Drum Designing and Geneva Mechanism

Pranav Joshi, 2081830

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Link to this SSA

https://www.overleaf.com/read/yngdzxhwgpzn#e9ab38

Goals

- To finalize the drum design so that the launching mechanism is functional
- To ensure the geneva mechanism is able to stop the drum

Summary

Link to the testing videos : https://tuenl-my.sharepoint.com/:f:/g/personal/p_d_joshi_student_tue_nl/EscsRqEcDuRNvuKoh44cQ94B0tS8Y-0lorf09LyNDulTgA?e=3ZljjW
From the 1st round of testing, it was concluded that the arm that holds the plane must be longer, and the arm should be balanced by a smaller arm with a counterweight. It was also concluded that a drum that produces more torque(ie; a bigger radius), should be utilized.

1 Elaboration

1.1 Testing and Issues Faced

After the first round of testing using drum 1. It was observed that the plane would slow down after some initial acceleration. In contrast to what was hypothesized, the velocity of the plane was not maximum when the string ran out.
Along with this, the plane would not launch tangential to its path, rather it would spin and fall off. To resolve these critical issues, the drum mechanism and rotating arm were evolved as elaborated in the following sections.

1.2 Evolution of Drum Mechanism

Initially, the shaped of the drum (ie;its constant diameter after a certain point) was blamed for the loss of velocity. However later, in the same testing session, it was understood that the rotating arm slowed down due to the lack of torque in the drum.

When the plane was attached to the rotating arm, the air resistance faced by the system kept increasing as the speed of the rotating arm increased. At a certain point, the torque provided by the drum wasn't enough to counteract the air resistance faced by the plane.

Hence, it was decided that a drum with a larger radius would be tested to check if the above theory was true.(Since Torque is defined as $\tau = r$ x F [1])
Such a drum design is displayed below 2.

For reference, design 1 had a diameter of 30mm at the top and 15mm at the bottom. Design 2 has a diameter of 60mm at the top and 30mm at the bottom.

Figure 1: Sem's Drum

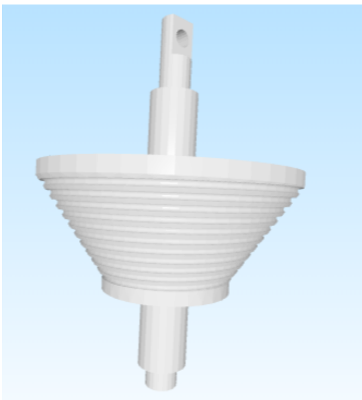

Figure 2: New Drum

1.3 Evolution of Rotating Arm

The length of the arm was blamed for the faltered trajectory of the plane upon launching. It was hypothesized that if the distance of the plane from the axis of rotation was longer, the plane would follow a more tangential trajectory. This theory[1] was based on the fact that if the motion of the rotating arm had a larger radius, the tangential acceleration and velocity of the plane would increase, which would make it easier for the plane to follow a tangential path when released. (As seen in fig 3 and in equations 1 , 2 and 3)

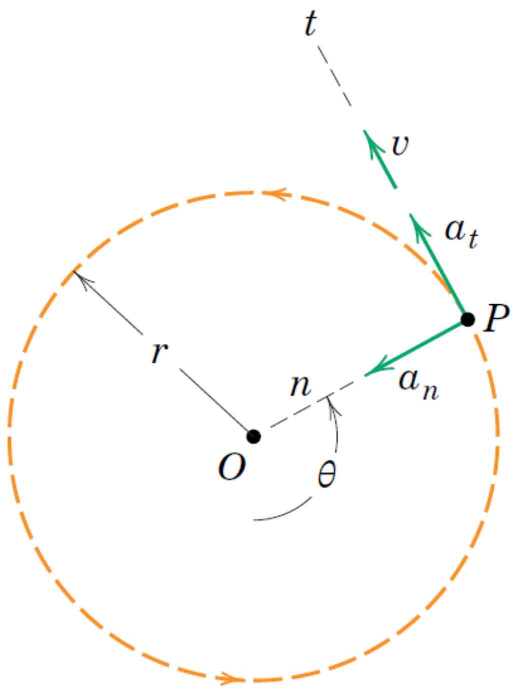

Figure 3: Circular Motion

$$Tangential Acceleration : a_t = r * \ddot{\theta} \tag{1}$$

$$Normal Acceleration : a_n = r * \dot{\theta}^2 \tag{2}$$

$$Velocity : v = r * \dot{\theta} \tag{3}$$

Here r (Length of the arm/Radius of the motion of the arm) is increased and $\ddot{\theta}$ remains the same, (since $\ddot{\theta}$ of the arm depends on the angular acceleration of the drum and the drum is unchanged).
Hence, the tangential acceleration increases here 1.
It is important to note that increasing r also increases the normal acceleration, as seen in eqn 2. But more importantly, since the velocity vector points tangential to the path of the rotating arm, the trajectory of the plane upon launch, will be tangential3

