MEE203 DYNAMICS LECTURE

PROJECT “PLACE, SHOOT, BASKET!”

Group 13: DieNamics

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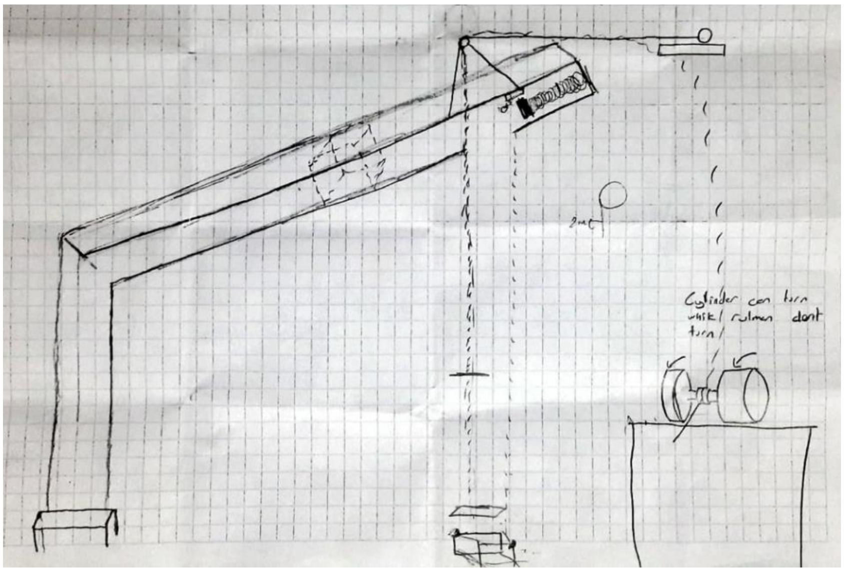
Introduction

Make two innovative designs and manufacture which one of them should place a hollow cube from the ground level onto a platform, and the second one should shoot a ball from a distance away from the platform and make a basket into the hollow cube. Understanding and calculating all the kinematic and dynamic calculations.

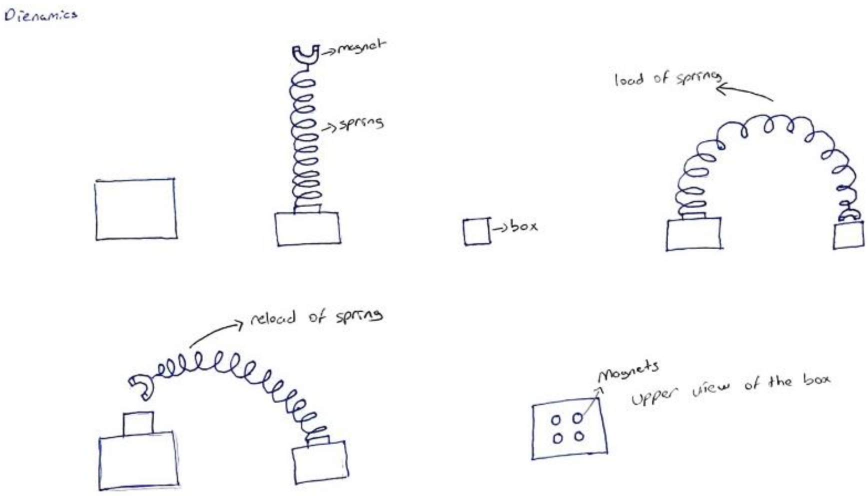
Conceptual Designs

- **Designs for Cube Placement**



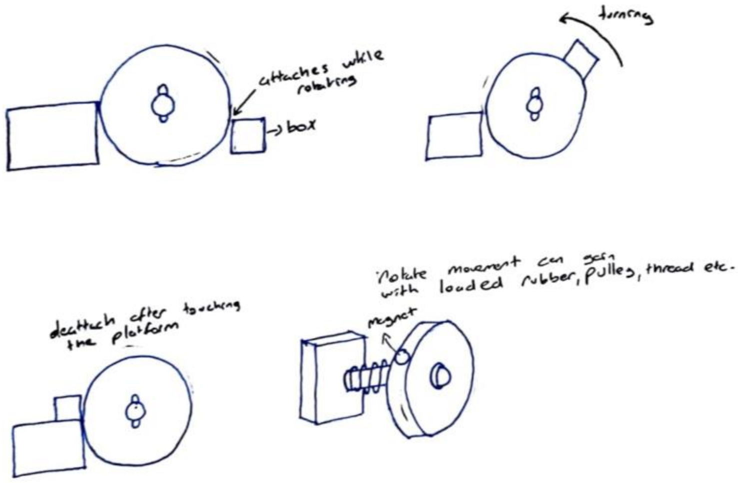
Lift to Heaven

Lift-like construct to move the cube to the bridge to carry it on the platform. We gave up on it because it was so big and hard to construct, and precision was low because of its size.



