

# Individual Steps of Rube Goldberg Machine(RGM)

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## Introduction

The Rube Goldberg machine (RGM) is a complicated machine which is designed using the basic engineering principle to accomplish a given task in the most innovative and entertaining manner. The machine consists of several steps where each step is triggered by the previous step. The team utilizes the concept of gear, springs, mouse traps, tracks, aerodynamics, Arduino kit, motor, pumps and bearings etc. to add the complexity and the fun element into the individual steps. To make the individual steps cheap and affordable, the team utilizes the used toys such as cars marbles, fidget spinner, cooking pin, used springs, bicycle wheel and cardboard. A lot of emphasis is also paid in making all the steps repeatable and resettable which was the most important aim of this project. Later in the project all these individual steps will be combined to accomplish an assigned task.

**Purpose:** To design the individual steps of a unique Rube Goldberg Machine which are cost effective, reliable, repeatable and resettable.

## Requirements

The customer requirements which are fulfilled in designing the individual steps includes following-

- Entertaining
- Resettable
- Durable
- Reliable
- Safety
- Cost effective

The engineering requirements obtained from the customer requirements are also fulfilled throughout the designing phase and presented in the following Table 1.

Table 1: Engineering requirements

Engineering requirement	Target values	Achieved values
Number of steps	12	8
Process duration	~6 seconds / step	5-6 seconds
Size	12 x 12 ft	< 12 Ft X 12 Ft
Sound	~ 20 DBs ( Decibels )	< 20 Decibels

