

# ENGR 101: Rube Goldberg Module

Final Report - Lab Section 088, Group 015

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## Machine Overview

Group 15's Rube Goldberg Module has 6 separate events, all activated by gravitational energy. A looping event, parallel event, and a mousetrap that pops a balloon are all incorporated in the module. Group 14 will trigger dominoes at 8"x0"x0" which will trigger the first event. The module will end by dumping a small cup of sugar into a cup of coffee. Figure 1 & 2 show flattened 2D models of the module. From the proposed design to the final design, two events have changed. Due to spatial reasons, removal of one of event #2's towers was necessary. Secondly, for maximum precision, event #4 was 3D printed, therefore changing its structure. Table #1 details the final operations of each event. Lastly, Figure 3 is a collage of 3D models of the machine.

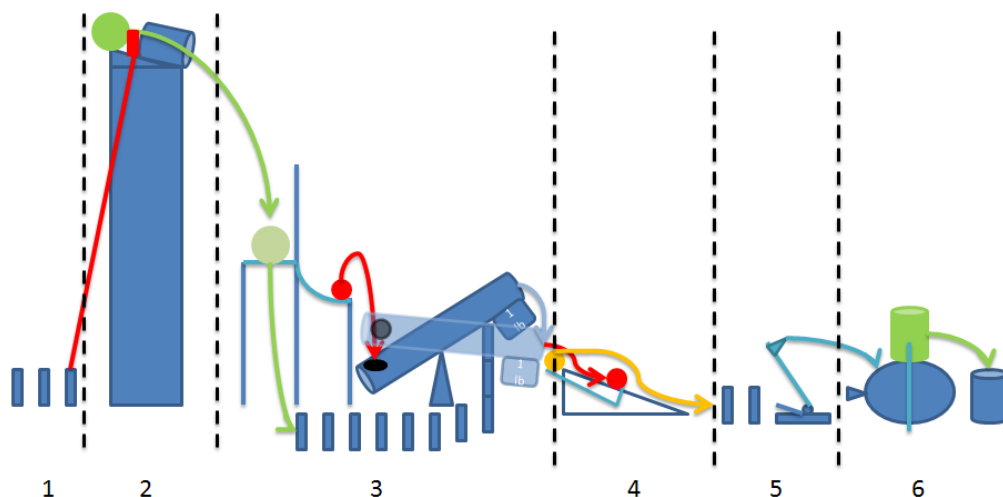


Figure 1. Final flattened 2D view of the final Rube Goldberg machine.

