DESIGN CYCLE CHALLENGE

2013

Goldberg Machine: A contraption that accomplishes something simple in a complicated way (Merriam-Webster Dict.)

TEAM 4 - Lego Destruction

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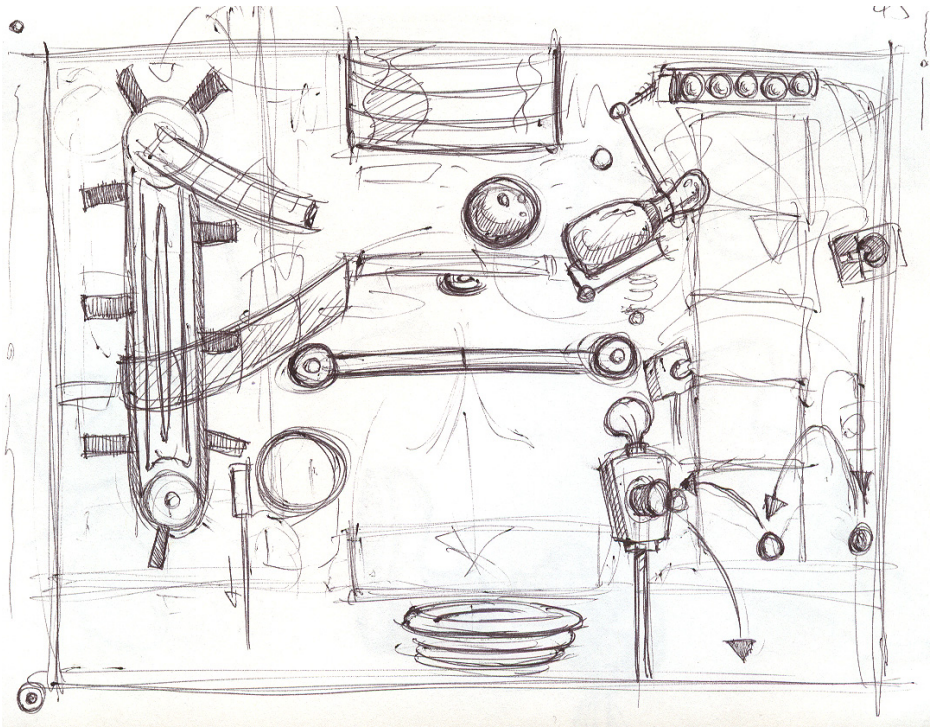
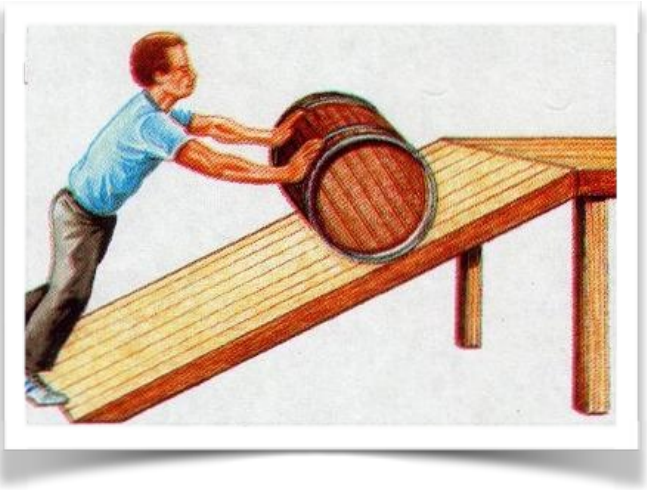


Design Brief

Our picture of inspiration is called Brick of Art: Yellow Man. Our interpretation of the picture was of a merciless person who has decided to change and let out all of his/her emotions. We reflected this picture in the final design of our goldberg machine. We built a big lego tower which is destroyed by a golf ball to represent the emotions pouring out of the body. The colours of the lego pieces show the different emotion that a person can feel such as happiness = yellow, sadness = blue, love = pink, anger = red. We also had people pulled down from a block to symbolise heartlessness of the world that pulls people down and breaks them.

