Light the City

Sumner-Fredericksburg Team 2

Team Members

Austin Langreck

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Kylie Meyer

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Contest Theme

Power the World

Team Theme

Light the City

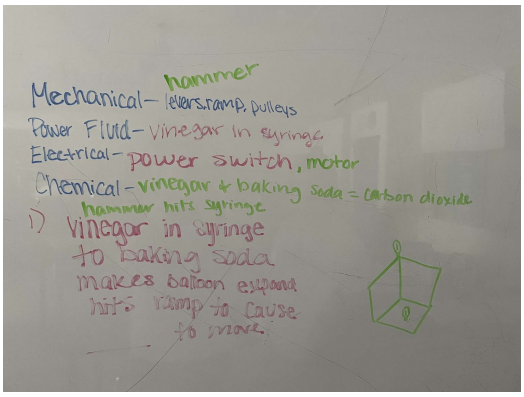
1. Initial Sketch & Description of Machine Design Planned

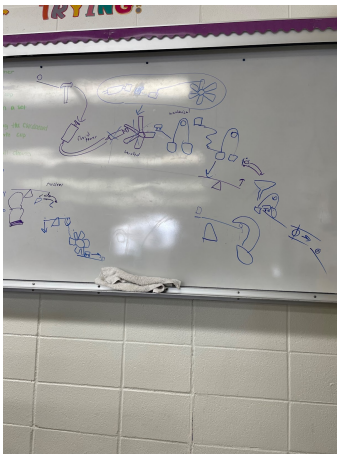
2. Progress Photos

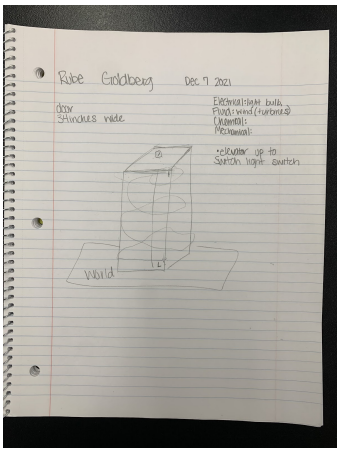
December 7, 2021

- Came up with initial drawing of structure and end goal of lighting a building up.

<u>Initial sketches</u>







December 30, 2021

- Planned out the different powers for each category with initial drawings of the structure.

January 3, 2022

- Gathered recycled materials: 5 Pieces of peg board and various pieces of wood

January 5, 2022

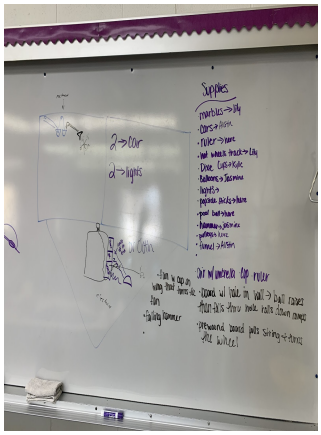
- Painted boards

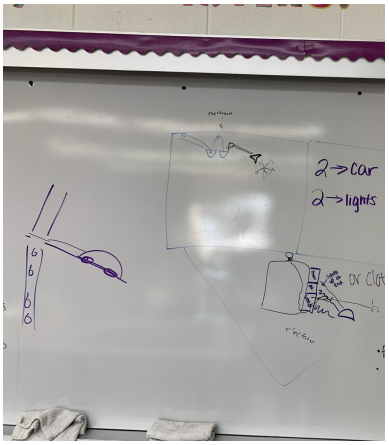
January 6th, 2022

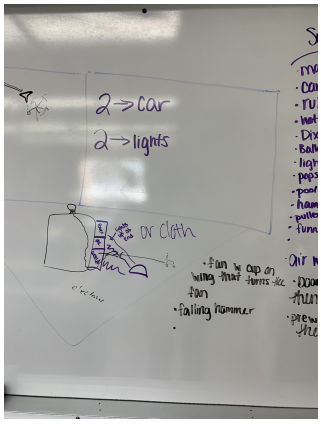
- Screwed the pieces together and screwed wood to our peg wood to raise it from the ground.
- Planned out each individual step.