According to David's SSA, to optimize the length of the arm that holds the plane, a counterweight can be used on the other side of the arm.

By doing this, the group was able to achieve the best result in that testing session. The plane reached a distance of 1.2 meters from the launching point.

1.4 Integration of Geneva Mechanism with Drum Mechanism

The Geneva Mechanism was not employed in the first session of testing. Integrating the Geneva stopping mechanism to the drum requires knowledge of the number of rotations the drum can make. This can be found by simply counting the number of grooves on the drum 2. According to this, this system should carry out atleast 10 full rotations. This drum is not yet finalized and is subject to further testing that will be conducted in the coming week. A drum that accomodates for the Geneva Mechanism is being designed by Sem.

1.5 Viable Solutions to Other Problems

For the testing session, the counterweight applied on the arm consisted of a few scrap metal plates, this can be replaced by unused bits of the U-beam (Since it is agreed upon that no more than 1m of the U-beam is used to make the rotating arm). The holding mechanism that attaches the plane to the arm did not function as theorized. This can be resolved by designing a holding mechanism that keeps the plane as close to the rotating arm as possible as seen in the rough figure 5 below

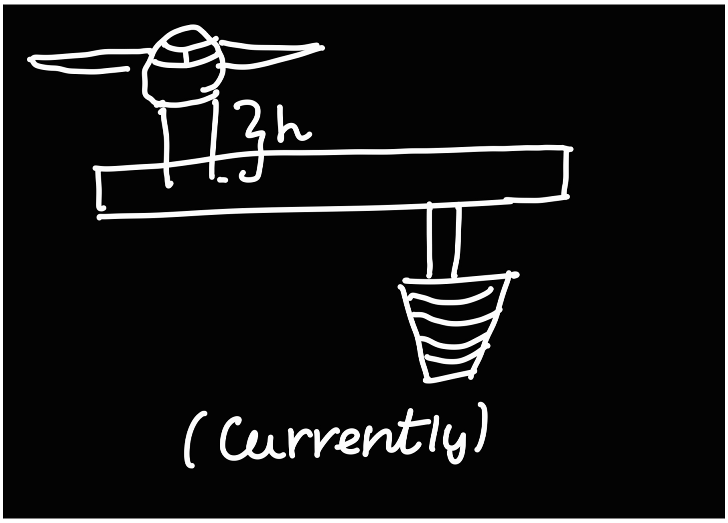

Figure 4: Current Height of Holding Mechanism

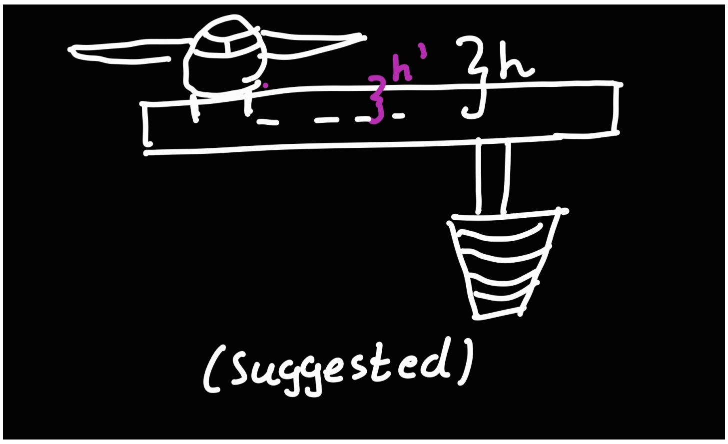

Figure 5: Suggested Changes

References

[1] J.N. Bolton J.L. Meriam L.G. Kraige. *Meriam's Engineering Mechanics: Dynamics 9th Edition.* 2020.