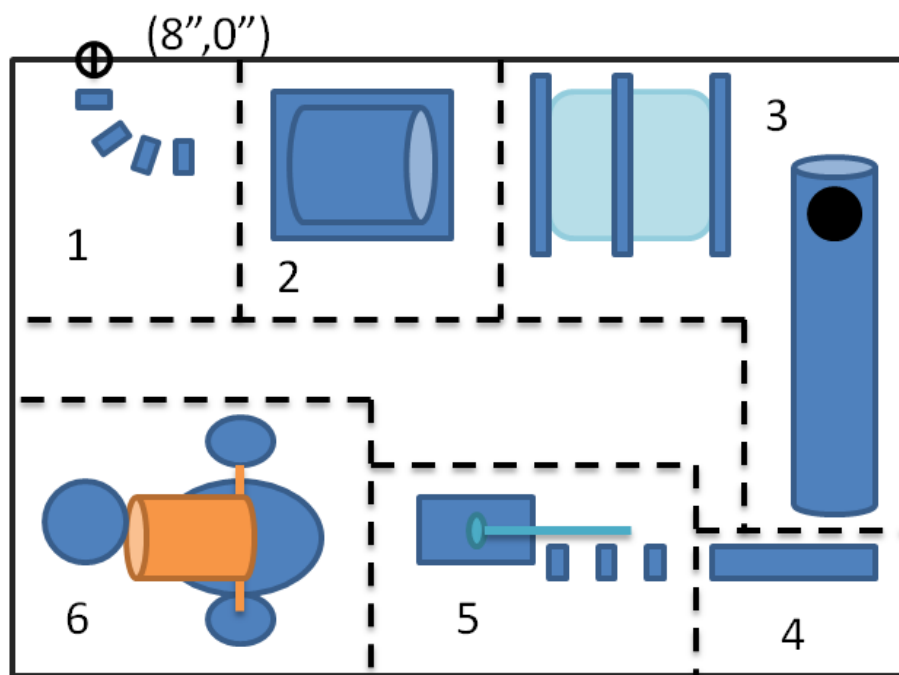
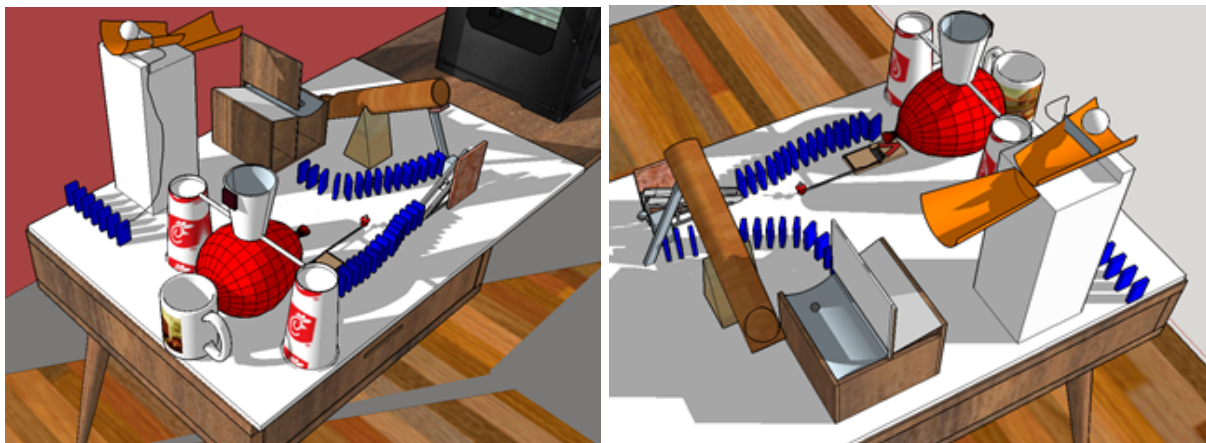


Figure 2. Final top-down detailed floor plan of the group's machine

The following table (table 1) describes the 6 events that will take place in group 15's module:

**Table 1. Machine operating script**

Event #	Event Description
1	Dominoes from group 14 will cross over. The last domino will have a string attached to it, and so when it falls, it triggers event #2.
2	The golf ball will roll down the split cup. It will fall when the cups end and trigger event #3
3	The golf ball will fall into a taught bed of cloth, consequentially making the bed become slack, while the complementary side becomes taut and let's a marble roll out into one side of a hinged paper towel roll. When the fabric slacks on the golf balls side, the golf ball will roll off and trigger dominoes, eventually knocking over the support for the paper towel roll, causing it to tip the other direction and release the marble to trigger event #4
4	The marble from event #3 will hit a golf ball, causing the golf ball to roll down a ramp. On the ramp, there is a hole with a "pressure plate" lever on it. When the ball falls into the hole, it will trigger this lever, causing another ball to rise up and roll down the ramp over the first ball, and then proceeding to trigger event #5.
5	The ball from event #4 will trigger dominoes, which will eventually trigger a mouse trap. The mousetrap has a pencil attached with a tack at the end.
6	Once triggered, the mouse trap with attached pencil and tack will pop a balloon that will be holding a cup upwards. Once the balloon is popped, the cup will fall over, hitting the coffee mug and dumping the sugar into it.