## Engineering Design Project

## Individual Steps of RGM

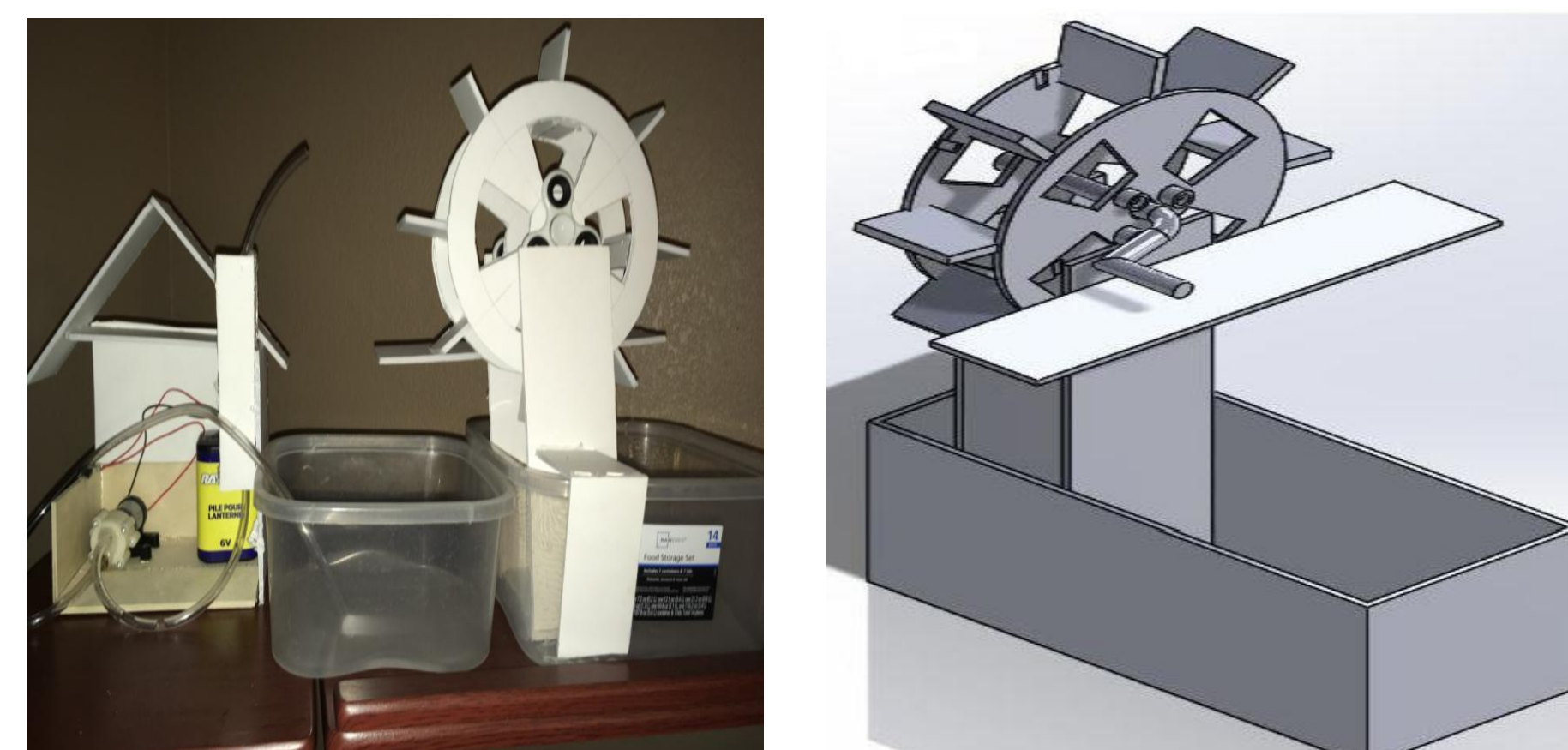


Figure 1.a: Isometric view of water wheel step



Figure 1.b: Isometric view of bicycle wheel step

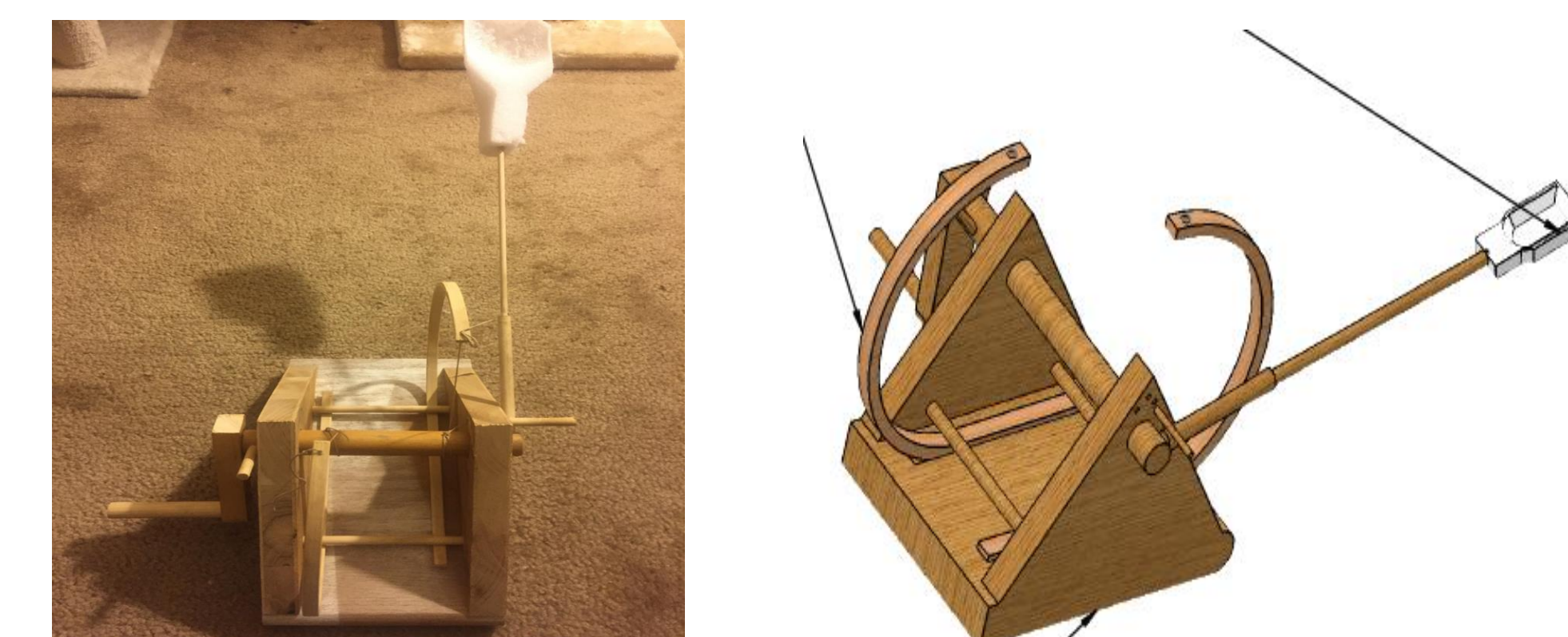


Figure 1.c: Isometric view of bicycle wheel step

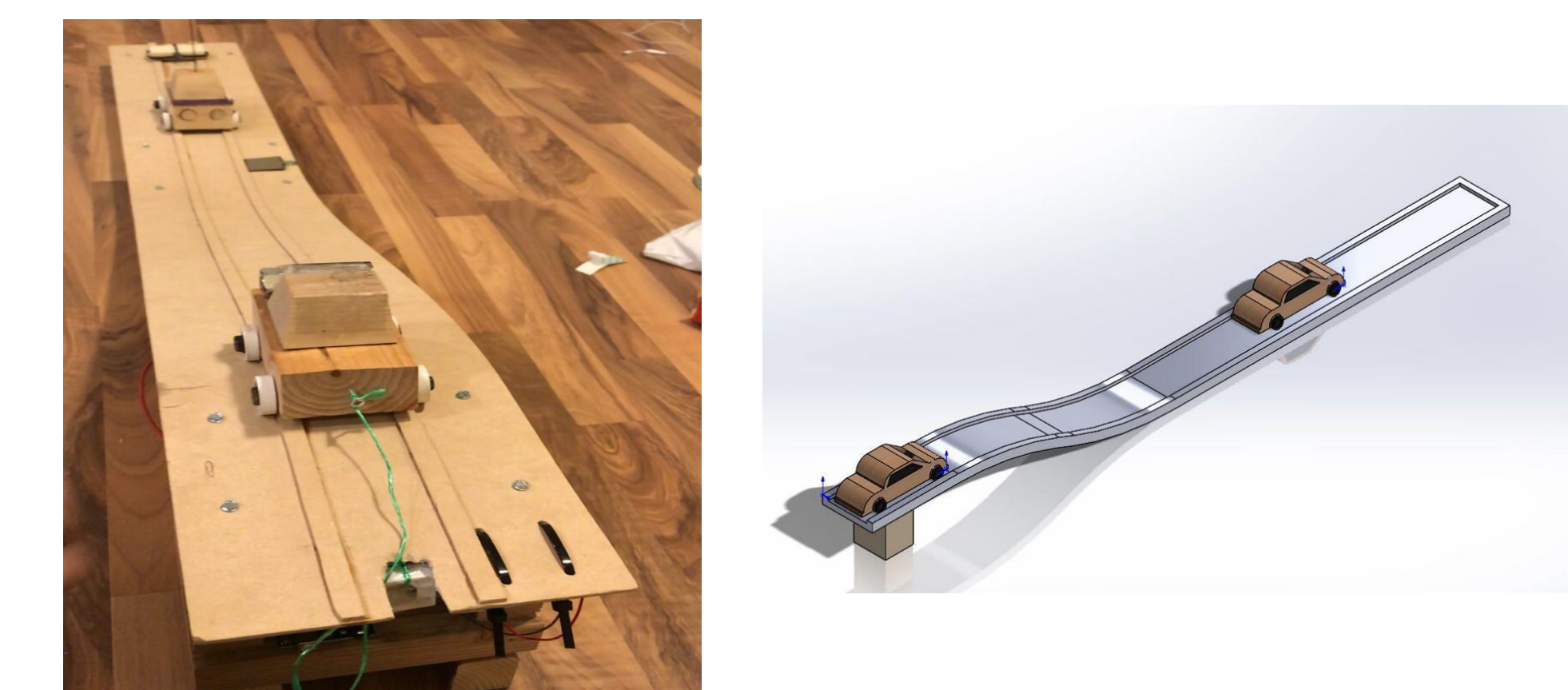