Springload of Work

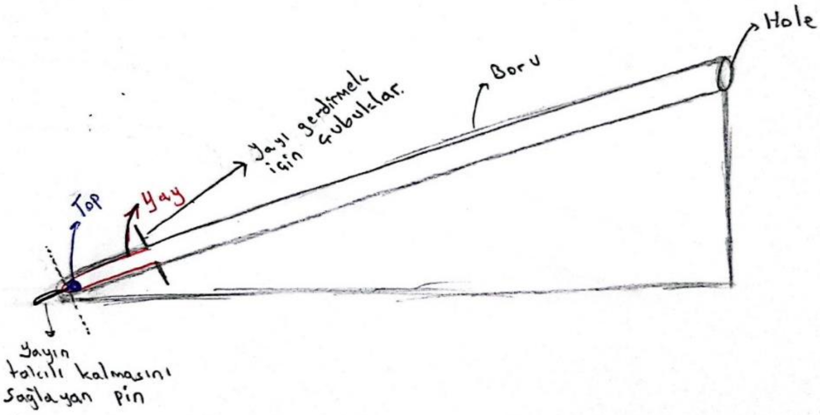
Stretched spring should take the box with magnets, carry it to the other side, put it on the platform, and leave it there. We gave up on this project because this also has low precision because of the spring



The Rolling Stone

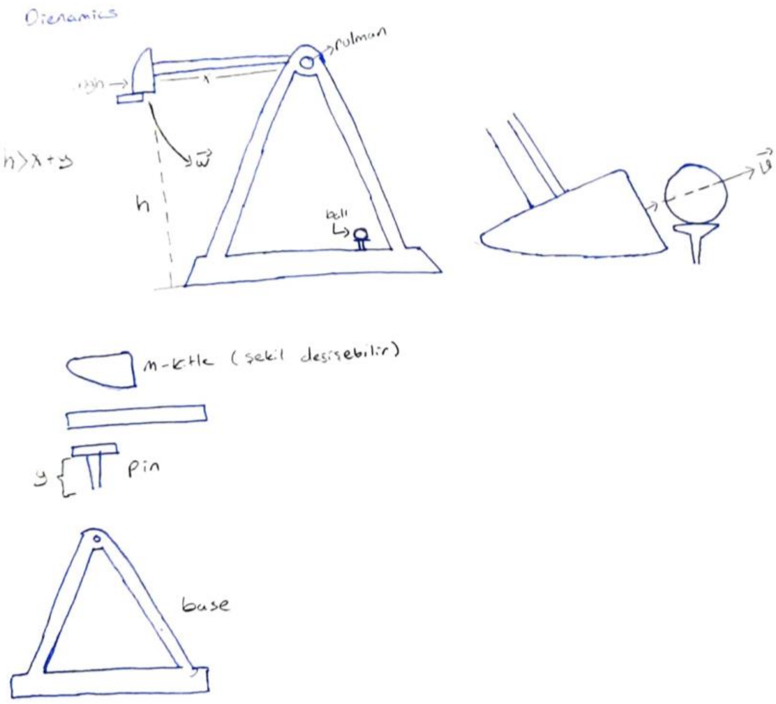
Ferris wheel like project which takes the cube from bottom with magnets and place it on a specified place. Rotation of the mill can be obtained by spring or rubber

- **Designs for Ball Throwing**



Pinball Plunger

Spring load mechanism to throw the ball just like in Pinball plungers. We stretch the spring and push the ball through the hole. We gave up from this project because of friction on the tube and the spring constant(k) is hard to calculate

