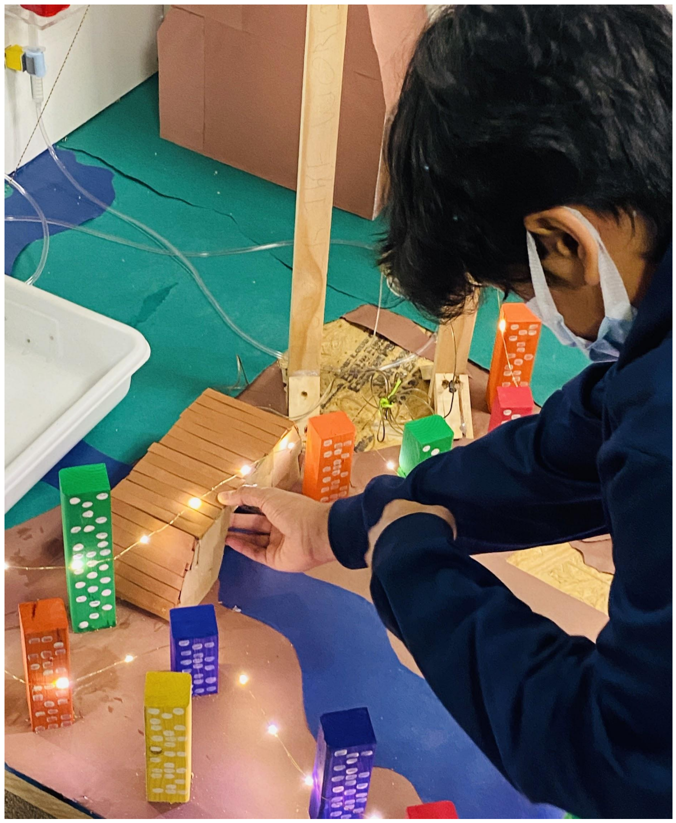
Eisenhower Team Gold



Team Roster

Beyer, Hailey	11	Nickerson, Claire	11
Liang, Eliska	11	Pankowski, Addison	8
Loomer, Lexi	11	Pankowski, Ava	12
Markum, Rheyanna	9	Sesham, Jalesh	9
Marshalek, Andrew	12	Siddiqui, Wajid	9

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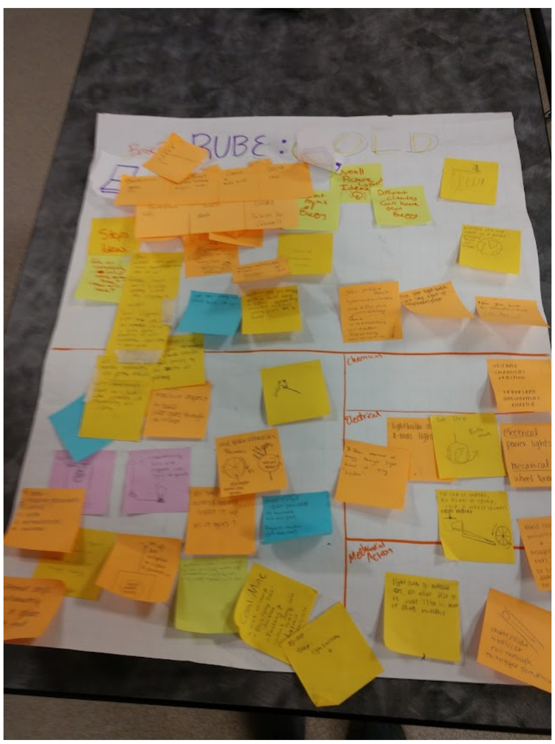
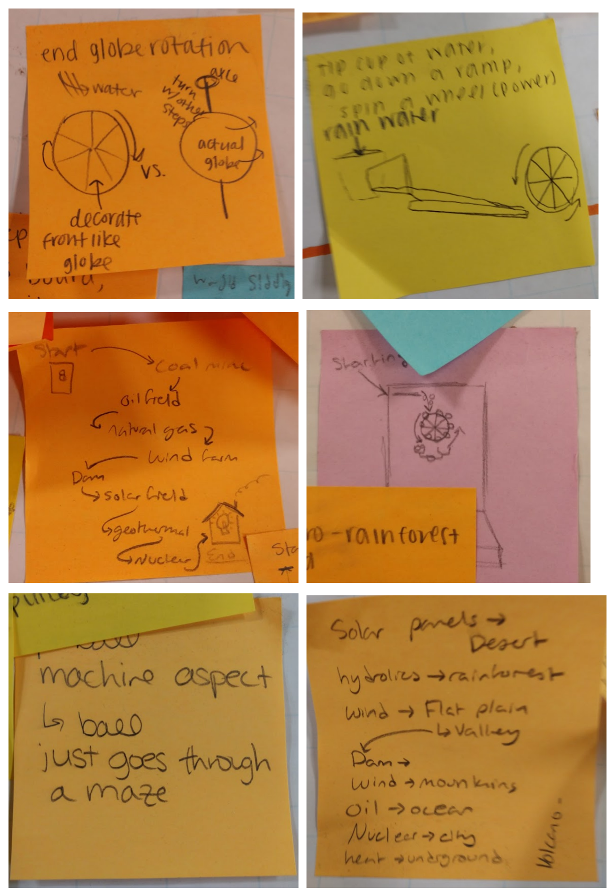
Initial Sketch and Description of Machine Design Planned