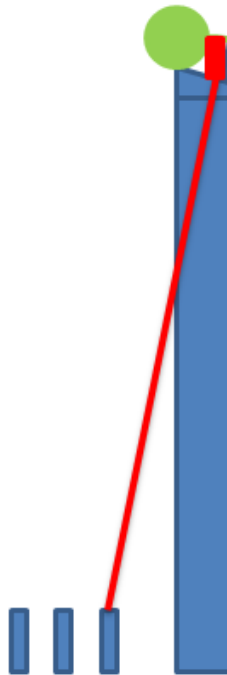


**Figure 3. 3D model of the final machine.**

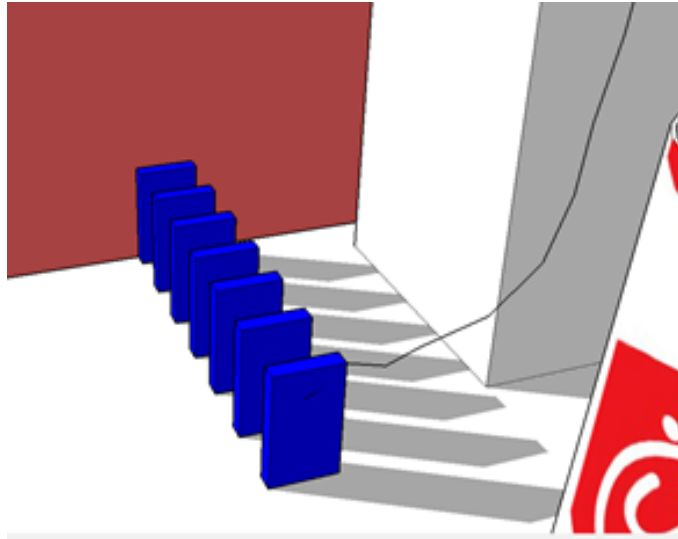
## Event Design Details

### Event 1 (Input Event)

Our first event were blue dominoes lined up shown in Figure 4 which will be triggered by group 14's marble. The last domino in the line up is a special domino that has a string attached using duct tape. On the other end of the string is a rectangular piece of cardboard attached using duct tape. The dominoes are all taped down so it is easier to set back up in time of need. Figure 5 show the 3D print of the dominoes lined up with the string attached.



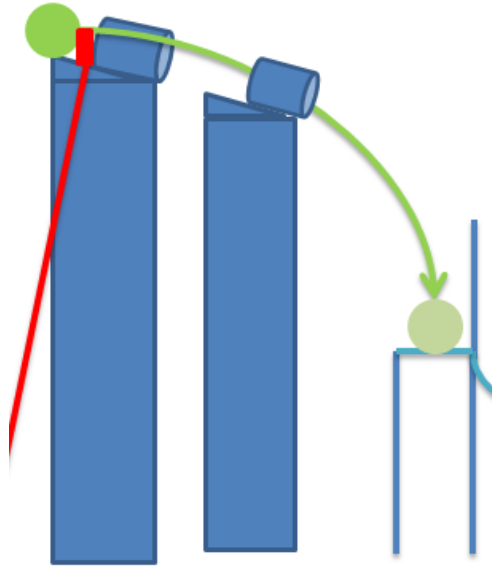
**Figure 4. Initial and Final Design of Event 1 (Input event).**



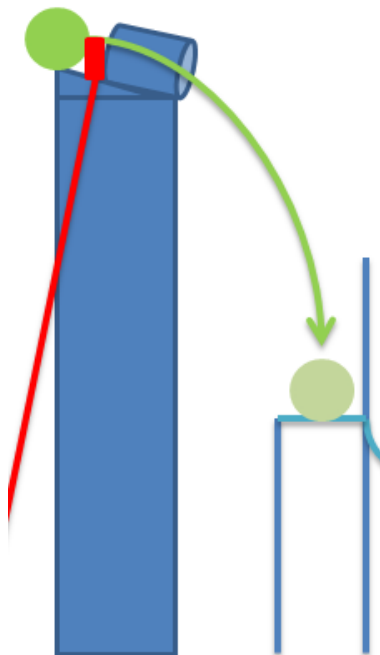
**Figure 5. Event 1 3D model (Input event).**