January 10th, 2022

- Worked on the steps and materials list.
- Discussed different resources and our final goal.







January 11, 2022

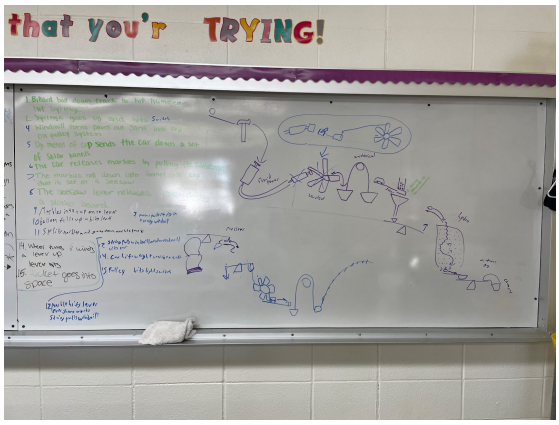
- Worked on step ideas- struggled with electric step.
- Planned on using a car at the end, but we struggled to make this work.

January 12, 2022

- Worked on our electrical step and the final steps for turning the lights on in the building.
- Thought about different ideas for the car: using a button, motor, or different toy.

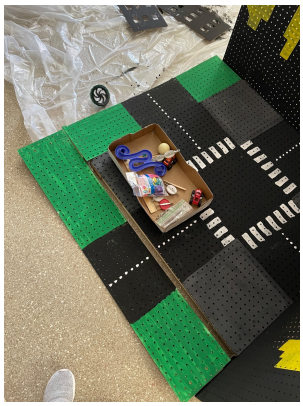
January 13, 2022

- Changed our electrical step to make a windmill turn.
- Filled in the final steps and made a windmill.



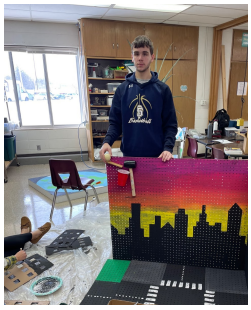
January 17, 2022

- Brought in supplies and bought other supplies.
- Cut out windows in the building and painted it black.
- Painted the road on the side pieces of wood.



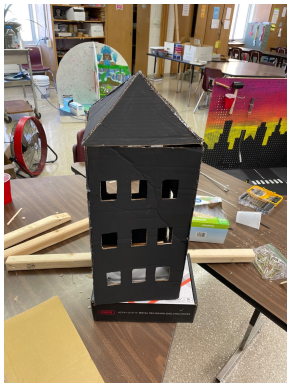
January 18, 2022

- Painted and glued the buildings together.
- Worked on first step of the billiard ball hitting the mallet.



January 19, 2022

- Worked on the lights for most of the class.
- Tried to find a way to press the “try me” button to light the LED string up.



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January 20, 2022

- Solved the problem with lighting up the LED string.
- Cut out, painted, and glued the roof of the building.

January 21, 2022

- Added metal brace to the structure
- Attached a single gang box.

January 24, 2022

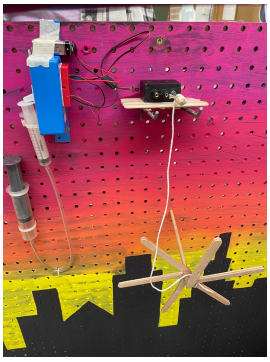
- Counted our steps- we didn’t have enough.
- Returned to planning stage to come up with steps.

January 25, 2022

- Built a brace on the back of the pegboard.
- Built a windmill and pulley and glued the track to the release mechanism.

