ECE 101 Rube Goldberg Project: Cat Feeding Device

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[5 pages (+1 references page) - 1940 words]

Introduction

The objective of this project is to develop a Rube-Goldberg device. This is a mechanism that accomplishes a simple task in a complex way. The task we chose was to feed a cat.

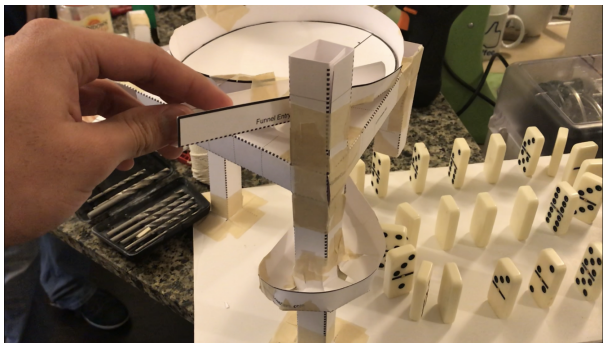
Design Process

1) We defined our problem as building a Rube-Goldberg machine. 2) We did background research by watching various Youtube videos of Rube-Goldberg machines.[1,5] 3) Our requirements were: a) construct a complex mechanism, b) work should be evenly split, c) it should be functional, and d) completed within the time-frame. 4) We discussed how we would split up the work. We shared sketches and ideas for mechanisms out of simple materials. 5) We decided each member would develop a mechanism. Each mechanism would be interchangeable. 6) We gathered and distributed resources and shared mechanism proposals. 7) We constructed a separate prototypes. 8) Prototypes were tested and refined throughout. We planned to test and refine the final construction before demonstration. 9) After testing and demonstration, we reflected as a group.

Technical Description

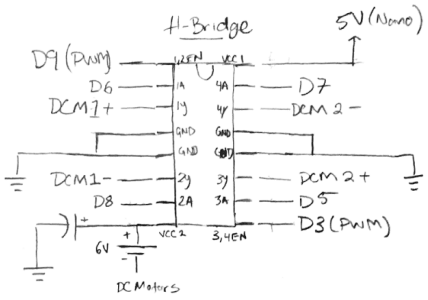
Our project was composed of several mechanisms designed by each member, then joined into one large mechanism. We decided on certain specifications so each mechanism would work with one another. Each mechanism was triggered by a marble entering at 1 foot of height, and had an output marble exiting at 1.5 feet. Everything between was up to each team member. We pooled resources, including K'nex components, Paper Rollercoasters™ tracks[6] (printable tracks, funnels, and curves), and electrical components (Arduinos, wires, servos, LEDs, and breadboards, etc).

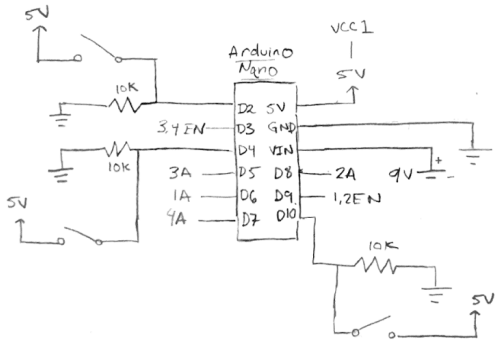
Tomas created the first mechanism demonstrated. Its primary materials were K'nex, paper roller coaster tracks, and dominoes. It included LED light strip for added visual effect. The mechanism starts with a straight track to a paper funnel. This feeds into a curved track that guides the marble into striking the first domino of a chain reaction. The last domino strikes a pill bottle attached to a pulley system. The pulley travels up to strike a ball release switch, releasing a ball into the next mechanism.



The next mechanism was designed by Derrick and was constructed from paper roller coaster tracks, cardboard boxes and tubes, a coat hanger, and some K'nex pieces (for pulleys). The output from Tomas' structure enters Derrick's and falls into a funnel. The funnel drops the ball onto a track which guides it into one half of a pulley system, pulling it out of balance. This pulls a paper track up, dropping a ball into a track which exits the mechanism.

The third mechanism was created by Chuck. Primary materials were K'nex and paper roller coaster components. Electrical components included circuits using paper switches and copper tape, a used computer fan, an electromagnet made from an old transformer[9], 2 K'nex DC motors modified for use with an Arduino Nano[2], and an H-Bridge[8]. The DC motor batteries were wired in series to generate 6 volts for the VCC2 pin of the H-bridge. A decoupling capacitor[3] separates the motor and the arduino circuit. This eliminates noise on the power line. Three 10K ohm pull-down resistors[7] connect the arduino input pins and ground.





The marble from the previous mechanism falls into a pulley system triggering a ball release. A ball drops into a funnel and into the "plinky" (noisemaker). The ball falls into a funnel and onto a track. The ball rolls into a trapdoor switch which shuts. Future marbles pass over it to the carousel queue. The switch triggers motor 1 via the Arduino powering the carousel. The carousel picks up a marble waiting in the queue and releases it on a track at the top. The ball meets the first junction switch. The ball travels the first path and alters the switch so all future marbles travel the other path.

