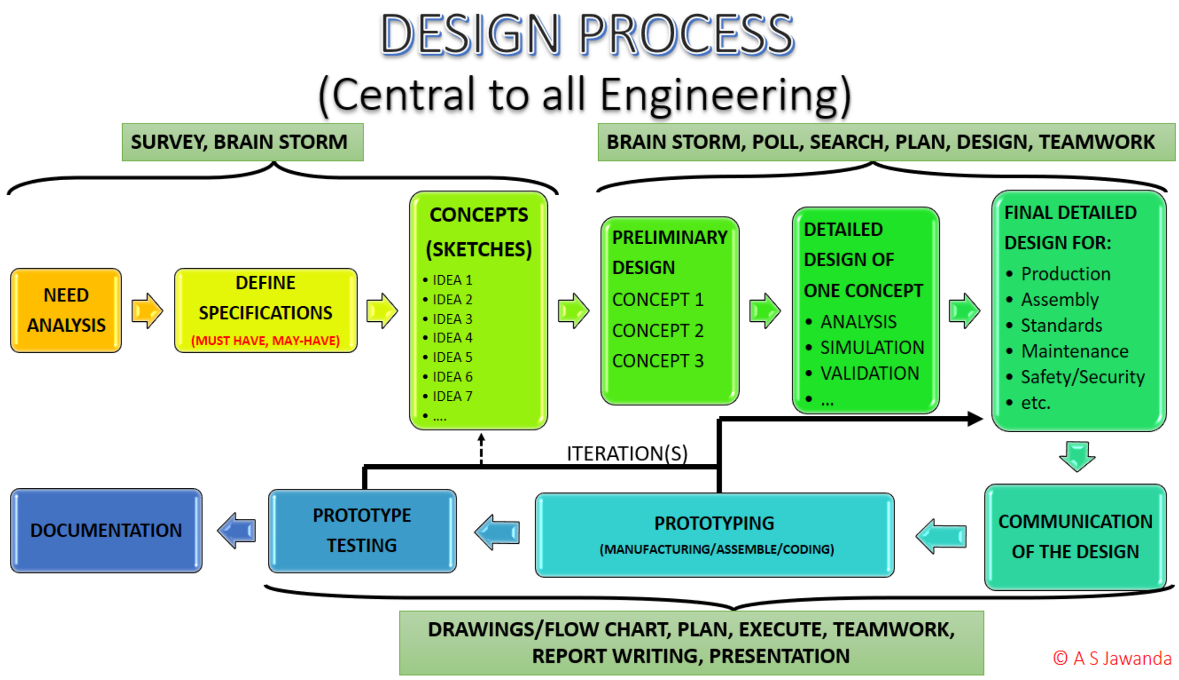
Precision Mangonel

UTA013 Engineering Design Project-I





Mangonel



Aim: The objective of this course in this project is to bring together the various components of this course with a view to help you learn the **engineering design process** shown above to design, simulate and fabricate any engineered product. The design of a Precision Mangonel is used as an example to illustrate the steps involved and the implementation by a team of engineers. A 'Precision Mangonel' is designed and instrumented with the aim of firing a missile (ball) at a target which is detected by an electronic measuring circuit. The angle of launch of the missile is changed using a calibrated electro-mechanical targeting system. The velocity of launch of the missile is calibrated in the launching electro-mechanical system.

Theory: Related to the design of a Precision Mangonel, in the Electronics Laboratories you have successfully implemented, simulated and operated a micro-electronic system to allow you to measure as well as display the angular velocity of the arm. In the Mechanical Laboratories you have developed a discretized analytical model of trajectory dynamics and used this to generate a simulation tool to allow you study the influence of launch velocity, launch angle and drag on the flight path of the missile. In the Dynamics Laboratories, you have developed analytical skills in order to calculate the static and dynamic stresses in the Mangonel material so that the design remains safe when operated repeatedly. In addition, you have seen the assembly of a full Mangonel and videos of it from the point of view of performance.

The engineering challenge is to design electro-mechanical systems which will convert the existing structure of the Mangonel under constraints of not changing the design of the basic structure or its materials (to preserve the design connect to history) to make it perform as a Precision Mangonel. Specifically, you are also required to custom design the throwing arm and missile (ball) holder's shape and material so that the range at which a target can be hit is maximised. The torque provided by the skein can be maximised by modifying the number of loops, and without changing it's material. In conjunction with the accompanying lecture series, you should be in a position to instrument and calibrate the Mangonel with a view to make it into a Precision Mangonel.