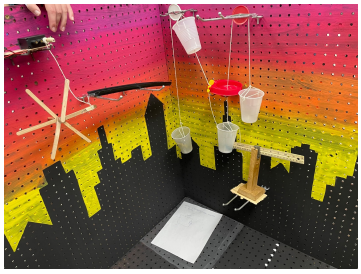
January 27, 2022

- Wired the switch to the motor so string pulls the windmill.



January 28, 2022

- Added the track for the car and set it on pegboard hooks.
- Set up pulley system for the car to fall into as well as the marble funnel.



January 31, 2022

- Added a cup above the lever to knock marbles into a cup which is connected to a pulley. A weight is attached to the pulley which releases a car down a track.

February 1, 2022

- Stuck on our next step because we were low on space on the right side and needed to come up with a way to bring it over to the left side.

February 2, 2022

- Spent time on our chemical step making it consistent.
- Added a track across the machine for a car and set up the last few steps.

February 3, 2022

- Placed the materials for the last steps.
- Put lights inside the building.

February 4, 2022

- Put the final steps together and fixed any small flaws.

3. Written Description & Image of Final Machine Design
and
4. Written & Numbered List of Machine Steps

Storyline

Over time, New York City has been lit up in many different ways. In 1882, it started with coal being hauled into the city and sent out to different buildings to enable them to have electricity. The Niagara River was the next step in generating electricity for the city. Although the use of coal is starting to die down, there are many other forms of generating electricity that are being used. In 2015, almost half of the electricity in the state of New York was produced by natural gas plants. A third of it was produced by nuclear energy. There is still close to 20% of the state's energy that comes from hydroelectric power. As of now, not very much of the state's

energy comes from renewable sources such as wind and solar. These are the different types of plants and sources that power the great city of New York.

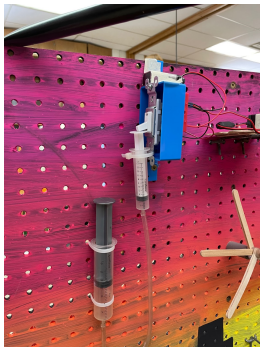
In our Rube Goldberg, we illustrated these six different types of energy sources. In **step 3**, we have a windmill which represents the wind power. In **step 5**, a car runs down a ramp that is designed to look like solar panels. **Step 6** shows the coal that we use. The black marbles are in a marble track that go into a cup connected to a pulley once they are released. **Step 6** also represents hydroelectric power. Blue marbles, which is the water, are dumped down into a funnel similar to a waterfall like Niagara Falls. **Step 8** represents our nuclear power. To create nuclear power, the energy must be released from the atoms by splitting them. In step 8, our balloon releases air when it is popped which represents the energy released from the atoms. In **step 10**, natural gas is represented by our chemical reaction. The balloon fills up with carbon dioxide by mixing vinegar and baking soda. The element of carbon is found in many natural gasses, including methane which may be the most abundant organic compound on Earth.

There are many different ways for energy to be produced. Only time will tell how the world will change even more and what our main source of power will be in the future and how we will continue to light the cities of the world.

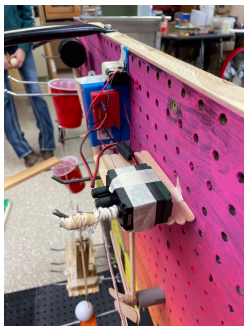
Complete List of Steps

1. Billiard ball is placed by a student and goes down wood track to hit mallet

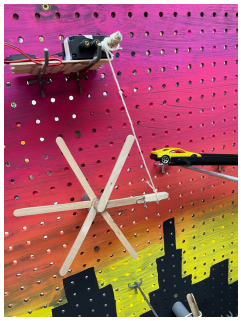
2. Mallet swings down and hits syringe which pushes the air through the connected tube to make the other syringe end go up and hit switch **(fluid power step)**



3. Switch turns the motor on. There is a metal rod with a string on it that is attached to a windmill. Once the motor turns on, it twists the string to pull the windmill up. **(electrical step)**