The marble travels to the electromagnet. The electromagnet is on by default, and holds a metal pendulum. The marble falls into a capture switch which turns off the electromagnet. This releases the pendulum. The pendulum swings toward a track on the other side with a magnetic paper pull tab holding a ball in place. The pendulum pulls the tab out of the track releasing the marble. The marble falls into the plinky system, and drops into the carousel queue and travels to

the top. At the first junction, it takes the alternate path (as will all future marbles). The marble rolls into the second junction switch which guides it toward a capture switch. This capture switch signals the Arduino to trigger motor 2, which runs for two seconds. This pulls a pin that is holding a wheel in place (dubbed the “hypnowheel”). The wheel rolls down a track and triggers a ball release. This ball falls onto a track below it and travels into a pulley system. This triggers a ball release into the plinky-carousel system. This rides to the top, passes the first and second junction into the third junction. The third junction switch guides it toward a paper tab. The collision with the tab releases baking soda into a volcano filled with vinegar. "Lava” flows over the sides of the volcano into a funnel and into a cup on a lever system. The lever releases a ball into the plinky-carousel system. The ball passes the first and second junctions into the third where it takes the alternate route. The ball falls into a capture switch completing the computer fan circuit. This pushes a sail system which pulls a tag releasing the “mace” (a weighted K’nex rod with a needle attached). The mace swings down and pops a balloon. A marble above the balloon drops into a funnel, and onto a track. The marble triggers the carousel off-switch before entering the next mechanism.

The next mechanism in the chain was developed by Brent. This mechanism consisted of cardstock, rubber bands, and marbles. Its design was a simple track to lead a marble to hit another marble that is in the middle of the track. It was to then fall down a hole in the track. It would travel to another marble which is released upon hitting it. This would repeat in a series of tracks arranged in a zig-zag fashion. The last marble would leave the output. This zig-zag mechanism was not constructed in time for the presentation.

The final mechanism was built by Alejandro. This mechanism was not demonstrated at the demo but a prototype was shared with the group. Its primary construction materials are wood, metal, and 3D printed components. It included electronics components such as an Arduino Nano, 2 servos, a pressure

switch, and an RC car. The ball leaving the last mechanism triggers a switch on the outside of the wooden frame. This causes one of the servos to rotate counter-clockwise and drop a ball into a lever mechanism. This triggers another switch causing a servo attached to a 3D printed panel to rotate and release cat food. The cat food falls into a chute system out of the mechanism and into a cat bowl. The weight of the cat food triggers a pressure switch on the RC car causing it to travel forward with the bowl towards the cat.

Project Management:

We decided to divide tasks by having each member design their own mechanism. Each mechanism could be interchanged in any order. Each mechanism had specifications so they could interface with one another. Each member was responsible for creating a functioning mechanism by the demo date but the internals of that mechanism were up to the member. During the demonstration date, we connected each mechanism with paper ramps.

Our group had planned to meet weekly on Tuesday mornings at 8:30am, in the engineering building. During our first meeting, we shared our proposals for project management. We set project milestones and deadlines for research and brainstorming, mechanism proposals, prototypes, and testing dates (see Google Doc on Trello). We used a Google Doc to list our physical, digital, and skill-based resources. Some members used Trello, but our primary organization method was the document.

We had issues finding good times for everyone to meet. Many of our members work jobs or had family obligations. Because of this, we were sometimes in the dark about each other's progress. We attempted to use Google Hangouts to address this issue, but attendance for this was spotty as well. Nearly every member, even those who had started the project well ahead of time felt somewhat rushed at the end because of last minute changes or issues that cropped up. The time spent on this project varied by member, but a considerable amount of time was spent on this project by the group in total.

Discussion

By the demonstration date, most of our team's mechanisms functioned, at least partially, and we had a fairly successful demonstration. As a group we learned a lot from this project.

Tomas realized his plans were a bit too ambitious, and needed to simplify his original plans to finish in time. This experience was shared by most of the team members. He had issues aligning the dominoes to trigger the ball release at the end. He made modifications to the pulley to enable this. Tomas' mechanism worked perfectly by the demonstration date.

Derrick also pulled off a very successful mechanism that worked consistently. He had challenges transporting his mechanism to our meetings in the Portland rain. This was difficult for several members because most of the tracks are made of paper! With more time, Derrick says he would create a mechanism where a pulley system pulls a plug releasing marbles to depress a lever releasing a ball. This was cut for time purposes.

Chuck's mechanism worked during independent testing but had issues during demonstration. More time was necessary to set up and calibrate the machine and a morning class prevented early set up. While the paper switches worked with simple circuits, and the Arduino inputs worked in testing, they did not work well together. Copper tape resistance, low current from the arduino, and imperfect copper contact may be to blame, Chuck hypothesizes. He wants to try experimenting with pull-down resistor values or with pull-up resistors to fix the issue. He learned about Arduino programming[4], H-bridge motor control, and the functionality of pull down resistors and decoupling capacitors. With more time he would fix the switch issues and add LEDs along the tracks which light up as the ball passes, allowing onlookers to track the ball.

Brent's major take-away was the importance of time management. Especially the allowance of time for choosing appropriate materials for his project. He feels that this prevented him from developing a well supported structure for his tracks.

Alejandro mirrored that sentiment. He discussed learning about the importance of allowing time for technical setbacks. He constructed several different mechanisms but each ran into problems. With more time he wants to spend more time with his mechanisms to work out the issues.

As a whole group, we learned the importance of frequent communication and meeting attendance. We experienced success when members were present during meetings to share ideas, resources, inspiration, and encouragement. Those who did not attend missed out on important information about design specifications and progress. Many members learned about the importance of starting early and working consistently. Several members learned that while it is good to dream big, sometimes it’s more practical to go simple. Some learned that at some point, you need to stop working on a project or avoid making large changes last minute. Finally, some learned that it’s better to present a less-than-perfect product than nothing at all. All members enjoyed working together to develop this project!

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