## Event 2

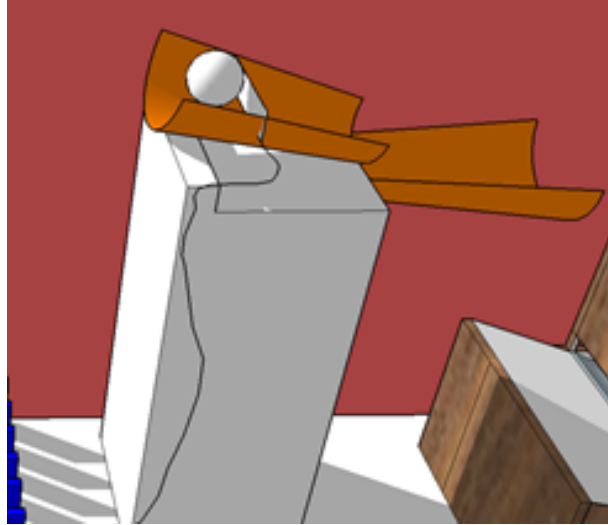
The second event is a foam structure that has a ramp on top which is a track for the golf ball to roll down into our next event. Figure 6 shows what our original sketch looked like with two foam structures. The ramp is elevated using a piece of foam and some tape for support. The ramp is a half a cup which has a slot for the cardboard to rest in. Attached to the half a cup is the other half of the cup which acts as a cushion for when the golf ball travels down the ramp. The second half of the cup is attached using a piece of cardboard with tape shown in Figure 7. The ramp then leads into the third event. Figure 8 displays the 3D print of the final one foam statue present. When this event was originally designed, there were two towers with two cups (Figure 6). However, due to spatial reasons, the final project was only able to use one tower.



**Figure 6. Initial Design of Event 2.**



**Figure 7. Final Design of Event 2.**



**Figure 8. Event 2 3D model.**

### Event 3

The third event shown in Figure 9 which is the Parallel Event was a combination of two different parts. The first part is the cloth contraption which receives the golf ball from the second event. When the golf ball rolls onto the cloth, it makes the cloth taught which transfers enough energy to roll the ball bearing marble into a hollow tube seesaw contraption being held up by a foam piece. Meanwhile the golf ball rolls off the cloth and hits blue dominoes that lead to the foam piece supporting the seesaw from coming down. Once the dominoes hit the foam piece it will cause the seesaw tube containing the ball bearing to tilt and roll the marble onto the next contraption. Figure 10 shows the 3D print of the final product all set up and ready to be triggered.

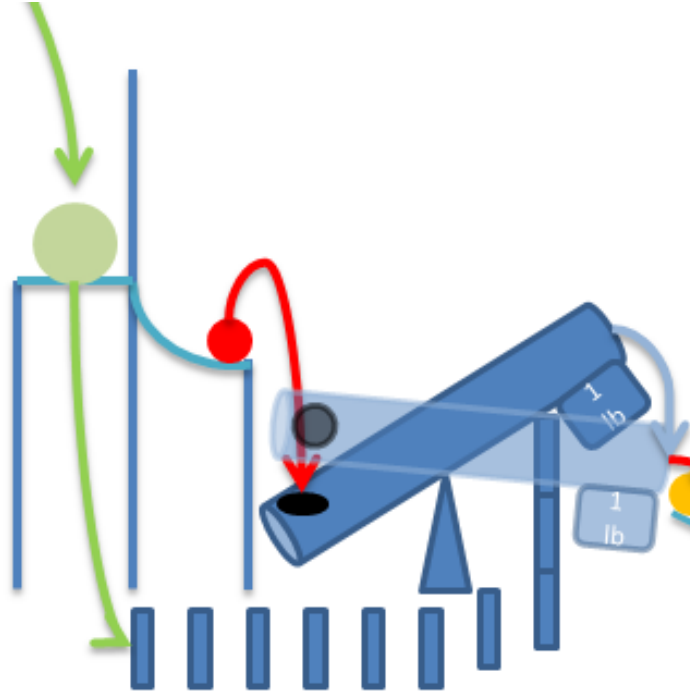


Figure 9. Initial and Final Design of Event 3.