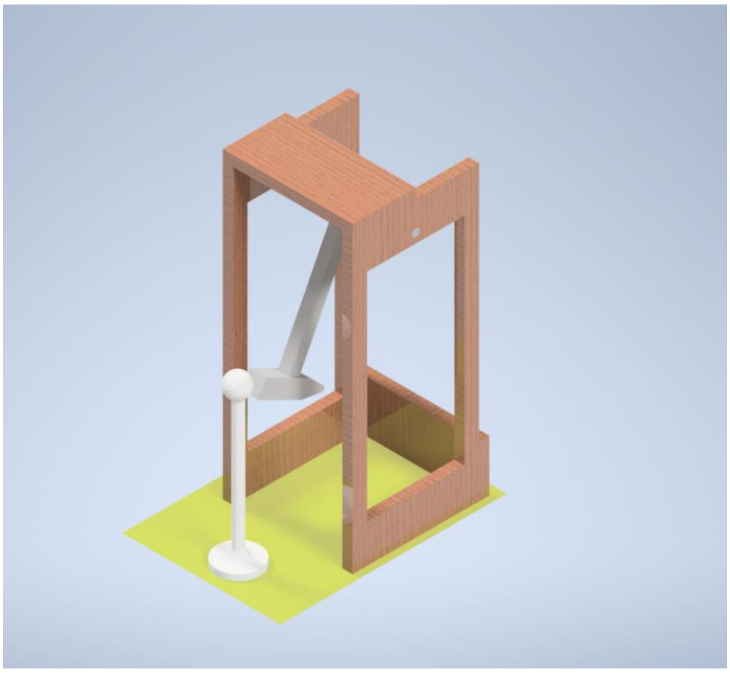


Croquet Club

Design inspired from the games Croquet and Golf; a Mallet is going to be attached to the wedge. When the wedge is pulled, the mallet is going to fall and rotate from the pivot point, hit the ball on the pin, and gain the ball a projectile motion.

Final Design

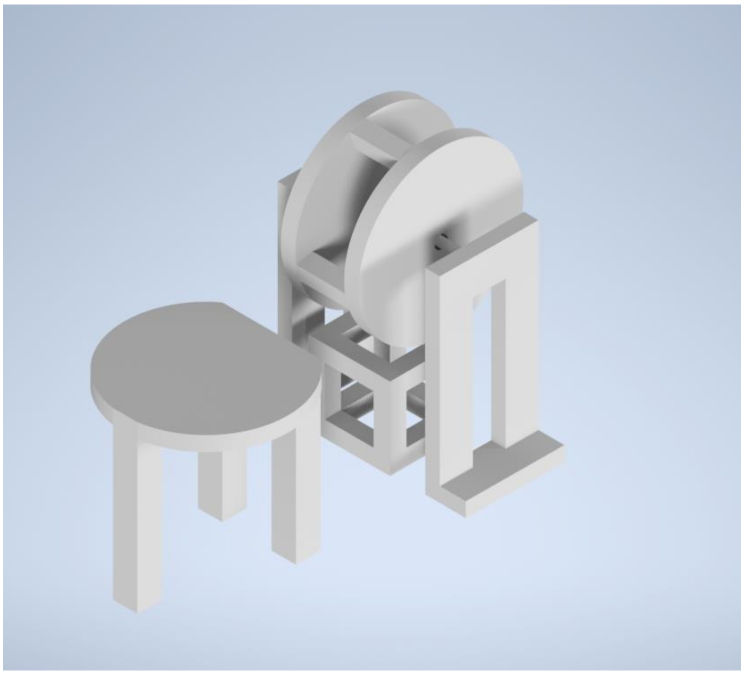
Our design pick for Throwing a Ball: Croquet Club



Croquet Club:

Hammer attached to a shaft which can return and hit a ball with angle to gain ball a oblique shot. We chose this design because of the less friction on the ball

Our design pick for Move the Hollow Cube: The Rolling Stones



The Rolling Stones:

In all our projects, we thought magnets were easy to use for holding and letting go of the hollow cube. After constructing a mill and attaching a magnet to it, the mill can hold the hollow cube which can be metallic, or another magnet attached to it. This mill can carry the cube over himself to the platform as high as the radius of the mill and release the cube while still turning with the force of a loaded spring, rubber, etc. It's smaller and more rigid, for those reasons; it has more precision than others. That's why we decided to use this design