Research

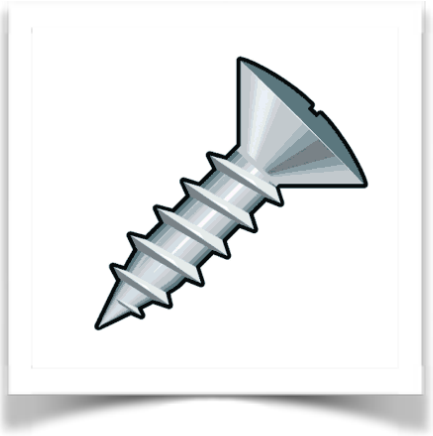
MACHINE PARTS



INCLINED PLANE:

A flat sloping surface. Inclined planes are used to make moving heavy objects easier. An object can go up or down an inclined plane. An example of an inclined plane is a ramp.

SCREW:

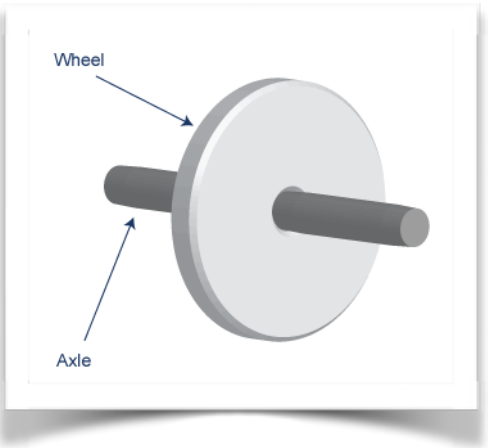


A screw is an inclined plane which is wrapped around a cylinder. The inclined plane is the thread that goes around the screw and the cylinder is the long rod. Screws are used to hold objects in place and push or crush two objects together. The end of a lightbulb has a screw so that it can be hung on the ceiling.

GEAR:

A gear is a wheel with teeth, which is sometimes called cogs. To use a gear, you need at least two cogs with their teeth fitting into each other. Since the teeth fit together, when you turn one gear, then the other gear will be automatically turned too. When two or more gears are connected, it is called a machine train. Gears can be big or small.

WHEEL & AXLE:



This machine is made up of two things, the wheel and the axle! The axle is the rod which goes through the wheel in order for it [the wheel] to turn. The wheel and axle help move things. The

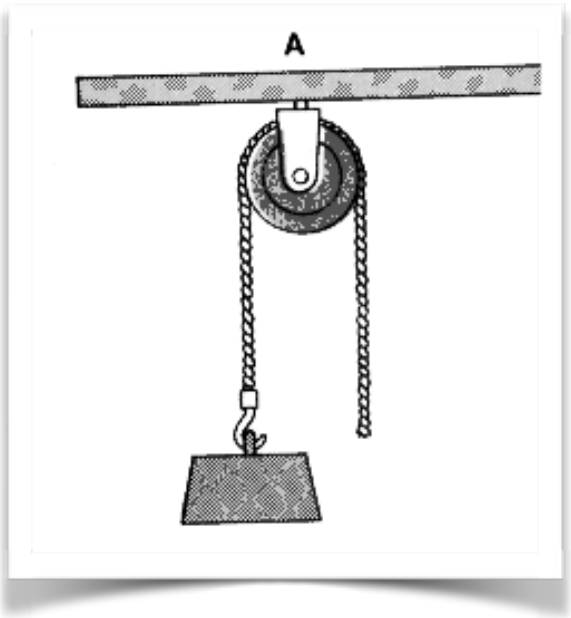
greater the speed of the axle, the faster the wheel turns.

WEDGE:

A wedge is made up of two inclined planes. The two planes meet and create a sharp edge. Wedges are used to push two objects apart, hold objects in place and cut an object into pieces. A knife is an example of a wedge with a sharp edge.

PULLEY:

A pulley is made of a wheel and a rope. The rope fits on the wheel and one end of it carries the load. When pulled on one side, the wheel turns and the load moves. A pulley is used for moving objects into sideways, up, down and unreachable places. A flagpole is an example of a pulley. The flag is attached to the rope. When the rope is pulled, the flag moves up or down.