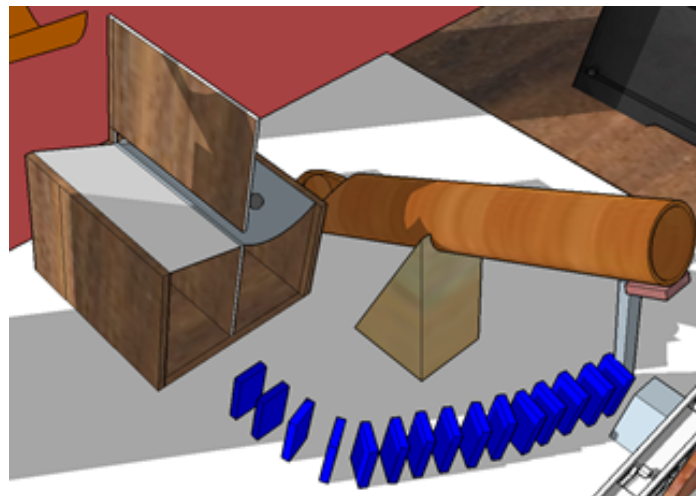


Figure 10. Event 3 3D model.

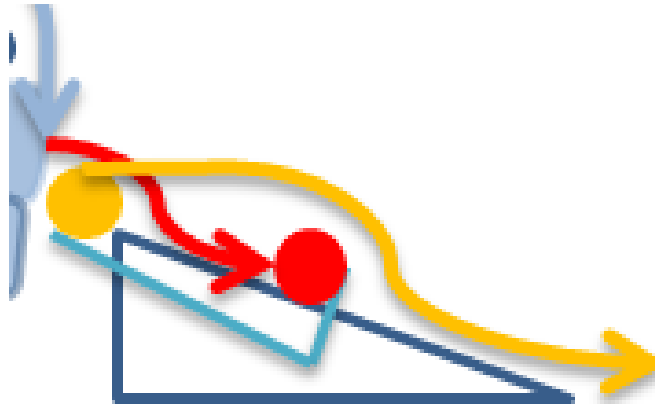


## Event 4

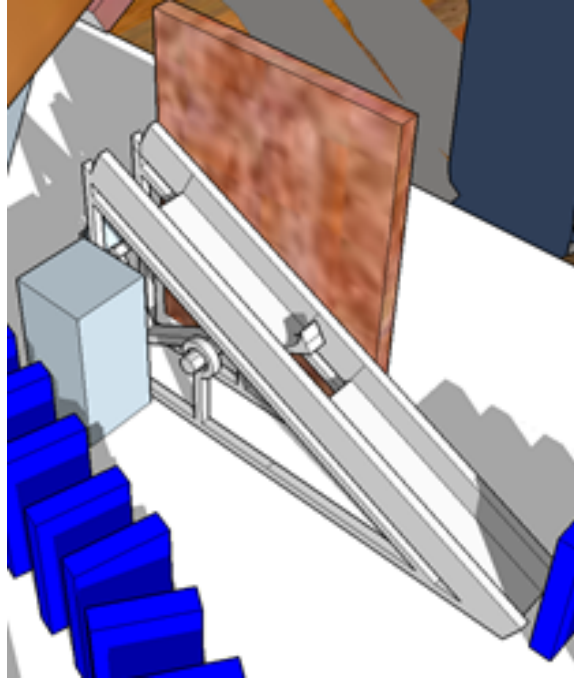
The fourth event which is the looping event was printed out using a group member's 3D printer. The contraption receives the ball bearing which roll down the ramp and falls into a ditch triggering the smaller ball bearing marble to roll down the same ramp. The original design plan was to utilize cardboard (Figure 11), however due to precision issues, the ramp was 3D printed (Figure 12). The 3D design for this event is portrayed in Figure 13.



