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Team 24 (Duckz) Design Cycle Challenge Report: Rube Goldberg Machines

Inquiry and Analyzing

Design Brief:

We will be creating a Rube Goldberg Machine within the four days of the Design Cycle Challenge using the items provided by the school and the objects we have brought from home. We will work in a team consisting of five, ranging between grades six through nine. Our machine must connect with two more machines from our two neighboring teams.

Design Specifications:

1) Our machine must successfully connect to the machines of our two neighboring teams(Teams #23 and #25).
2) Our machine must start and end with dominoes.
3) Our machine must include at least three simple devices(any combination of the following: pulley, lever, inclined plane, wedge, wheel and axle, gear, screw).
4) The design of our machine must somehow have at least 3 connection towards, or represent our icon image. (For said icon image, see below)

5) The machine must incorporate at least 7 different materials. (Materials list: cups, metal, elastic, sand, books, baskets, cones, coat hanger, pipes, string)

Specification Tests:

1) The machine immediately starts by itself when Team #23's dominoes connect to ours.
2) At least one domino is placed at the beginning and the end of our design.
3) The machine includes at least three simple devices. (for list of devices, see Design Specification #3)
4) We are able to describe at least three parts of our design that connects or relates to the concept and/or image of our icon image.
5) The machine incorporates seven or more different materials. (For list of materials, see Design Specification #5)

Research

We first should know the different types of energies that are being incorporated in our Rube Goldberg Machine, so we can understand the science behind how and why our machine functions.

Energy is otherwise known as the capacity for doing work, and "work" means when force is used to move something. It should be noted at "all forms of energy are associated with motion" ("Energy." *Britannica MICROPÆDIA Ready Reference*.). There are generally two forms of energy: kinetic energy and potential energy.

Kinetic energy is all about motion and the actual movement of objects. With kinetic energy, energy is being transferred from one place to another. When an object gains speed, it gains more kinetic energy. The official measurement for kinetic energy is known as joules. There are two factors that affect kinetic energy: motion and mass. Mass is how much an object weighs, while motion is how the object moves. Examples of motion include translations (items moving down a path), rotation and vibration. Kinetic energy is also closely related to velocity, or the speed of moving objects.

Potential energy is stored energy that is waiting to be released due to it's position. Force has been prepared before hand, and only needs a trigger to let the energy loose. Forms of potential energy include compression, stretching and the height of the object's placement. A simple example of potential energy is dropping a ball down from a certain height. The work done in separating the ball from the ground is kept into the ball, and is released when dropped. The stored energy is known as gravitational potential energy ("Potential Energy." *Britannica MICROPÆDIA Ready Reference*.). Finally, potential energy is converted into kinetic energy.

Next, is learning a bit on the background of our project: the Rube Goldberg Machine. The machine was named after Reuben Lucius "Rube" Goldberg. He was a cartoonist known for creating unnecessary complicated machines to achieve everyday tasks. His strips were all over the newspapers, being published one to two times a month for the next couple of decades, and earned the public's interest. His crazy machines were then named after him.

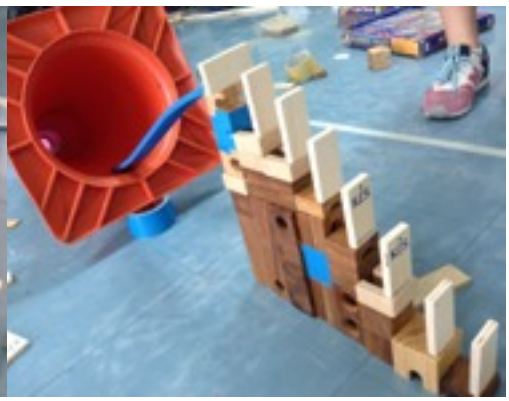
Finally, we need to know what we might want to include in our own Rube Goldberg Machine. Most likely, devices known as “simple machines” will be used. These machines include screws, inclined planes, wedges, wheel and axles, gears, levers and pulleys. Simple machines will often help us in moving objects. For example, the inclined plane, which is a tilted flat surface, and the wheel and axle allows us to move items easier by reducing friction. When using a pulley, you won’t need as much energy to transfer a heavy object when compared to moving the same item with your bare hands.

Developing Ideas




Design #1: This design incorporated all of our original ideas, and was a result of us playing around with the provided materials. It starts off with a staircase of dominoes that pushes a marble down a ramp. The marble will then trigger a pulley that will push of another marble that uses a screw and pipe to hit a section of dominoes before connecting to the next team.