Figure 1.d: Isometric view of both the car's step

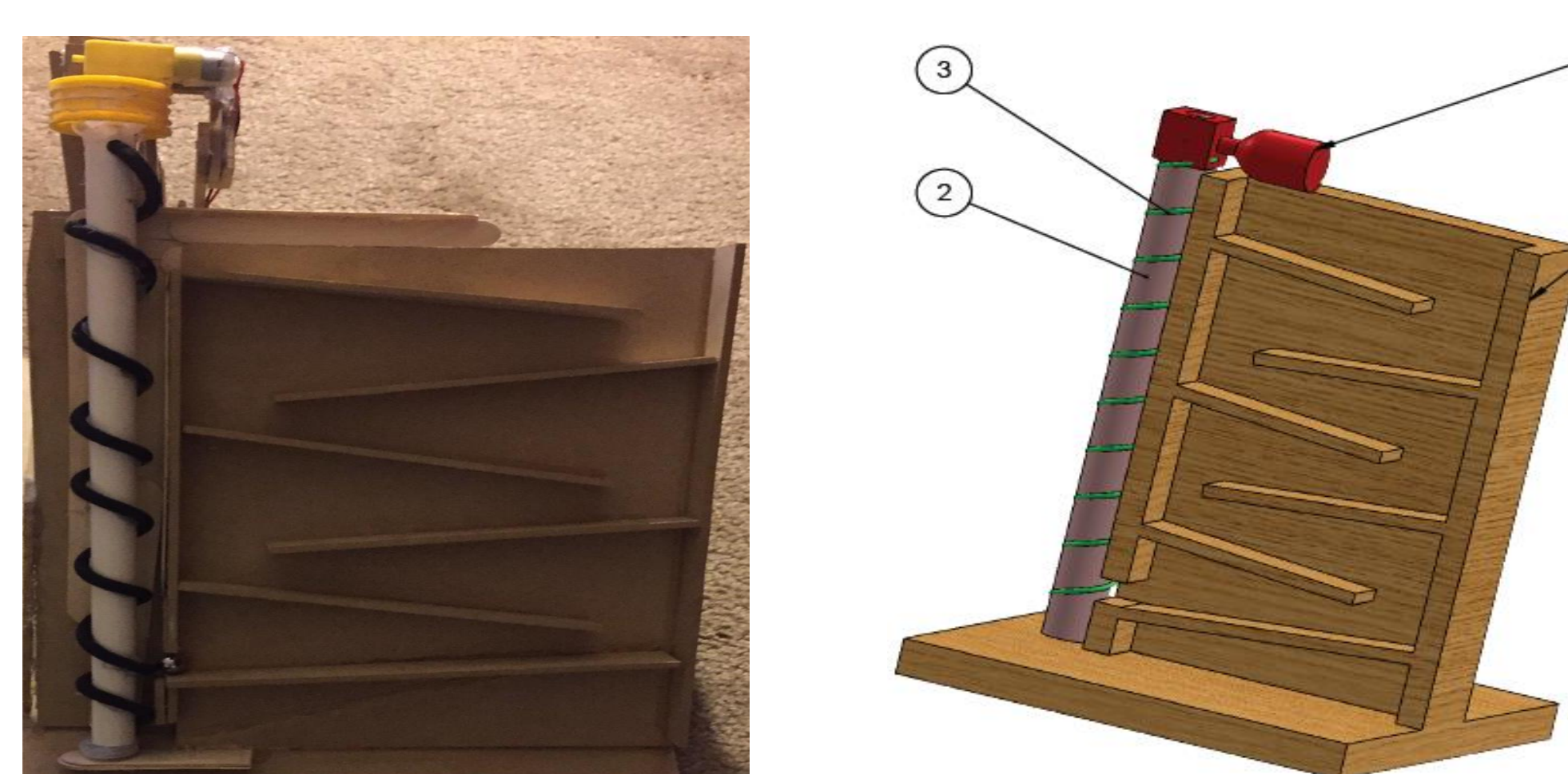


Figure 1.e: Isometric view of screw step

## Individual Steps of RGM



Figure 1.f: Isometric view of aerodynamics step

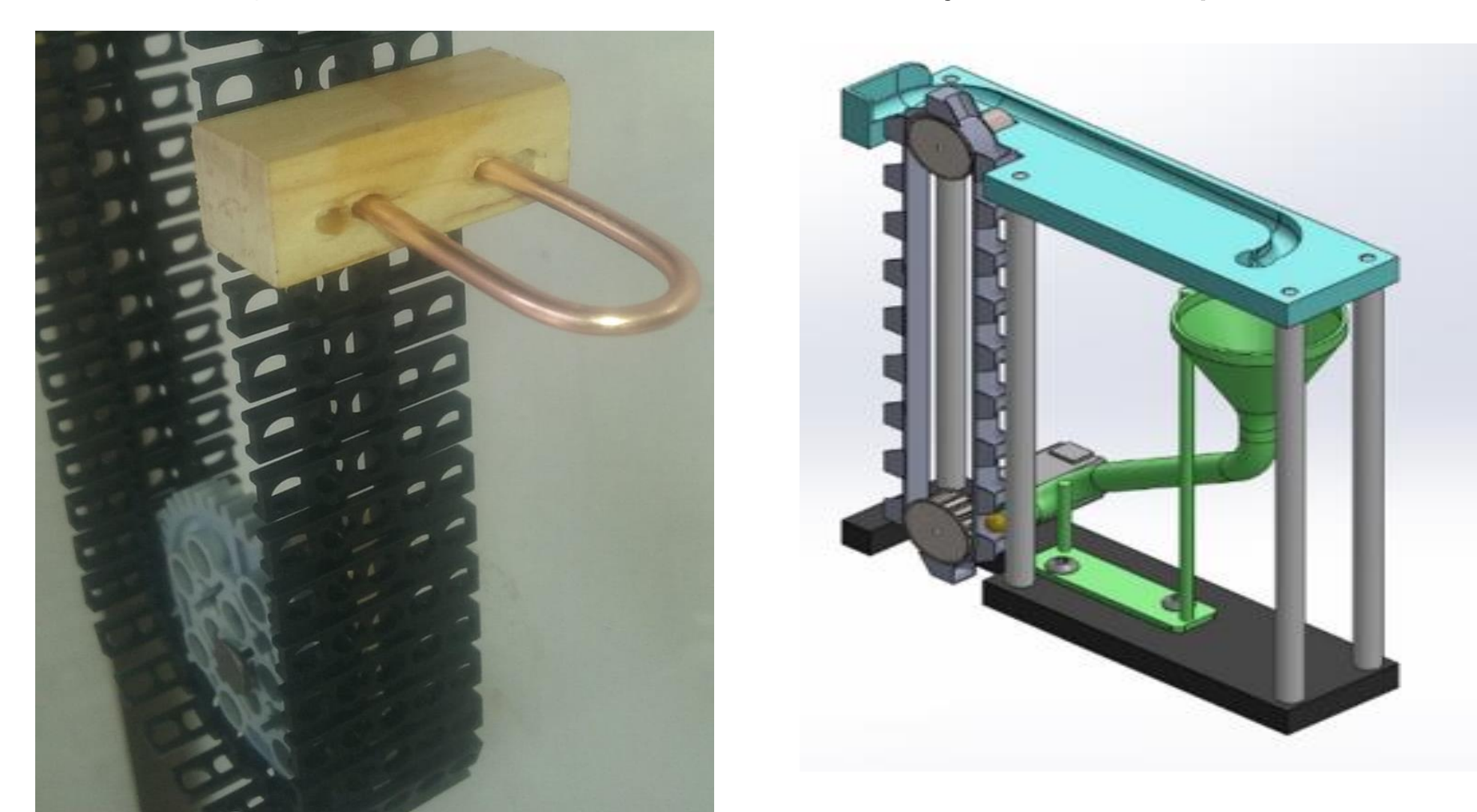


Figure 1.g: Isometric view of wheel step

Figure 1 represents all the individual steps which includes the steps of water wheel, Catapult, Bicycle wheel, Car on track, Car hitting the another car, gear mechanism, aerodynamics concept and Arduino kit.

Rube Goldberg mostly utilizes the object taken out of the waste or used items [1]. In the current project also the team has used mostly the recycled material such as bicycle wheel, used cars, springs, card board, gear and tracks of the cars. Card board and wooden planks are used to make the base of the individual steps. Rube Goldberg has frequently utilized the items like sea-saw, gears, catapult, pulleys and swings etc., some of them have also been incorporated in the teams design in the most funniest and innovative manner.