**Figure 11. Initial Design of Event 4**



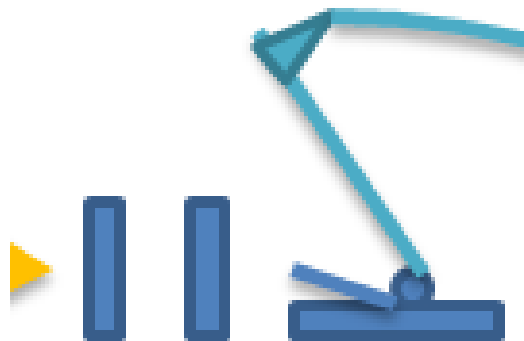
**Figure 12. Final Design of Event 4**



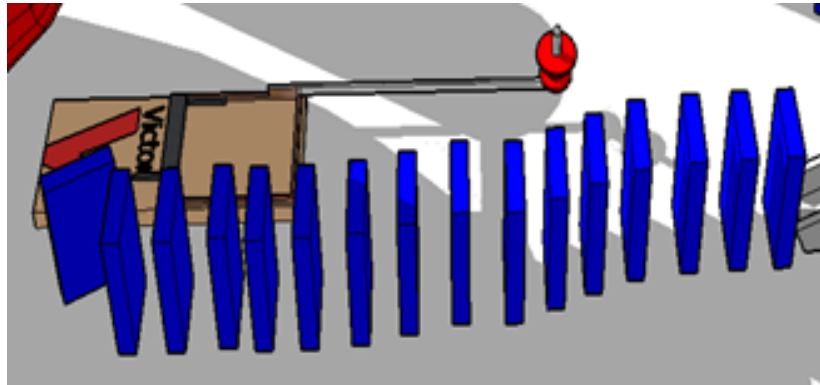
**Figure 13. Event 4 3D model.**

## Event 5

The fifth event (Figure 14) is triggered by the smaller ball bearing marble rolling down the ramp and hitting the blue dominoes which lead to a loaded mousetrap. All the dominoes are taped down so the reset of the machine is swifter. The mousetrap has a plastic rod glued and taped with a tack at the end. In addition the mousetrap is also glued down and taped to prevent it from flying off the board. The 3D of this model is portrayed by Figure 15.



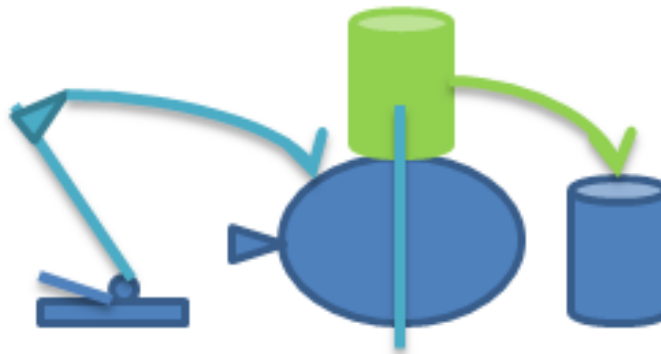
**Figure 14. Initial and Final Design of Event 5**



**Figure 15. Event 5 3D model.**

### Event 6 (Output Event)

The sixth event (Figure 16), which is also the output event, are two big foam cups taped down to the board. The two cups have a rod going through them with a paper cup attached containing the sugar cubes. The cup also has a weight on one side so that when the cup falls, the weight of the cup will go to one side all the time. There is a mug positioned perfectly so that when the cup falls, the sugar cubes will land in the coffee. This whole contraption is centered around the balloon holding up the cup. However, once the balloon is popped from the tack, the cup containing the sugar will tilt towards the mug. Last minute a piece of fishing string was added to secure the balloon from moving. A 3D model of this event is displayed in Figure 17.