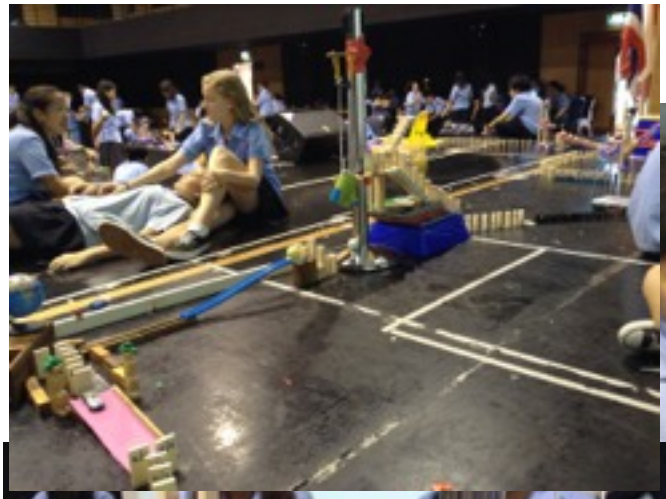


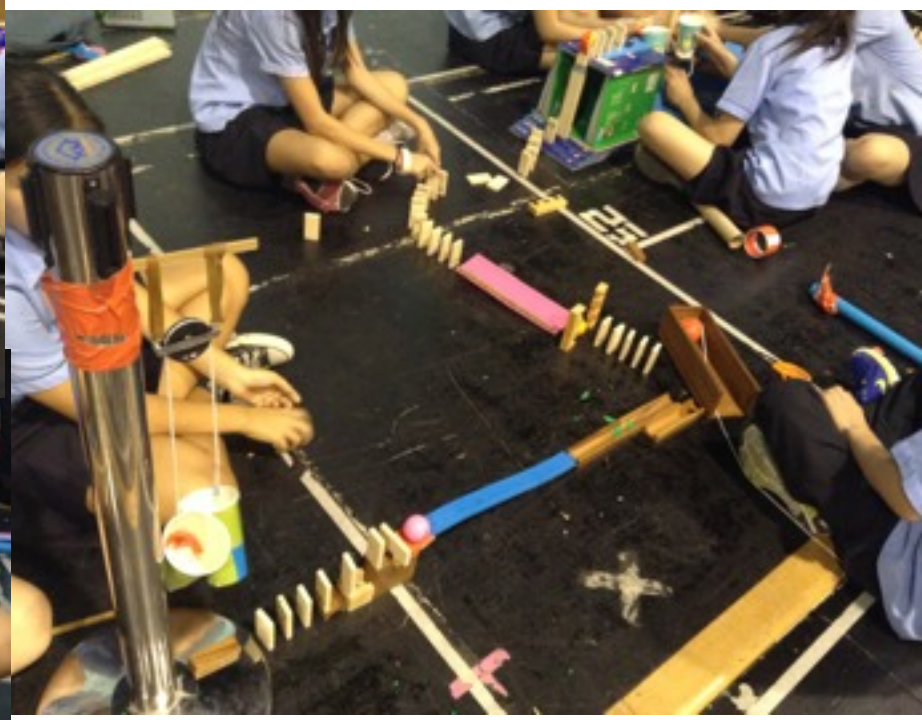
Design #2: While keeping the domino staircase idea along with the ramp, we added a cone to the design for uniqueness and to gain more velocity with our marble. The marble was to shoot out of the cone, go across a lever before bouncing off blocks of wood and hit a toy car that was to trigger a domino chain around a mini globe. The pulley and screw had been removed from this design.



Design #3: This design was heavily based off the second one, retaining the domino stairs and cone. The main difference was that we wanted to use a pendulum system (also known as a "wrecking ball" within the group) to break a wooden block structure, that was supposed to hit a row of dominoes that will connect us to the next team.

We had a lot of trouble making this design work, so we decided to scrap the entire thing and come up with our final and greatest design.





Design #4: Our proudest creation, and our final design choice. We changed the domino stairs slightly, replacing the wooden blocks with self-made wooden stairs and books. The pulley was once again added it as we were determined to make it work. The dominoes knock a heavy marble into the pulley, which drops and sets off a few dominoes. The dominoes gently push a golf ball down a ramp. It bounces off some wood before hitting another small track of dominoes that push a small toy car down an inclined plane. The car sets off one final stretch of dominoes before continuing onto the next team.