Our team was most excited about the building process, though there was much to do on the planning end. We fell into the process of brainstorming different ideas through the use of a giant poster paper with sticky notes contributed by each team member. With ideas all over the map in terms of complexity, durability, reliability, and functionality, narrowing down our horizons was left on what fit best with our chosen storyline. The initial storyline for our team, and the storyline ultimately chosen, was to bring together as many forms of energy production as possible. This includes, but is not limited to, coal, solar, hydro, and nuclear power. We knew that we needed to include wind power as well in some way and initially were planning on using a fan. The fan did not end up working out, so we added handmade windmills instead as some more decoration and representation in our piece.

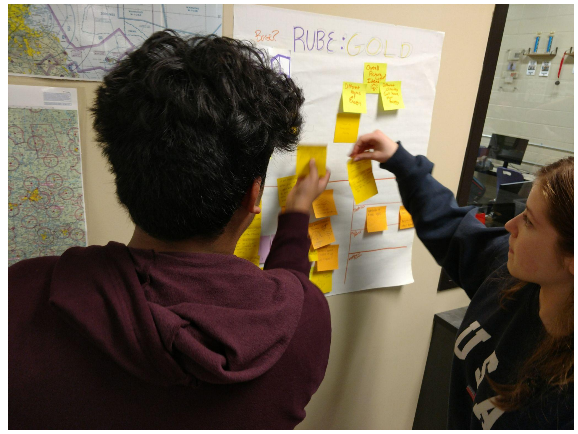
IDEA BOARD

This is where we kept all of our ideas. We moved the notes around as we worked through which steps we were working on.





Progress Photos

 Define the problem & Generate concepts	 Generate concepts & Develop the solution
 Building the frame of the system	 Building and Testing the steps
 Building and Testing the steps	 Final touches