UTA013: Final Group Project

In the condition of the ongoing pandemic while from home the physical Model of the Mangonel at the campus is not accessible to you. Yet, understanding the structure of the Mangonel and its working from the videos shared with you during the course it is required that we should be able to demonstrate our understanding using physical mock-ups and simulations.
For this particular activity students in each subsection are required to form **groups of 3 students**.

Marking Scheme: **Final Group Project (20 Marks) = 20% of course.**

There are two parts of the Project:

A. Designing precision engineered physical product (Mangonel).

Note: This will be evaluated for 10 marks (5 marks each for the Mechanical and Electronics components).

Mechanical Component: This will be evaluated for 5 marks.

Your design team is required to demonstrate using any materials available to you easily available from nearby market or at home, for the fabrication of a 'Mangonel arm' which meets the requirements as follows. As our Mangonel is a scaled down model of a weapon (20 times smaller than the original weapon used by the romans), SAFETY is an important criterion which must be demonstrated for every step in real life described below.

1. Make/take an arm of any appropriate material and dimension with a receptor at one end to hold a ball (any soft material) steady before launch and launch it at an angle which is predictable for every launch. The design of the ball holder is also unrestricted but it must operate and connect securely with the arm.
2. Demonstrate the working of a torsion spring, like a skein is used on the actual Mangonel to store energy when in loaded position for launching the ball from the arm taken in the first step. Specifically, arm must receive its power from the Skein and be triggered.
3. Make a video to demonstrate the launch of the ball to hit a target repeatedly with precision which is engineered by controlling the velocity and angle of launch of the ball through the calibration of the tightening of the skein and the design of the ball launching at a desired angle.
4. Show how your team tried different ideas for the above measurement and prediction of velocity and angle of launch. Show how the failures help in learning from the iterations to make the design better.
5. Your project team has to calculate physically the FOS (Factor of Safety) of the throwing arm materal you have used. Show an experimental determination of the strength of the material of the arm.

Electronic component: This will be evaluated for 5 marks.

Design and simulate a micro-electronic project for Precision Mangonel using Tinkercad, capable of

1. Evaluating angle of launch of ball by the Mangonel.
2. Initial Velocity of Launch of the ball, Calibration of the circuit already done in labs to measure the angular velocity of the throwing arm with the actual velocity of launch of the ball is expected now. Use the Mechanical rig made by your group above,
3. Measure the distance of the target to be hit by the ball (missile).
4. The distance from step 3 can be used to drive a motor which will position the Mangonel structure (given in PDF files) at an inclination to repeatedly launch the ball at the target at the angle evaluated in

step 1. **Think** how to use the weight and location of CG of the Mangonel in triggered position given at the end of this document.

B. Poster Demonstration:

Note: Poster will be evaluated for 10 marks along with it's presentation and viva-voce.

a. **5 marks** will be for the mechanical design demonstration (**MED component**) and
b. **5 marks** will be evaluated for precision-based data acquisition and automation (**ECED component**).

All the groups are required to make a A3 size poster, for demonstrating the use of the engineering design process for the **mechanical design steps** and the **implementation of precision-based data acquisition and automation** of the desired design of the Precision-Mangonel.

The following specific design aspects should be explored and demonstrated in the poster:

The processes of design, alternative selection, analytical and experimental testing is to be presented using text, pictures, graphs, diagrams etc. as you like. For example, in case of design the Mangonel throwing arm, the arm cannot self-destruct and therefore you should carry out some structural analysis on the arm to ensure that it and the rest of the Mangonel is strong enough. Also, while simulating the precision Mangonel using TinkerCAD, taking screenshots of the working sketch of the micro-electronic project as well as of the coding section is required (**screenshot comprising of one of the team member name and timestamp is mandatory**).

Your team should explore and be able to answer the following for the final design and viva-voce.

i. On what factors will the maximum range of the launched missile (ball) depend upon?
ii. What kind of ball holding methods /design concepts can be attached to the throwing arm and what difference do these design make?

iii. What factors will affect the precision of the Mangonel and how can you attain a greater **precision?**

iv. Methods to obtain max. **precision** for given distance of throwing the ball (i.e., selection of suitable electronic components to design a Precision Mangonel)

v. We have learnt that the velocity and launch angle are critical for precision in hitting a target. Hence, your redesign of the Mangonel as well as the design of micro-electronic project should seek to optimize these for precision. Accordingly, consideration should be given to methods to vary these parameters.