## Analytical Analysis

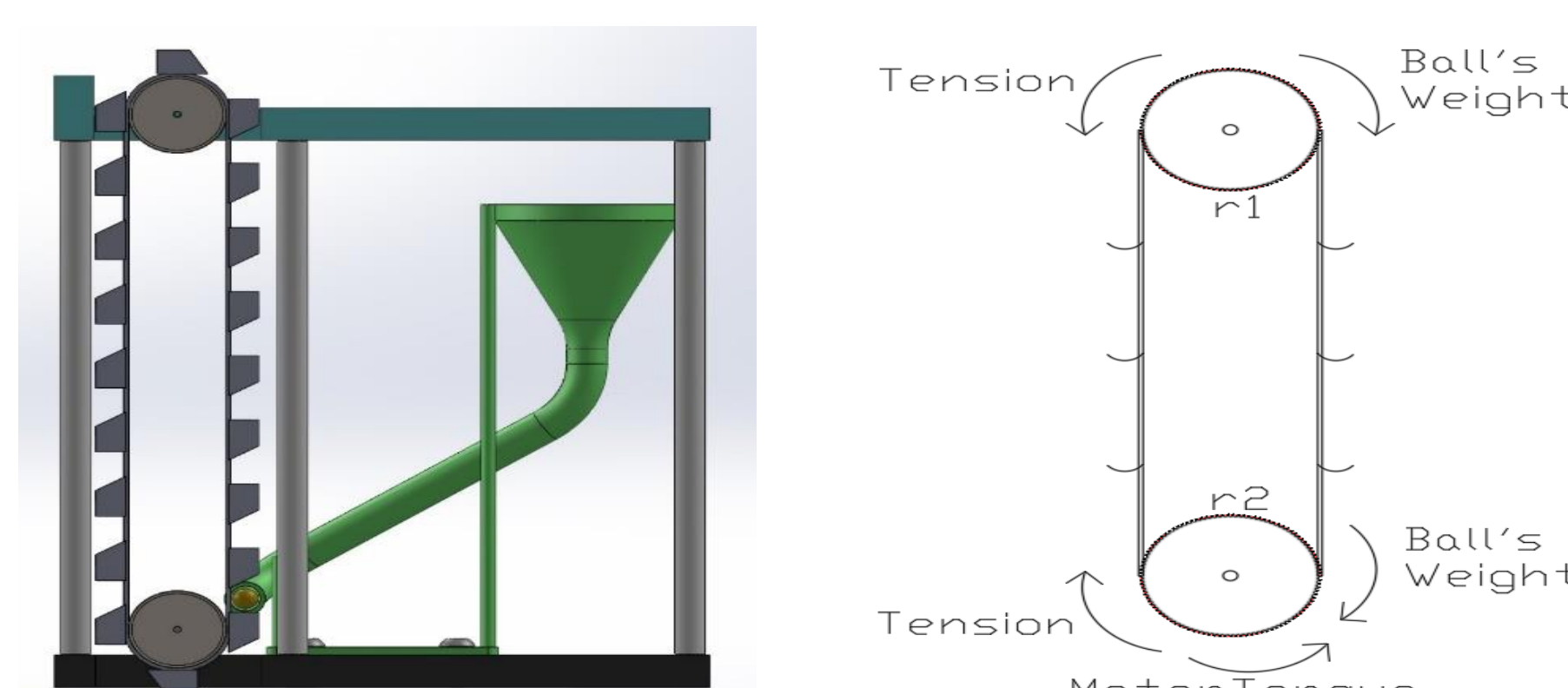


Figure 2: front view of 3D model and free body diagram

According to Newton's law of angular acceleration [2]:

$$\sum \tau = I\alpha(t) \quad (1)$$

Summation of torque is applied to both the motor and solved to get the acceleration in terms of motor torque.

$$v'(t) = \frac{2 \tau_{motor}(t)}{(m_{r_1} + m_{r_2})r_2} - \frac{4 m_e g r_2}{(m_{r_1} + m_{r_2})r_2}$$

Where,  $\tau$  represents torque,  $m$  mass,  $r_1$  and  $r_2$  represents both the wheel,  $r$  radius and  $t$  time.

Angular acceleration is then plotted in terms of motor torque and presented in Figure 3.