LEVER:

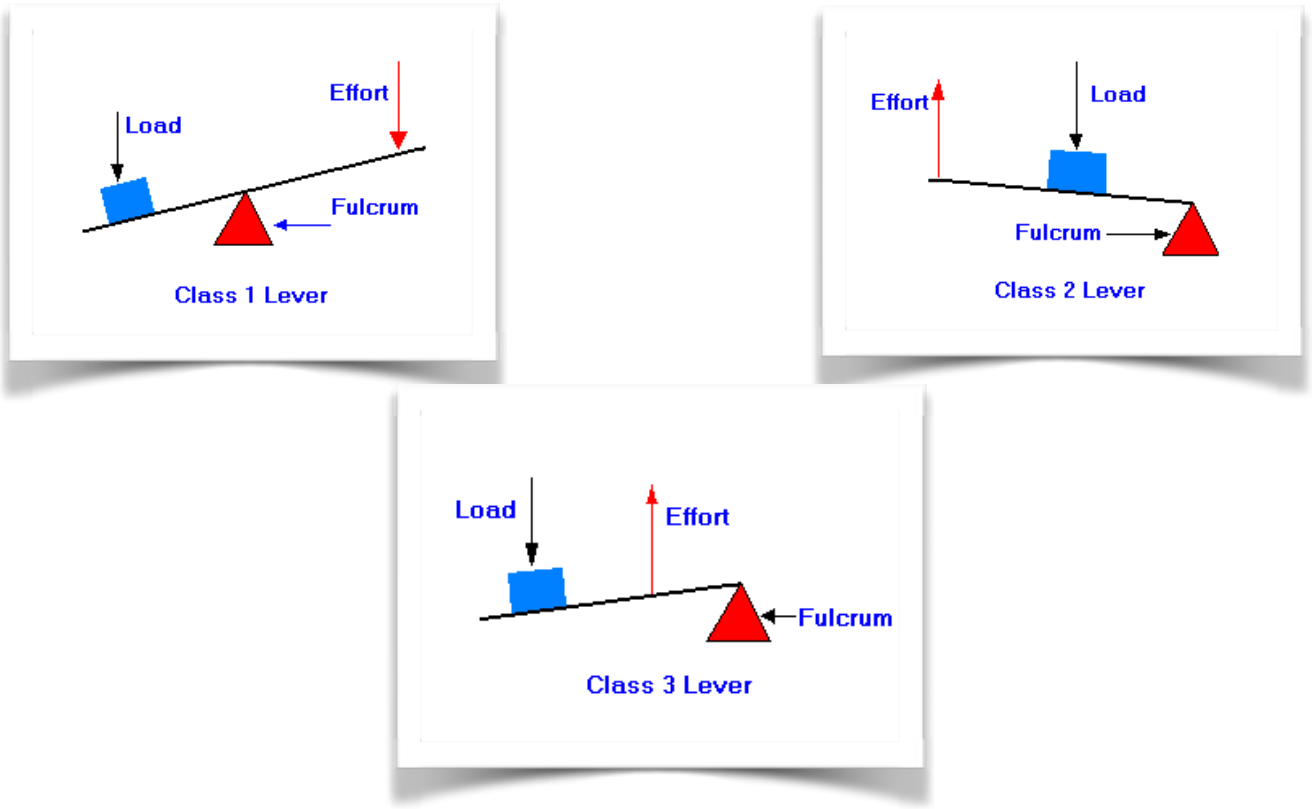
A lever is made of a board or bar that rests on an object. The object which the bar or board is resting on is called a fulcrum. Levers are used to make moving objects easier with less force.

There are three parts of a lever:

1. Effort - the force which moves the lever
2. Load - the object which the lever is going to be moving
3. Fulcrum - the point where the lever moves

There are three kinds of levers: the first class lever, the second class lever and the third class lever. In a first class lever, the fulcrum is placed under the middle of the board/bar. In a second class lever, the fulcrum is placed under one end of the board/bar. In a third class lever, the effort is in the middle of the fulcrum and load. An example of a first class lever is a seesaw. An example of a second class lever is a wheelbarrow. An

example of a third class lever is a fishing pole. The fish is the load, the hand is the effort and the handle is the fulcrum.