Written Description and Image of Final Machine Design

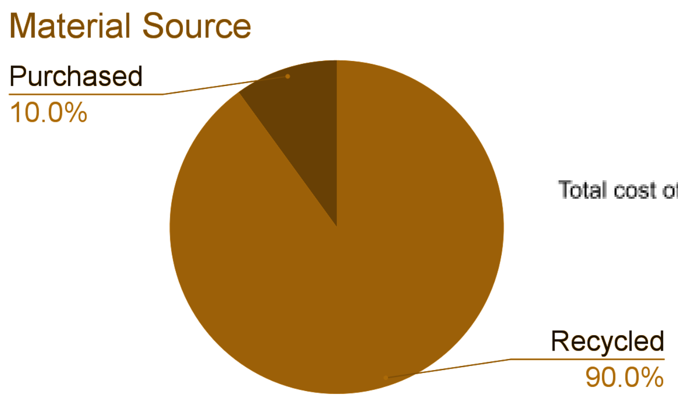
Our machine starts out with the flip of a switch which leads us to the coal mines. In the coal mines there is water* build up--small marbles-- blocking the path of the coal truck which needs to be cleared. Once the switch is flipped, it activates a motor which lifts the barrier blocking the water* from flowing down the ramp and clearing the pathway for the truck. The water* then clears out of the coal mine and enters a tropical rain forest in which the water* enters a waterfall. The marbles drop down a plinko board system which collects at the end of the waterfall into a small cup. The weight collected from the gathering marbles pushes water through our fluid power system stream which sets off a button that opens a valve allowing water to enter a small lagoon with a water wheel. When the water pushes against the water wheel the turning action causes vibrations to run through the ground which causes the volcano to become agitated and erupt. Sitting in their car watching the view are Dave and Daisy. Dave and Daisy notice the eruption and speed off to escape the flying Debris. On their way back to the city they pass the bustling wind farms and powerplant. All of these energy sources work together to bring power to our beautiful planet.

*blue marbles


List of Machine Steps

1. Operator flips the light switch
2. **Electricity flows to turn fan** **Advanced - electricity
3. String wraps around the axle to lift a gate
4. Marbles are released down a track into a cup
5. **Cup pushes syringe creating a transfer of hydraulic power** **Advanced - fluid power
6. Syringe pushes a push-button
7. Electricity flows turning a motor on the cap spins loose
8. Water flows down an inclined plane
9. Water turns water wheel
10. String wraps around wheel
11. String goes around a pulley to change direction and lifts balloon releasing baking soda
12. **A chemical reaction between baking soda and vinegar occurs expanding a balloon** **Advanced - chemical reaction
13. **Balloon lifts second class lever** **Advanced - mechanical component
14. Car rolls down a ramp
15. Car falls into cup lifting lever
16. Lever creates an electrical circuit
17. Electrical circuit makes globe spin and lights turn on

Cost of Machine and Percent of Recycled Materials Used



Total cost of machine: $104

Itemized Material List			
Item	**Purchased or Recycled**	**Item**	**Purchased or Recycled**
2x4 pine wood	R	Push button	R
Screws	P-$21	Electric board	R
½” chipboard	P-$12	Soda bottles	R
⅛” hardboard	P-$11	Metal support beams	R
Paint	P-$15	Plastic tub	R
9v batteries	P-$10	Water wheel kit	R
Electric box & light switch	R	Paracord	R
Wires	R	Clothing clip	R
Motors	R	Vinegar	R
String	R	Baking soda	R
White plastic	R	Toy car and track	R

½” Wood MDF	R	Cardboard	R
Marbles	R	Large funnel	R
Plexiglass	R	Insulation foam	R
Corks	R	weights	R
Dowels	R	Tin foil	R
Solo cup	R	1 ½ x ¾ wood	R
Foam pad	R	Newspaper and glue	R
Syringe	R	Paint	P-$8
Tube	R	Colored paper	P-$5
Hot glue	P-$15	Lights	R
Colored felt	P-$2	Corrugated plastic	P-$5

Major Successes and Challenges

Pascal's Law is our friend:

The biggest problem we faced while designing the hydraulic power step was having our syringe slightly off each day. At first we would fill up the syringe to be completely full then attach it to the tube and other syringe to form the hydraulic power step. At first we had the ratio set to 1:1. Then we changed the ratio so we were sending from a small syringe to a large syringe. Throughout all of our different syringe testings we realized that the air pockets inside the tube were throwing off our hydraulic step. Because of this, each day when we set it up, we made sure to fill one syringe and tube completely with water and attach them to the completely air free second syringe. This allowed us to avoid air pocket problems. Pascal's Law allows for us to lift more weight with a smaller input force. It uses a multiplication of forces. This can only be done with hydraulics—an example of this is when you use a hydraulic lift to lift a car.

Marbles everywhere:

During the beginning of building the machine, we had created a ledge that connects to a homemade Plinko board. As we were designing our Plinko board, we had been able to effectively create a design that was unique as well as functional that was able to connect to the steps before and after. The Plinko board's design was able to hold onto the marbles throughout the course of them passing through it.