**Figure 16. Initial and Final Design of Event 6**



**Figure 17. Event 6 3D model (Output event).**

## Machine Setup and Reset

We begin our Rube Goldberg Machine Set Up by standing up the blue dominoes in our input event. The last domino is a special domino that has a string attached on one end. The other end of the string is attached to a cardboard strip which is basically a gate used to release the golf ball which is activated when the last domino falls down. During Machine Setup, we need to place the cardboard gate in the little slot so it will prevent the golf ball from releasing. The second part of Machine Setup is to place a ball bearing marble on the loose cloth side so when the golf ball does fall, there is enough energy to move the ball bearing marble to the next event. The third part of Machine Setup is to tilt the seesaw contraption back and hold it up using a long foam piece. The fourth step of Machine Setup is to stand up the blue dominos leading from where the golf ball hits to where the foam piece is holding up the seesaw. During the contraption, the golf ball roll off the cloth and triggers the dominos which then knocks down the foam piece allowing the seesaw to tilt one way. The fifth part of Machine Setup is to place the smaller of the two ball bearing marbles in our looping contraption. When the marble from the seesaw goes down the ramp, it will fall into an indent which trigger the smaller marble to roll down the same ramp onto the next event. The sixth part of Machine Setup is to stand up all the blue dominos leading to the mousetrap. The smaller ball bearing marble from the looping event will hit the dominos. The seventh part of Machine Setup is to set the mouse trap carefully. Next blow up a balloon so that the cup containing sugar cubes sits snugly atop of the balloon. The dominos will then trigger the mousetrap which will pop

the balloon letting the cup with the sugar cubes pour out into a cup of coffee. Ending our Rube Goldberg Machine.

The reset for our group's Rube Goldberg Machine is exactly the same as our Machine Setup. Our group can set up our contraption pretty quickly each time. However we wait till the very end of the timer to place the golf ball so that in case someone bumps the table or something goes wrong the golf ball won't trigger the rest of the machine.

## Summary

Our Rube Goldberg Machine is the combination of many unique and creative design events our group came up with. The first major design stage of this machine was simply to move an object from an input event to an output event. This was the easiest and most straight forward portion of the design process. After these two events were established, our group came up with several more events including a parallel event and a looping event. These events were neither strong in their foundation and weren't really very reliable in testing. This was effectively our first draft of events. In these events, errors occurred often and many revisions were made to increase our machine's success rate. During our first design, many events which were conceptualized but few made it to the final working machine. These designs failed for several reasons. These reasons included complexity, physics issues and material availability. With only 5 minutes to reset our Rube Goldberg Machine, our group had to create a simple machine that could be reset within a few moments. Throughout the building process, material availability often represented a challenge in the lab. Since our lab group was the last group in the week, we basically got all the leftover materials. Certain materials which we needed for our machine's operation could not be used due to limitations on quantity. One event that failed almost every time in the beginning was our parallel event. This concept relied upon the use of a golf ball exerting enough force to make the cloth taught and pop a ping pong ball into the next event. This parallel event, though interesting on paper, was impossible to achieve in the class room. It was far too complex to work 100% of the time. This design was somewhat altered using a ball bearing marble which would roll off instead of the ping pong ball popping up. This change in our parallel event made our Machine that much closer to achieving consistency. This was not the only change made during the design process. Nearly every event was altered during the quarter. The final machine is now nearly 100% successful with few to no errors and a simple yet unique design. Throughout the design process, the lessons learned emphasized several crucial aspects of engineer design. These aspects included communication with team members, communication with section members, and being able to think outside the box.