Who invented Rube Goldberg machines?

A man named Reuben "Rube" Lucius Goldberg invented the Goldberg machine. At a young age, Rube Goldberg loved drawing. Unfortunately, his artistic skills weren't approved by his father, who later sent Goldberg to an engineering college. After he graduated, Goldberg helped design sewer systems in San Francisco, drew cartoons for a newspaper which eventually won him a prize. His drawings showed simple household items connected to each other to perform an easy task. These drawings became so well known that Webster's Dictionary defined the term rube goldberg as "accomplishing by extremely complex, roundabout means what seemingly could be done simply".

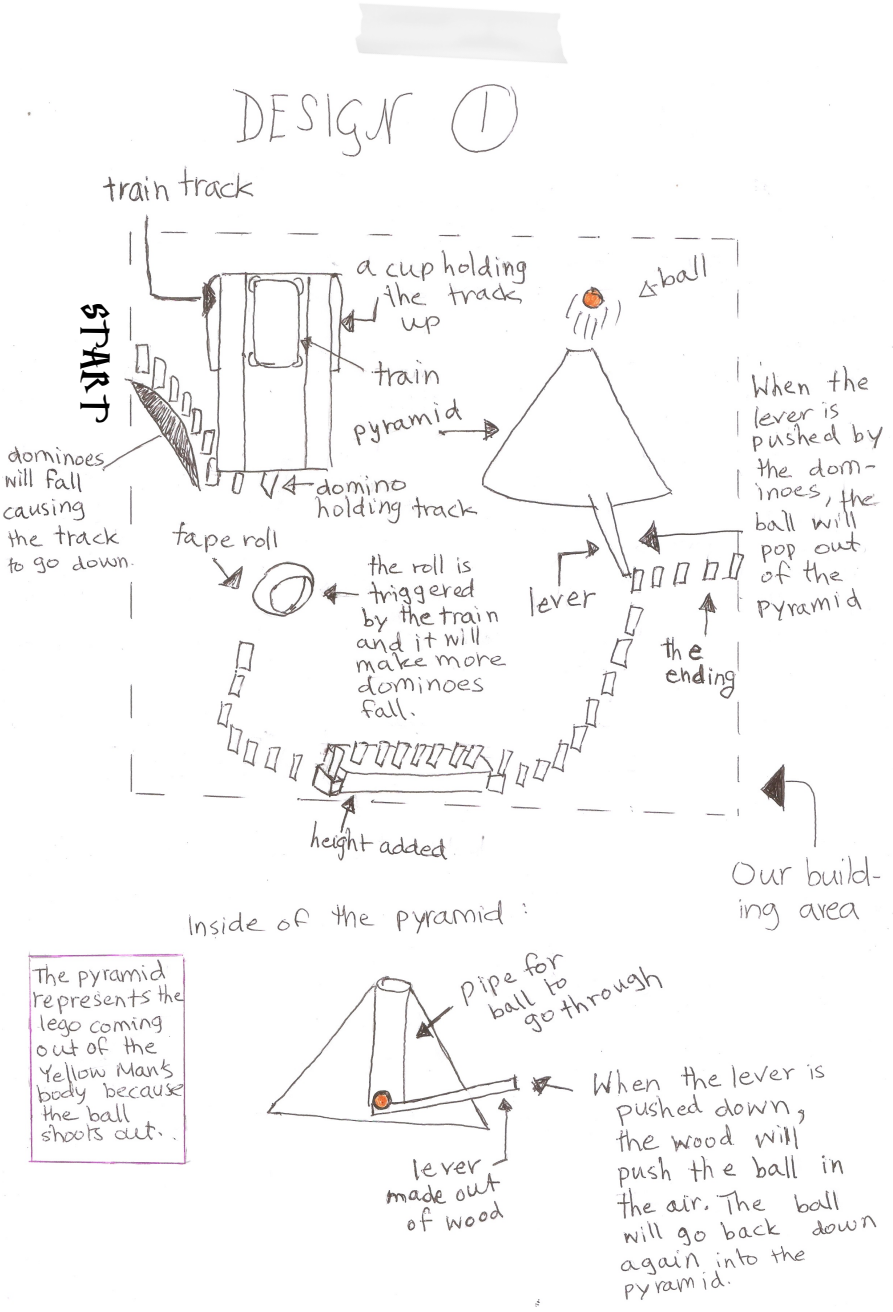
Design Specifications and Ideas

Design Specifications:

	Design Specifications
1	The machine will have 3 main actions.
2	The machine will have 2 potential energy sources.
3	The machine will start and end with dominoes leading to the next group.
4	The machine will use materials other than dominoes.
5	The picture of inspiration will be reflected in our machine.

Tests:

Specification	Design 1	Design 2	Design 3
1	✗	✗	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓



Errors/Improvements:

The pyramid idea didn't work because the ball was pushed through the air at an acute angle instead of through the pipe. This slowed down the ball and it wasn't able to reach above the pyramid.

The train didn't always hit the tape roll. The angle had to be changed for every trial. When we added tape to the cup, the train fell down sideways.

Highlights:

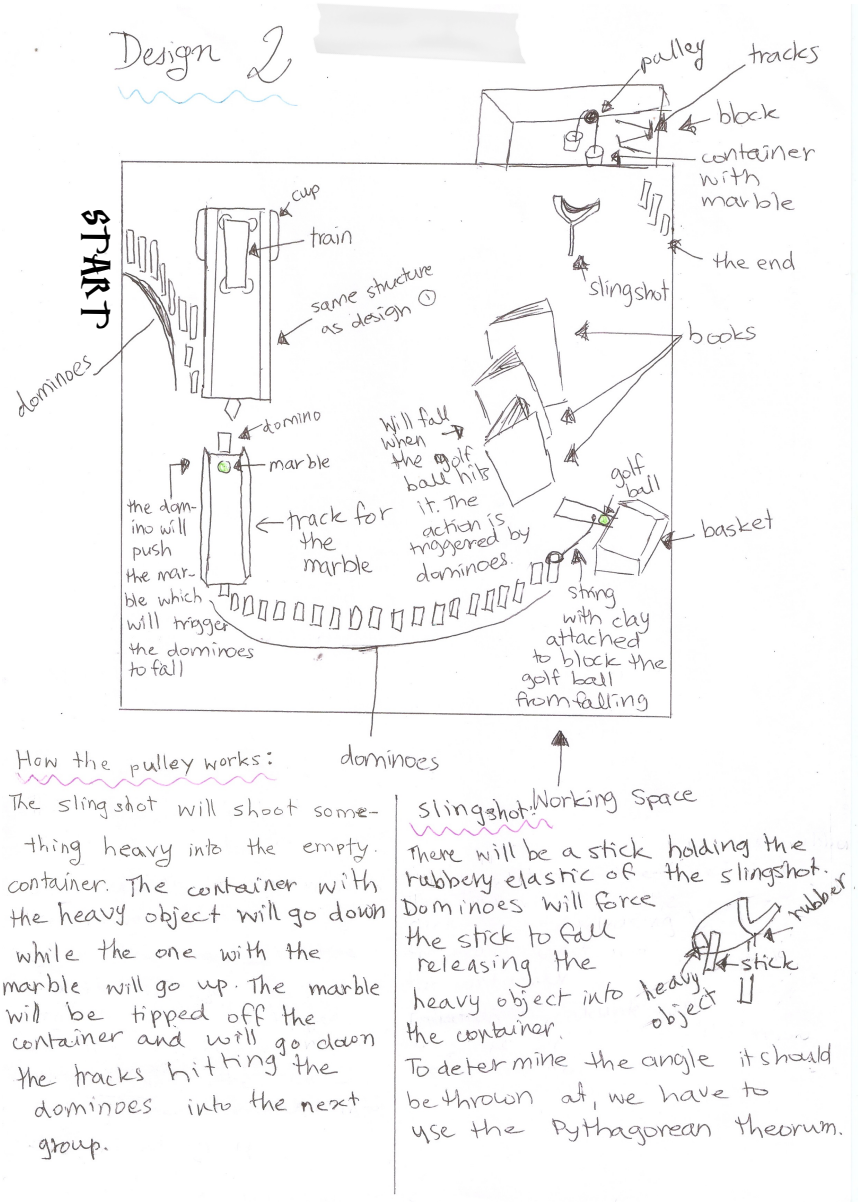
If the train hit the tape roll, then the roll would hit the dominoes. The dominoes part worked very well and always fell if the tape roll hit it.