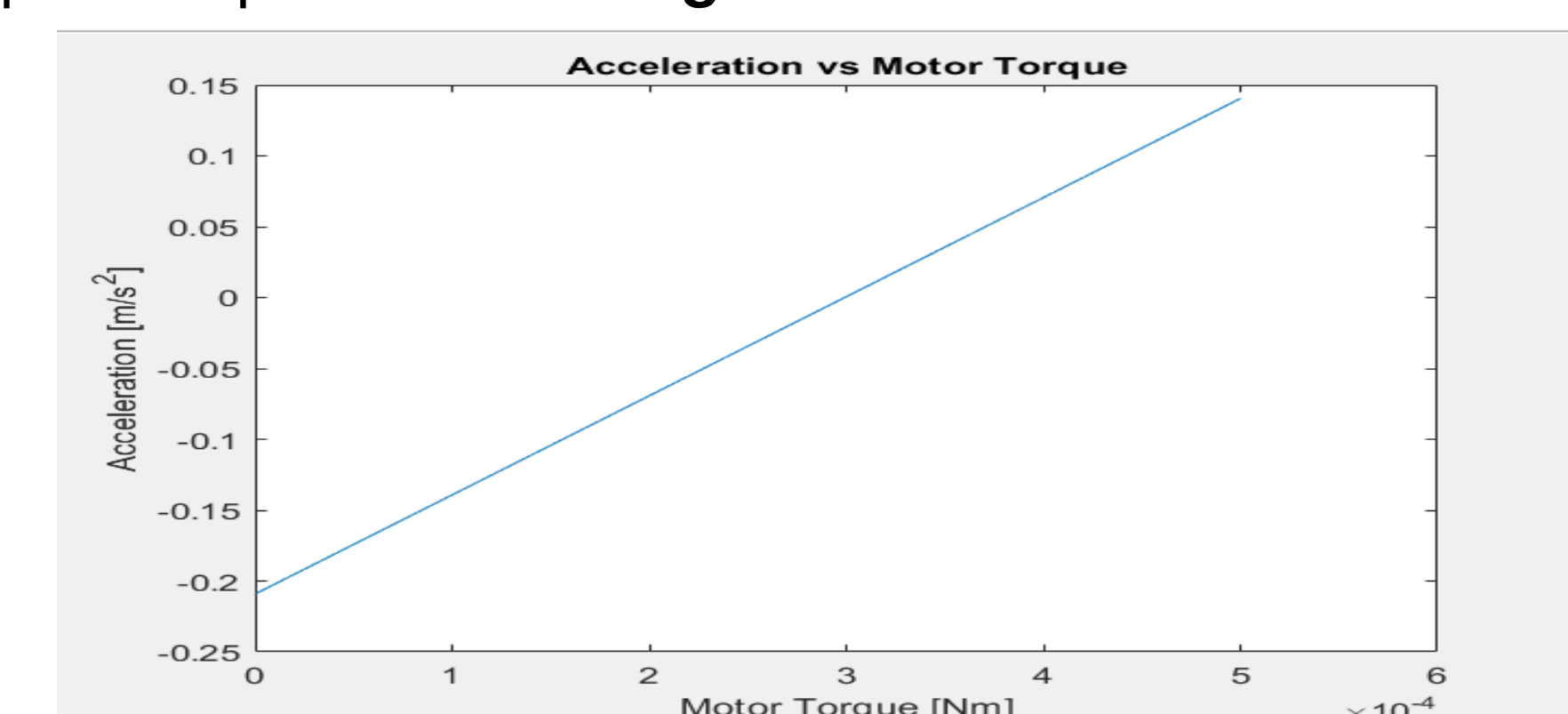


Figure 3: Acceleration as a function of motor's torque

## Technological Innovations

### • Arduino Kit

Arduino Kit is a simple device that will enhance the complexity of the Rube Goldberg Machine. Arduino kit is effectively used in this project to make the individual steps resettable. In the Figure 5, As the ball rolls down and reaches at the base, a servo motor is switched on to take the ball at the top of the screw.

It is also programmed to flash the "Hello Rube Goldberg" as shown in the following Figure 5 and 6 in one of the step at the start. This will also attract the audience during demonstration.