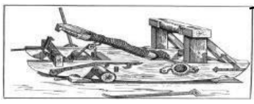
vi. The missile holder design and the material properties and geometric dimensions of the throwing arm should be given some consideration as well.

vii. How can we calibrate the throwing distance requirement for a Precision Mangonel with **tightening of the skein?**

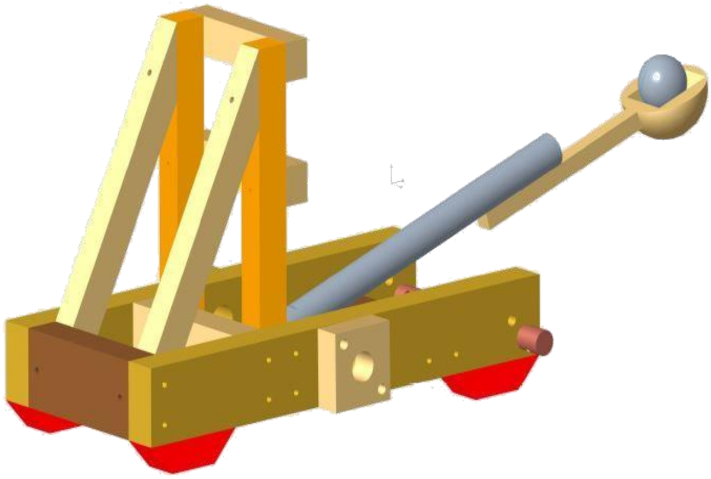
viii. Refer to the design given below. The detailed drawings of the parts are given in the file 'TheMightyRomanMangonel.pdf' the 3D PDF of the assembly is given in the file 'Mangonel_3D_Creo.pdf'.

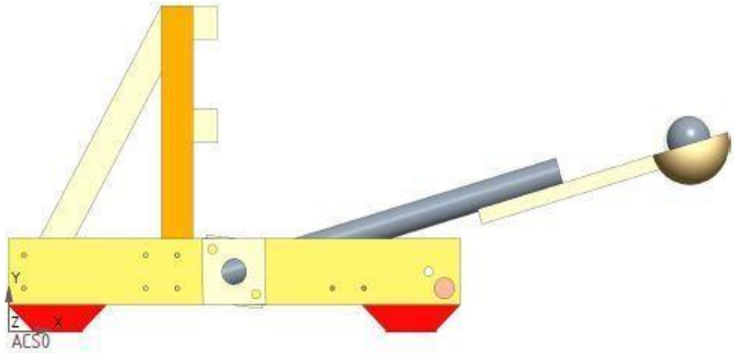
   a. If you need to automate the working of this Mangonel (automatic operation with control over the launch angle and velocity as per the requirement). Please suggest how you can do that. The electronics required may be demonstrated in simulation using TinkerCAD.

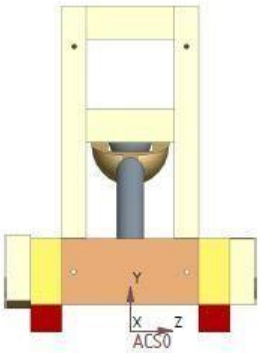
   b. What kind of **motors** are you going to use and **where you are going to place the same?**

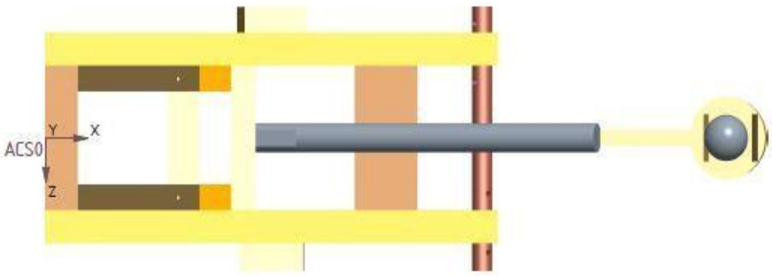


__Mangonel__









Location of CG from shown Coordinate system ACS0 is
X, Y, Z = 6.6594880e+02, 1.6273166e+02, 0.0000000e+00 in MM

Weight of the full assembly = 2.5 Kg.