Parts that can be used in Design 2:

- Though the train didn't work for every trial in our machine, it can be used for our next design because it is a good energy source.
- The dominoes have to be used for the next design because one of the design specifications was that the machine will start and end with dominoes.

Errors/Improvements:

- The books didn't fall when the golf ball hit them because they were too strong.
- When we arranged the parts of the design in our block like the plan, the slingshot ended up being too close to the block. The angle was too steep to shoot anything.
- In the diagram, the ending position was in a different place than where it was in design one.

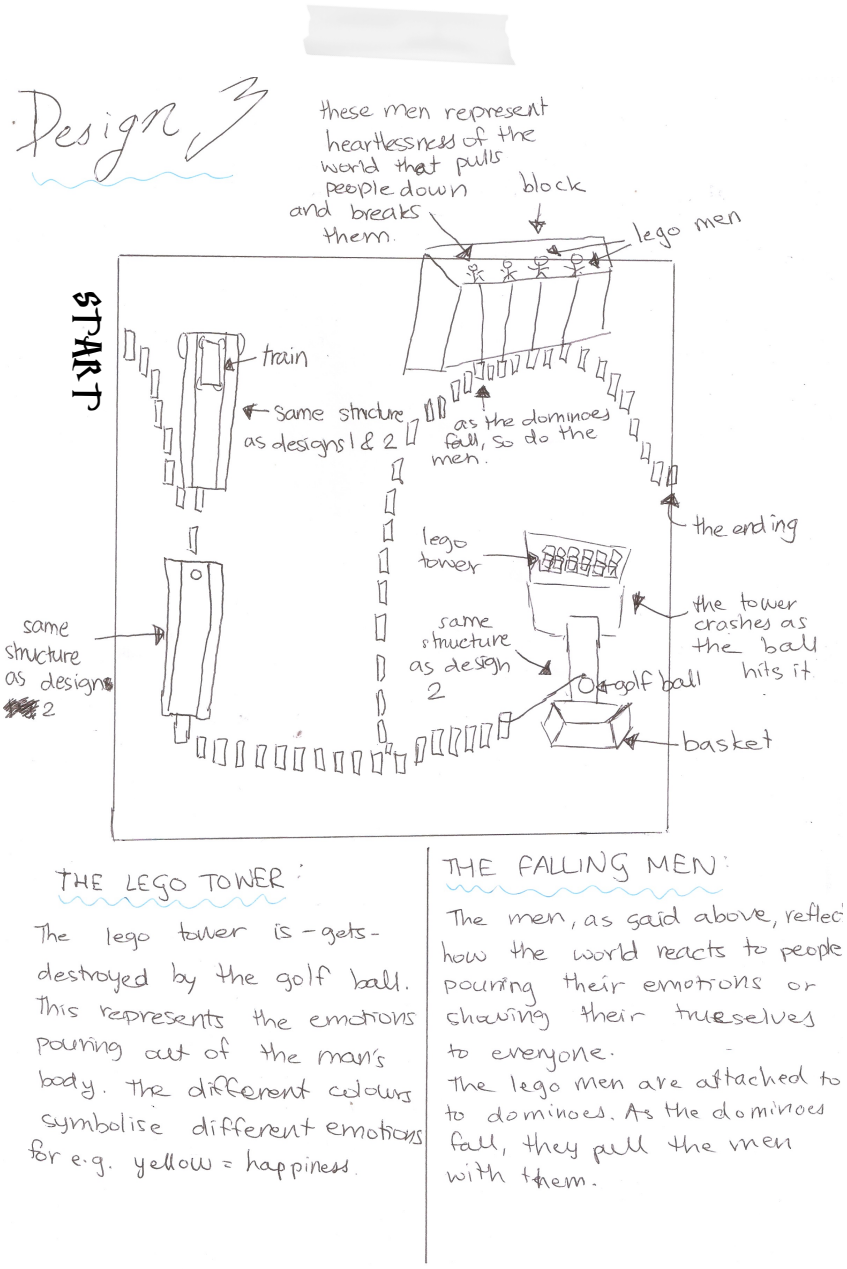


Highlights:

- The train fell the right way triggering the marble to go forward.
- The dominoes worked as planned and also undid the barrier of the golf ball so that it [golf ball] would crash into the books.

Parts that can be used in Design 3:

- The successful parts - the train, the marble, the dominoes and the golfball - can be used in the third design.
- Instead of the books, we could have something different that reflects more of the picture like lego or blocks.
- Most of the really cool machines weren't on the ground. There's more suspense because we aren't sure if it will work or not and the suspense is a good thing.



Errors/Improvements:

A problem that we had was of the train going in another direction and missing the domino in front entirely. To fix this, we taped the cup holding the track on the floor.

Another problem was that the barrier of the golfball wouldn't always remove itself by the domino. We discovered that if there was tension in the string attached to the domino, then the barrier lets the ball through.

Highlights:

The dominoes going in separate ways was one of the highlights because there are two things happening at once.

- The lego tower being destroyed by the golfball is also a highlight because the lego tower is one of the main representations of the picture.
- The falling men are also highlights because the way they are pulled down is very smooth. It is also a representation of the picture.

Our Final Design:

We chose Design 3 as our final design. This design passes all the tests. It also has many representations of the picture (our inspiration) and works properly. The machine is not very complicated and is easy to follow along.

Evaluation

The first specification failed for the first two designs, before we tested and brainstormed for new ideas and machines we would make. We tested it by having people watch our machine and then telling us how many main actions they saw. The first two times failed because the people we asked said we only had one or two. The third one the same people said they saw three and that's why it passed this specification.