On the other hand, we were faced with some challenges. First, when we set off the marbles, the marbles were moving at a speed where most of the marbles would miss going into the Plinko board and flying into other areas of our machine. To fix this, we cut plexiglass and made a cover and slope to guide them so if the marbles passed the board, they would roll back and then fall into it. Another problem we faced was at the bottom of the Plinko board, as when it was going into a cup for our next step, not all of the marbles had gone into the cup. The solution for this was to add more guides around the cup so the marbles would hit the guides and fall back into the cup for the next part to start.

Not enough connection:

For our final step, we wanted to lift a lever to complete an electrical circuit so that a globe would spin and lights would turn on. This would connect all our steps to "power the world." The first few times we tried this step, we had problems where the electrical circuit would not complete (the globe would not spin, and the lights would not turn on) or the circuit would not effectively complete (the globe would spin sporadically, and the lights would flash instead of turning on).

To fix this problem, we tried many different solutions. First, we added more layers of tin foil so that our trials would not wear down the tin foil, making it ineffective. Second, we used less tape to hold the wire in place to the tin foil. We made sure it was still secure but more of the wire was exposed to create that connection. To further increase exposure, we also stripped back the wire so that more of the wire was in direct contact with the tin foil.

Divide and Conquer:

During the planning process for the machine. We were brainstorming possible steps. For example one of the team members had thought of a nuclear reactor step, another had brainstormed a volcano for the chemical reaction step. After we had thought of all the steps for the machine we ran into a problem. We wondered who would do each step. In the end, it was decided that the person who came up with the step would do it. For example, the person that brainstormed the volcano step would complete the volcano.

However, this led to multiple other problems: The first was that there were some people who weren't present on that day or whose steps were not chosen. Another was that some steps were grouped together and because of that, it was too complicated for one person even if just one person initially came up with it. To fix these issues our team leader had the people who weren't there assigned to a step to work with someone. And the other people chose to work with people on the complicated steps.

This process of step selection contributed substantially to the efficient construction of the machine. Because mostly everyone got a step they were already thinking of and had some of it planned out due to those people coming up with it. It meant they could implement and complete the step faster. Also because most people got to choose it was more enjoyable to complete the process. When objectives are more enjoyable to complete, they are finished quicker and are of a higher quality.