There were various reasons in which we chose this to become our final design. First off, it kept our signature bit: stair dominoes. We were also taking everything that worked from our previous designs and incorporating them in, which included the ball and ramp and the car hitting dominoes. Finally, we chose this design due to the different simple machines that were included. Said machines included a pulley, two inclined planes and the car's wheel and axle. This makes our seemingly simple design seem more complex once analyzed and examined closely.

Creating the Solution

Teamwork is key in any piece of group work. We would discuss our ideas before doing anything rash. It was a little slow during the first day, and Ivan, the sixth grader, was rather reluctant to speak. But as the week went on, Ivan, and all of our members started opening up and discussion became something that came naturally. When building the machine, we would let our teammates do what each of them do best. For example, Ruby and Kiara, who quickly proved to be our most creative members became the leaders for the design. Maggie was much better at piecing the things together, while Ivan was had skill in tinkering with devices and finding solutions, especially with the pulley. Por, who was much comfortable with the academic side of the project was entrusted with editing the video reflections and the report. When someone would make a mistake, most notably with the dominoes, no one would get angry. We were supportive of each other and helped each other along. By using everyone's strengths and talents, and assisting each other when we aren't as proficient in a category, we were able to overcome all the challenges we encountered with our Rube Goldberg Machine.

Our design had to incorporate the theme or concept of our icon image, which is the earth painted on human hands. This could mean lots of things, and we decided to cover as many as we could with our design. Such meanings included a connected world, the human affect on the planet that was conducted through our hands, and the structure and characteristics of planet earth itself.

First off, we added a globe in for decoration, which is the most obvious hint towards the theme. The domino staircase was to mimic climbing one of nature's landmarks, the mountain. The pulley and the edge of the stairs could be seen as a cliff. The blue colored ramp was to represent a flowing river. We had green clay on top of some of our wooden blocks to represent trees and the forests. The path for the car was driven right through it, a symbolization deforestation and mankind laying it's hands on the earth.

Evaluation

Testing the design specifications was mostly done by looking at our overall design. Checking the requirements for starting and ending with dominoes, as well as successfully connecting to the machines or our neighboring teams was done during the trials. All of the transitions seem to be successful. Now, we had to focus on our simple devices. They were at the back of our heads during the designing process, and we were racking our brains for ways in which we can incorporate at least three simple devices into the machine. In the end, we had a pulley, inclined planes and a pair of wheel and axle devices through the miniature car. When we checked to see how many materials we used, it was rather impressive with how much we managed to add into our machine. We used books, wood, metal, baskets, future-board(plastic), toy cars, marbles, string, cups and clay. Then there was the matter of incorporating the theme or concept of our icon image into the design. At first glance, it seemed that we only had the decorative globe as a reference, and not reaching our specification of at least three connections. But after we sat down and started analyzing our design, we noticed the hidden connections, and realized that we really had achieved the specification.

We made lots of changes to our design over the course of only four days. There were elements that we've always kept, which was the domino staircase and the ramp, but even those sections were eventually revised. For instance, for the first two designs, the domino staircase was done using wooden blocks, but we later switched to using much more stable, more portable and easier to set up self-made wooden steps. The metal pole was always on our minds during designing, but it was hard to incorporate it into all of the designs. Though after the second design, it was clear that having that pole in our machine would be very helpful towards making the machine work as a whole. The cone and the pulleys were elements that were always on debate. It would occasionally work and occasionally fail, so it was hard to determine whether or not to include in our machine. We tried adding a pulley in the first design, but it failed. The cone was rather efficient in the second design, but lost it's magic touch by the third. So we decided to add back the pulley and get rid of the cone. There were times in which we would add clay to various parts of the design to tweak some issues, such as holes or needing items to stop moving(especially marbles and dominoes). There were other minor changes as well, such as the arrangement of the pulley and the alignment of the ever so annoying dominoes, and every single edit we made to each design had a much larger and profound affect on the entire machine.

A major improvement could be making sure the machine's success is much more consistent, but a lot of it relies on the quality of the cloth tape and domino placement. A much larger improvement would be making the machine much more complex. We didn't have anything like catapults or screws, but we could have considered adding such contraptions to our design. It would also boost our uniqueness and creativity. Either way, we are all happy with the Rube Goldberg Machine we all worked together to build.

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