In our first design, the second specification wasn't met; there was only one potential energy source. In designs two and three, there were two or more potential energy sources. We improved our designs by adding extra potential energy sources.

There wasn't any problem with the third specification throughout every design test, we always managed to start and end with dominos. This was tested by running through the machine and seeing that it started and ended with dominos every time. It was also tested when we played it with all the other machines.

We met our fourth specification by having materials that were not dominos in every design. We had a variation of train, legos, marbles, string, wood, and play dough in our designs as well. This was tested by making plans and ideas for machines that use materials other than dominos.

Our main idea and motive for this machine was our fifth specification, so most of our original ideas had something to do with the visual stimulus. Although we still had ideas and included things that weren't related to our pictured; such as the ramp and golf ball. We showed a few people our picture of inspiration and our machine and asked them if they saw the similarities reflected.

Our machine could be improved in quite a few areas. For one, in the consistency test we got 3 out of 5. We could improve the consistency when the train comes down the ramp and hits the domino. Quite a few times it wouldn't go straight which means it didn't hit the dominos that push the marble. We could have made a better ramp out of wood instead of future-board, with railings to make sure the train goes straight to the dominos so that it will hit the marble.

Next, there was another ramp where we had a golf ball triggered by a domino with a string attached and playdough at the end which was used to keep the golf ball in place. The golf ball was used

to crash into a wall of legos. It's tricky to make the string pull hard enough to make the playdough move and the ball go, and keep the ball in place before it is triggered. This was the most inconsistent part of the machine. We could have improved it by using something else other than play dough, like a plastic which would move easier. Also, if the string was shorter maybe it would have had a stronger pull on the play dough.

Another problem was the people on the box; sometimes they wouldn't all fall down because the dominos weren't placed near enough to each other and the strings were too loose. So we could have improved this part by being more careful with the domino placing and shortening the length of the string by a few centimetres.

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