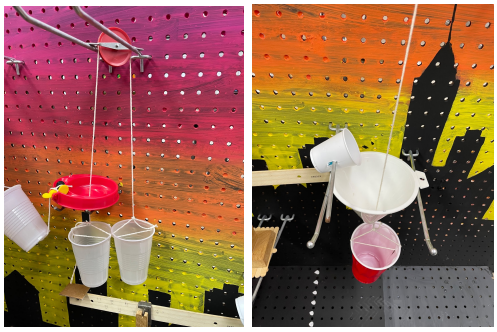


4. Windmill turns and hits car release

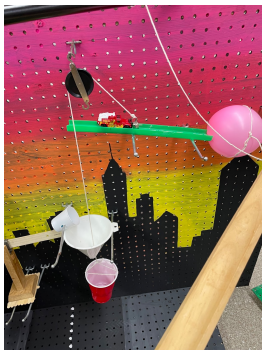


5. Car goes into cup on pulley and releases marbles set on marble track **(mechanical step)**

6. Marbles go down track into a cup connected with a pulley system which goes down a lever and releases marbles down the funnel into a cup.



7. The cup pulls a string which pulls up a weight which releases a car down a track.

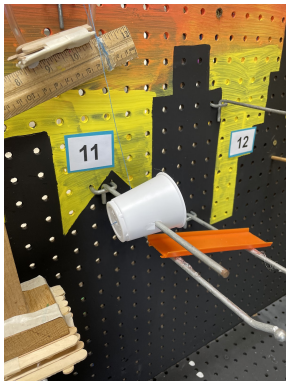


8. The car has a tack glued to it and pops a balloon at the bottom of the track

9. The balloon releases marbles which goes down a track and falls into a cup on a lever

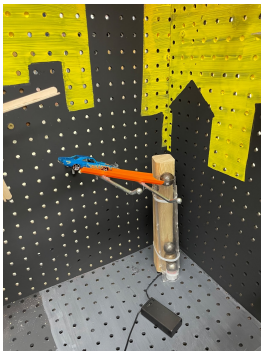
10. The lever lifts balloon up which allows the baking soda to mix with the vinegar which fills up the balloon with carbon dioxide **(chemical step)**

11. The balloon hits a first class lever which pulls a string attached to a cup.



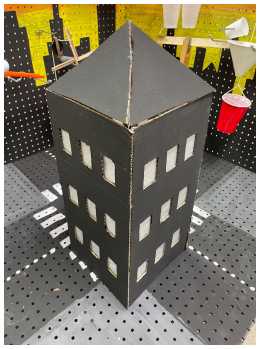
12. The marbles go into a cup on a pulley system. The other string pulls a windmill.

13. The windmill hits a car which goes down a track



14. The car hits a weighted marble that goes into a tube

15. The marbles turn on the lights that light up the building



5. Cost of Machine & Percent of Recycled Materials Used

Item	Quantity	Origin	Price
LED lights	1	Purchased	$5.35
Paint	6	*Repurposed*	$0
Peg wood	5	*Recycled*	$0
Toy cars	2	*Repurposed*	$0
Syringes	2	*Recycled*	$0
Tubing	1	*Recycled*	$0
Mallet	1	Purchased	$4.28
Wooden ramp	1	*Recycled*	$0
Billiard ball	1	*Recycled*	$0
Popsicle sticks	1	*Repurposed*	$0
Cups	9	*Repurposed*	$0
String	1	*Repurposed*	$0
Tube	1	*Recycled*	$0
Funnel	1	*Recycled*	$0
Ruler	4	*Recycled*	$0
Marbles	1	*Repurposed*	$0
Dowels	1	*Repurposed*	$0
Balloons	1	Purchased	$1.07
Baking soda	1	*Repurposed*	$0
Vinegar	1	*Repurposed*	$0
Pulleys	5	*Repurposed*	$0
Motor	1	*Repurposed*	$0
Weighted marbles	4	*Repurposed*	$0
Batteries-9V	1	*Repurposed*	$0
Nails	1	*Repurposed*	$0