Calculations

With respect to the formula $Mgh = \frac{1}{2}MV^2 \rightarrow V = \sqrt{2gh}$ we can find the velocity of the mullet. With impact formulas we can find the Velocity of the ball as $V_{ball(after\ Impact)} = \frac{2m_{mullet}}{m_{mullet}+m_{ball}}V$, After splitting Velocity to X and Y axis We can found Maximum Height of Ball with $\frac{{V_y}^2}{2g}$, Time of flying can be found with $\frac{2V_Y}{g}$

With respect to those formulas

$$y = y_0 + (V_0)_y + \frac{1}{2}gt^2$$

$$r_{table} + h_{cube} \ = h + \left(cos\theta \times V_{0(ball)}t\right) + \frac{1}{2}gt^2$$

$$\rightarrow \boldsymbol{r_{table}} + \boldsymbol{h_{cube}} \ = \boldsymbol{h} + \left(\boldsymbol{sin\theta} \times (\frac{\boldsymbol{2m_{mullet}}}{\boldsymbol{m_{mullet}} + \boldsymbol{m_{ball}}}\boldsymbol{Vt})\right) + \frac{\boldsymbol{1}}{\boldsymbol{2}}\boldsymbol{gt^2}$$

*Final height of the ball should be height of the table and cube added together that what ball can get in.

$(r_{mill} = radius\ of\ the\ mill,\ h_{cube}\ = height\ of\ the\ hollow\ cube$

$\theta = angle\ between\ balls\ velocity\ and\ x - axis,$

$g = Gravitational\ acceleration)$

*After finding the t (time) we can find where should we put the cube using x-axis formula

$$x_0 + (V_0)_x \times t$$

$$\boldsymbol{x} = \boldsymbol{x_0} + \left(\boldsymbol{cos\theta} \times (\frac{\boldsymbol{2m_{mullet}}}{\boldsymbol{m_{mullet}} + \boldsymbol{m_{ball}}}\boldsymbol{Vt})\right)$$

*Cube must be placed exact $\frac{h_{cube}}{2}$ back of the displacement of the ball to get a basket.

Our Calculation

We decided to take θ as 53°, Weight of our hammer is 500g, Length of the hammer is 25cm. Weight of the ball is 67g and our hammer pin is 25.5cm above the floor. Our table is 20.5cm and our cube is 10cm

First height of the hammer is 72cm and the last height of the hammer is 18cm

$$(\boldsymbol{72} - \boldsymbol{18}) \times (\boldsymbol{9.81}) = (\boldsymbol{1/2})\boldsymbol{V^2}$$