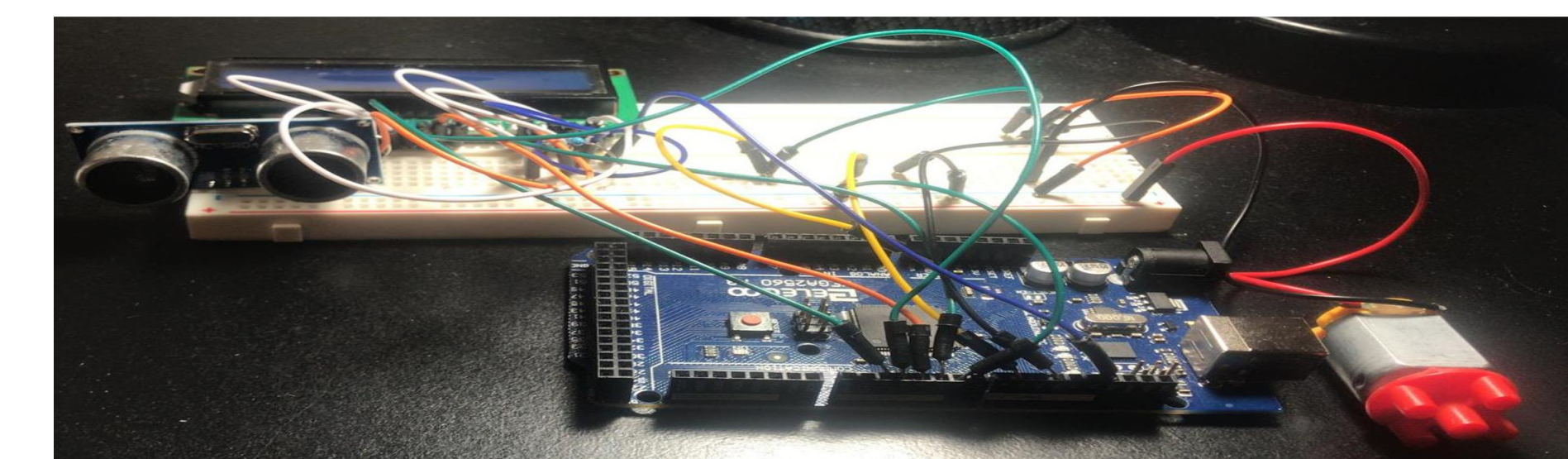


Figure 5: Picture of Arduino kit

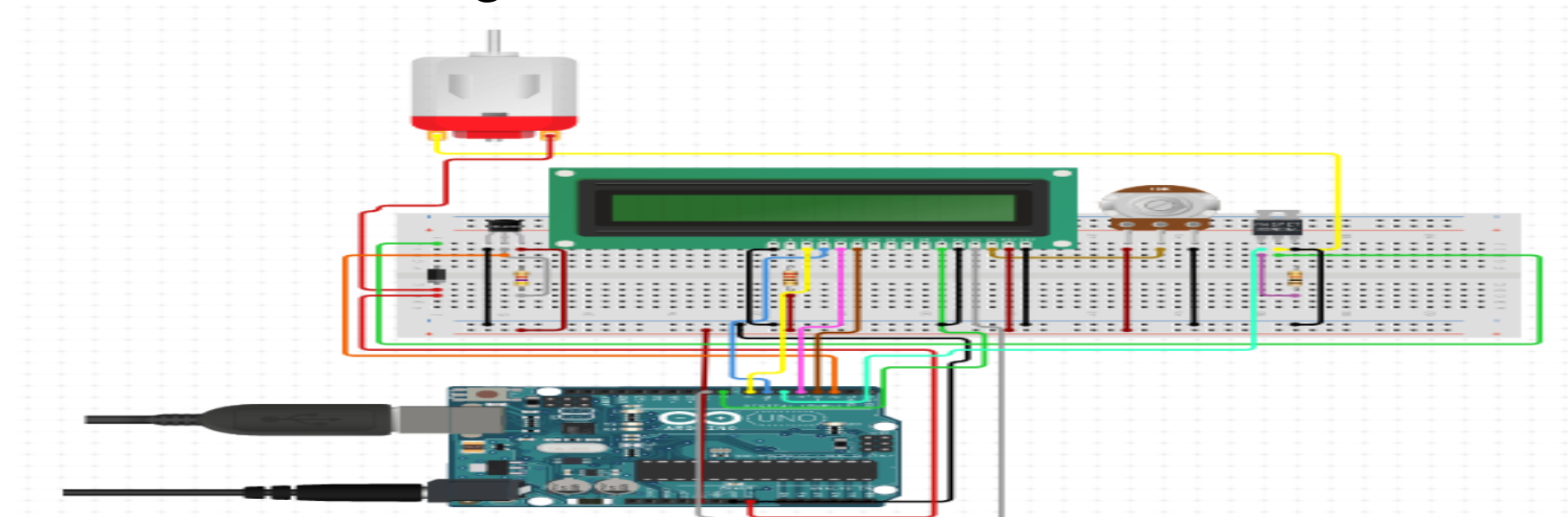


Figure 6: Model of Arduino kit

## References

[1] Mousetrapcontraptions.com. (2018). *Rube Goldberg History*. [online] Available at: <http://www.mousetrapcontraptions.com/history-4.html> [Accessed 9 Nov. 2018].

[2] En.wikipedia.org. (2018). *Angular momentum*. [online] Available at: [https://en.wikipedia.org/wiki/Angular\\_momentum](https://en.wikipedia.org/wiki/Angular_momentum) [Accessed 26 Nov. 2018].

## Acknowledgments

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