Light switch	1	Purchased	$0.65
Single gang box	1	Purchased	$1.80
Rubber bands	2	*Repurposed*	$0
Golf ball	1	*Repurposed*	$0
Cable Ties	1	*Repurposed*	$0
Tack	1	*Repurposed*	$0
Paper clips	1	*Repurposed*	$0
Marble track	1	*Repurposed*	$0
Hot wheels tracks	3	*Repurposed*	$0
Cardboard	1	*Recycled*	$0

Total Cost: $13.15
Percent recycled: 62/67 =**92.5%**

6. Major Success & Challenges

Successes

- Design Planning
    - We spent many class periods planning our steps out and how to incorporate them into the theme. This helped us when it came time to build the steps because we all knew exactly what we were doing.

- Car with Tack
    - We were stuck on step 8 which was supposed to be a wheel with a dowel through it which rolled down a track. This idea was hard to make work with the room we had, so we changed our idea to adding a tack to the car that goes down the track to pop a balloon.

- Fluid Power Step
    - We were able to be creative with connecting our electrical step and fluid power step by having the plunger of the syringe flip the switch. We also came up with using a mallet for hitting the plunger because it would have more kinetic energy and a larger surface area than a hammer.

Challenges

- Electrical Step
    - Our initial plan was to have a car be our electrical step at the end, and it would turn on the lights for our building. We had a hard time figuring out how we could make this work. We thought through different ideas and ways that this could be accomplished. We ended up moving our electrical step to a different part of the Rube, the windmill step, in order to make it work better.

- Steps
    - One challenge we encountered was making sure that we had enough steps. Originally we thought we had 16 steps but realized that we only had 11 when we went through and clarified what was truly a step. We had to brainstorm again and find ways to add more steps throughout the machine.

- Lighting up the Building
    - We had difficulties coming up with an idea to light up the building at the end. We originally wanted to have an electric car flip a switch to turn the lights on. We had trouble figuring out how this would realistically work. By using the engineering design process, we brainstormed and came up with new ideas that would work better. We ended up deciding on using a button placed at the bottom of a plastic tube to be pressed by weighted marbles.

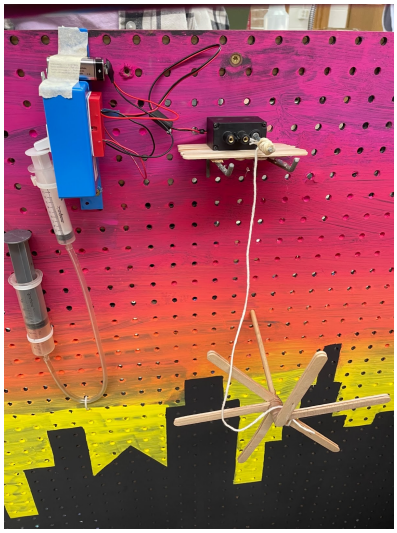
7. Written/Visual Documentation of Advanced Components

Electrical Steps

- The plunger of the syringe hits a light switch which turns on a motor. The motor rotates a rod which pulls a string attached to the windmill. This allows the windmill to turn. The closed circuit with the switch and the motor allows the current to flow through the series circuit.
    - 9 V battery

Ask: how will we move the windmill
Imagine: we could use a motor
Plan: use a motor, rod, and string
Create: we built the windmill
Improve: we used a rubber band for more friction for the string to wind around the rod

- Weighted marbles fall on the button which turns on the lights inside the building.
    - Try Me button in lights-3V CR2016 Lithium Battery X2