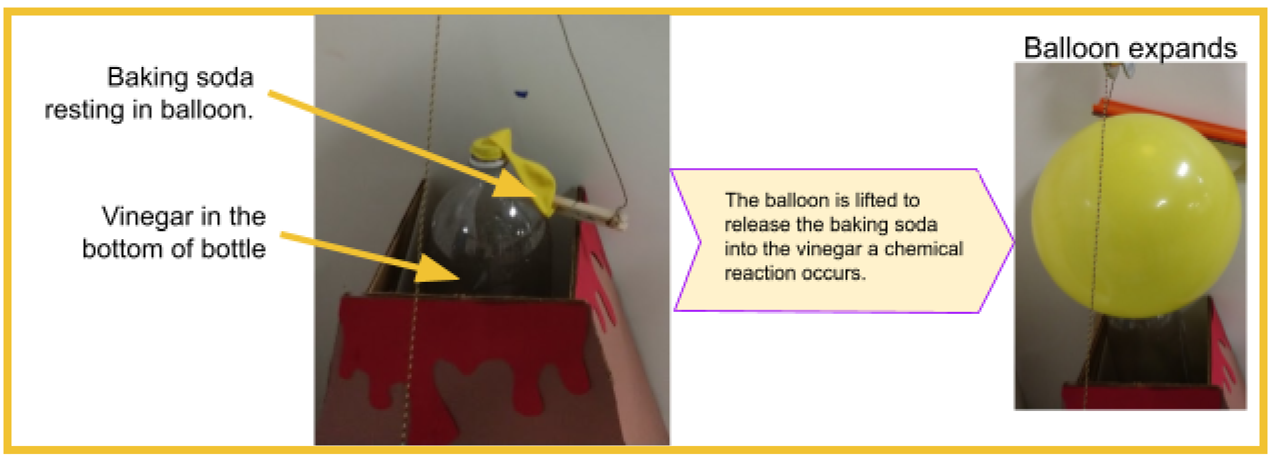
Advanced Components

Chemical Reaction

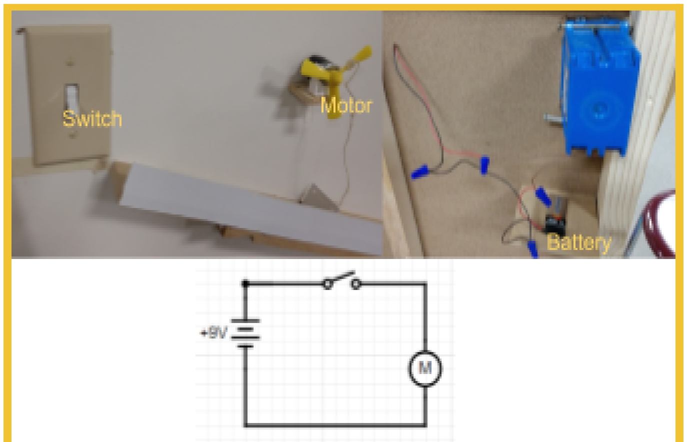
For the chemical reaction step, we combine vinegar and baking soda to produce carbon dioxide, which then allows the balloon to inflate.

Before we start the machine, we pour vinegar into an empty soda bottle and baking soda into an empty balloon. We then attach a clothespin to the balloon, which is connected by string to the water mill, which is the previous step. As water turns the water mill, the string wraps around it, making the string tighter and raising the balloon. As the balloon is lifted, baking soda falls down the bottle, creating the chemical reaction between vinegar and baking soda. The end result is the balloon inflating and knocking a car down a ramp for the next step.

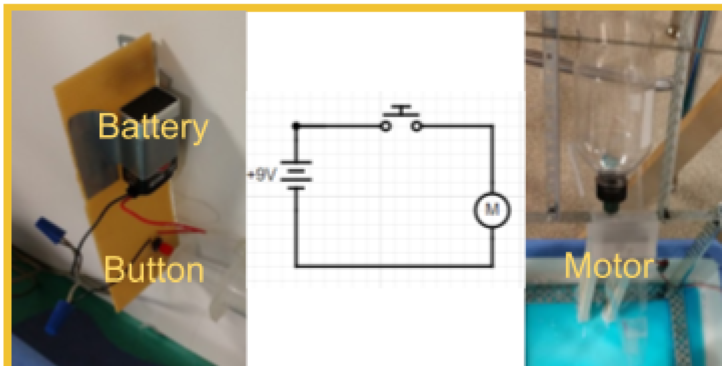
Chemical Reaction Equation:
$NaHCO_3(s) + CH_3COOH(l) \longrightarrow CO_2(g) + H_2O(l) + Na^+(aq) + CH_3COOH^-(aq)$
Sodium Bicarbonate + Acetic Acid ⟶ carbon dioxide + water + sodium ion + acetate ion