V= 23cm/s

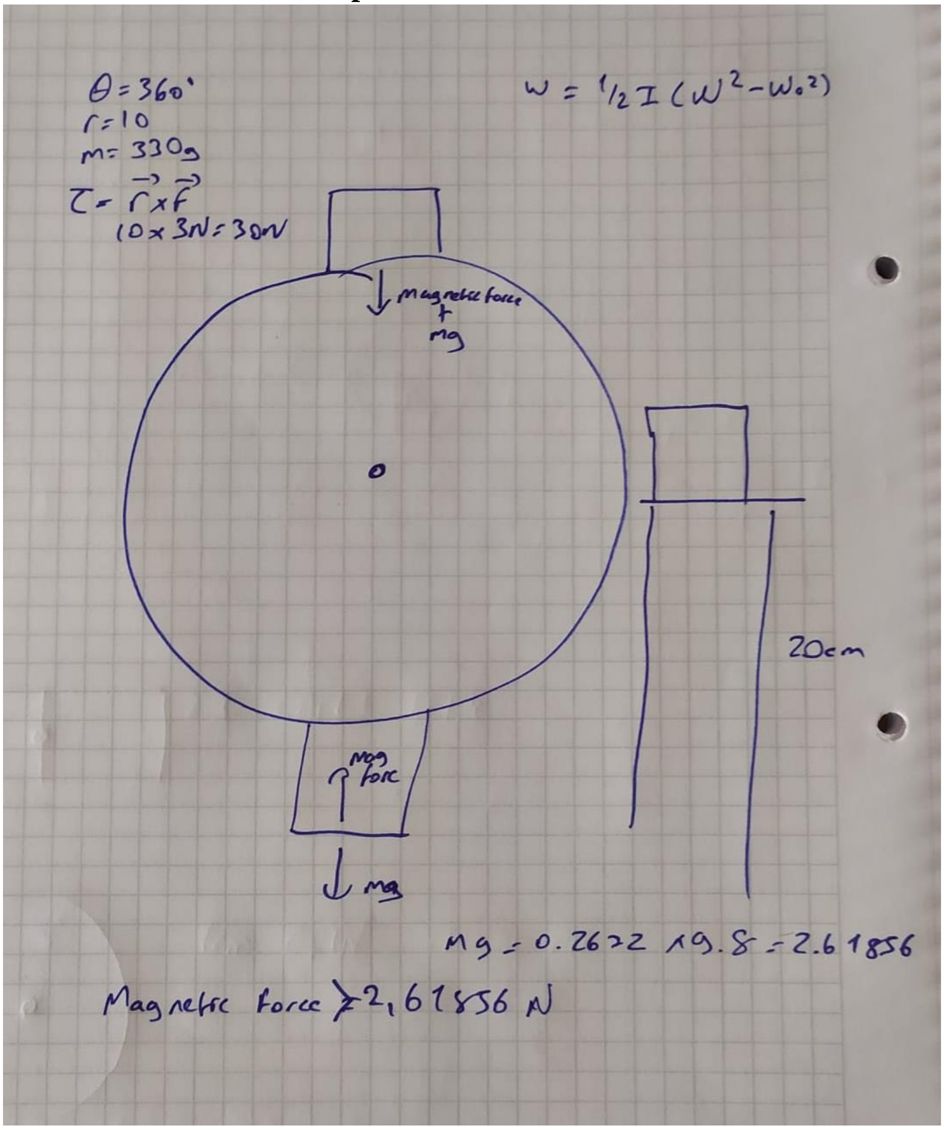
$$\boldsymbol{20.5cm} + \boldsymbol{10cm} = \text{25.5cm} + (\frac{\boldsymbol{4}}{\boldsymbol{5}} \times ((\boldsymbol{500g})/(\boldsymbol{500g} + \boldsymbol{2.9g}\ )\ (\boldsymbol{23})\boldsymbol{t})) + \frac{\boldsymbol{1}}{\boldsymbol{2}}(\boldsymbol{9.81})\boldsymbol{t^2}$$

t=4 second

$$\boldsymbol{x} = \boldsymbol{0} + \left(\frac{\boldsymbol{3}}{\boldsymbol{5}} \times \left(\frac{\boldsymbol{1000}}{\boldsymbol{500} + \boldsymbol{2.9}}\boldsymbol{1.8}\right) \times \boldsymbol{32.5}\right)$$

=155cm (Cube must be placed 155 cm front of the ball)

Calculations for Cube displacement



Materials

For a mullet we decided to use a 500g of hammer with 25cm handle. For basic constructions we use MDF (medium-density fiberboard). Nails for combine and construct. Bearing to reduce friction and ping pong ball to throw. We use turning machine to cut shaft and finally rubber band to move the Mill on the project “The Rolling Stones”

Bill of Materials

Material	**Price**
Hammer	70₺
Bearing	60₺
Ping Pong Ball	4₺
Shaft (Iron)	60₺
MDF	200₺
Total	394₺

*Materials with very low price (nails, washer, etc.) is not included on the total price

Photos of Final Design

Conclusions

With no use of electricity or circuits we can design a product which can carry a box or throw a ball to our designated parameters. We gained a lot of experiment on this project from start to finish we learned that in our design we should calculate offsets of the parts and use standard values for our part choosing. While we buy our bearing, we can’t find a standard part to drill a hole for it

Will there be a change if the surface area of the mallet changes?

You have contact between a sphere and a plane. That’s not much area except for a slight indentation.

The velocity of the ball depends upon the transfer of energy from the mallet to the ball which is 1/2Mv^2 where M is the mass of the mallet and v its velocity. The surface area of the mallet face has no direct relationship with the velocity of the ball unless it implies a greater mass of the mallet head.

Assuming conservation of energy $\frac{1}{2}Mv^2 = \frac{1}{2}Mb^2$ where m is the mass of the ball and b is the velocity of the ball. In reality, b will be smaller since some energy is lost on impact mainly as sound energy.

What is relevant is the weight of the mallet and the velocity of the mallet as it contacts the ball. The surface area at the point of contact is key, and that area is a small fraction of the size of the mallet.

Refferences

Physics from a Croquet Mallet and Ball Submitted by Rich on 19/01/2019

https://archive.thepocketlab.com/educators/lesson/physics-croquet-mallet-and-ball