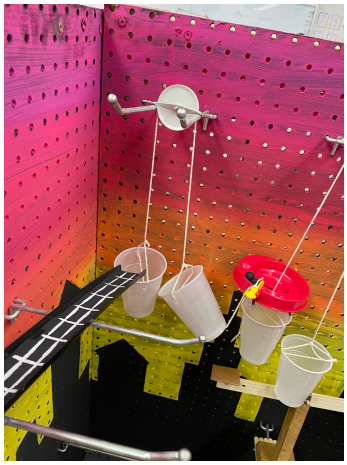


Total Volts in Machine: 2 3V batteries & 1 9V battery

Mechanical Step

- The fixed pulley has two cups tied to the end of the string, so they are balanced. A car goes down a track into one of the cups. This causes the other cup to go up. It has a string attached to the stopper of the marble track. Once the cup goes up, it pulls on the stopper and releases marbles.

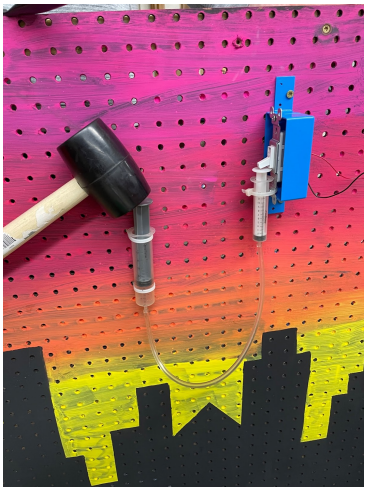
Ask: how will we release the marbles
Imagine: we could use a pulley
Plan: we can have cups attached to the stopper
Create: we built the structure
Improve: we shortened the pulley so it worked better.



Fluid Power Step

- The rubber mallet hits the top of the first syringe. The plunger is set on 10mL and is connected to another syringe through tubing. The fluid we used is air. Once the mallet hits the syringe, it pushes the air through and the other plunger comes out, hitting the light switch.

Ask: how will we activate the light switch
Imagine: we can use fluid power
Plan: use a hammer to set off the syringes
Create: we set up the syringes
Improve: we added more air for more force



Chemical Reaction Step

- There is a balloon with baking soda in it. It is laying on a first-class lever which lifts up the balloon when hit on the opposite side. The balloon is attached to a cup with vinegar in it. Once the balloon is lifted, the baking soda mixes with the vinegar to have a product of carbon dioxide.

Reactants:

- $NaHCO_3$ (baking soda)
- CH_3COOH (vinegar)

Products:

- CO_2 (carbon dioxide)
- H_2O (water)
- $NaC_2H_3O_2$ (sodium acetate)

Balanced Equation: $NaHCO_3$ (*s*) + CH_3COOH(*l*) ⟶ CO_2 (*g*) + H_2O (*l*) + $NaC_2H_3O_2$ (*aq*)

Ask: how can we fill up a balloon
Imagine: we could use vinegar and baking soda
Plan: have the balloon empty into bottle with vinegar
Create: we put together and tested the reaction
Improve: we put cardboard at the end of the ruler for a bigger target for the balloon

8. Reflections

LILY: I learned to work well with others, be patient, and always be thinking of new ideas. This project required me to work with people for a common goal, just like I will in the workplace. The skills I learned will help me in the medical field when I encounter problems and need to find solutions.

AUSTIN: The most important thing I learned was organization. We planned everything out prior to action which helped us stay on track but also allowed everyone to know what the plan was for the day. This will help me in my career as an accountant to stay organized and focused.

KYLIE: The most important thing that I learned was to adjust. We planned all of our steps out and many of them we had to change. We had to adjust to what would be the best for our Rube and learn how to find a solution when our first or second try doesn't work. I will use this in my future career as a teacher when my first plans don't work to persevere to try to find a solution.

JASMINE: I learned to work as a team with others. Problem-solving was a big part because not everything always works out as you want it to and knowing how to adapt to different things is important. This will help me when becoming a vet because you need to know how to solve problems and not only listen to what you think is right but listen to what the person coming in needs.

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