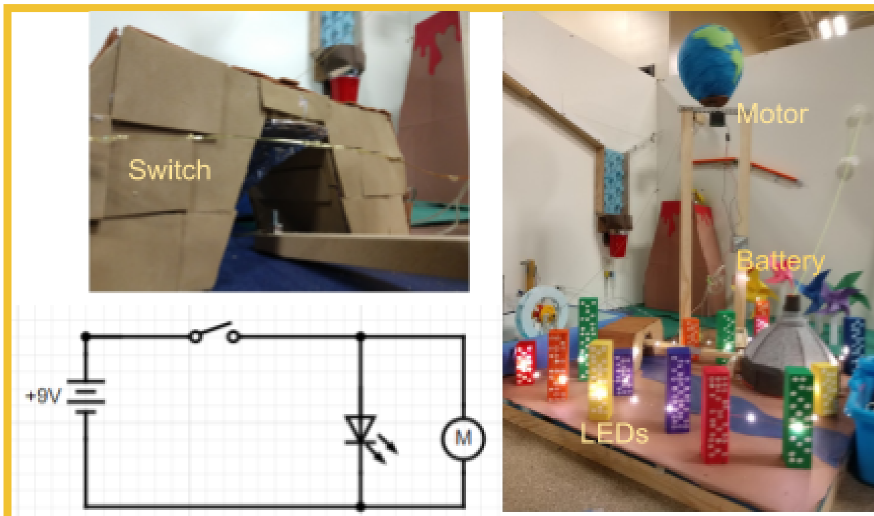
Electrical Steps



When the switch is turned on, the the motor is spun, releasing the marbles. The switch is connected to the battery and motor, so when the switch is turned on, the circuit gets completed.

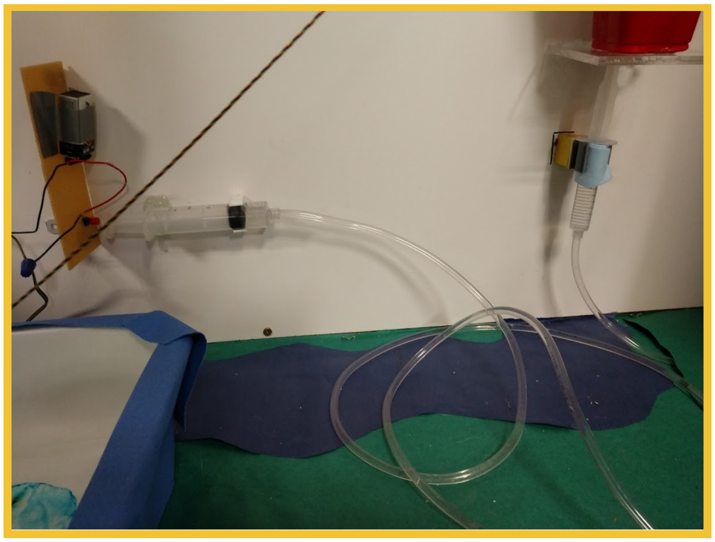


When the syringe presses against the button, the circuit gets completed and spins the motor, releasing the water.



After the cup is knocked down to let the weight lift the lever, the lever touches the bridge, then the motor and lights turn on. At the end of the lever, there is a metal piece which is connected to the motor, LED, and battery circuit wire. Under the bridge is tin foil connected to the other circuit wire, so when the lever touches the bottom of the bridge, the circuit will be completed.

Fluid Power



Pascal's Formula

$$P = \frac{F}{A}, \; P_1 = P_2$$

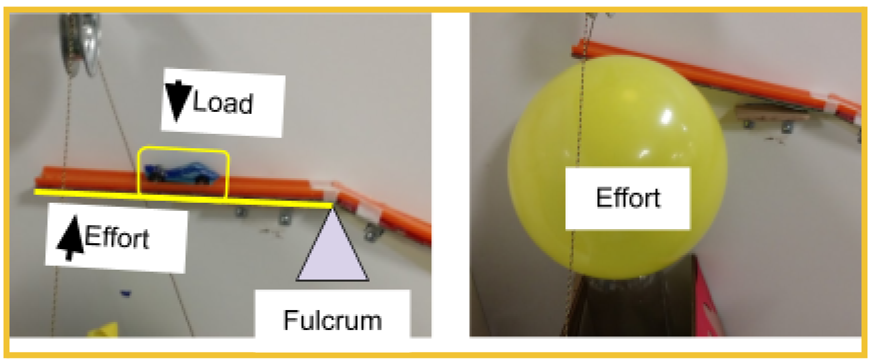
$$\frac{500g}{0.5in} = \frac{F}{0.75in} = F_2 = 750g$$

Hydraulic Power (Also known as Fluid Power) is the action in which to use force by moving pressurized liquid through controlled circulation. The liquid used is most commonly water, water-soluble oil, or water-glucose solution which is given to a motor/machine which turns it into a highly strong mechanical force which can lift/move very heavy loads. For example, Gasoline Pumps. They use hydraulics to pull them from the vehicle's storage tank. Our hydraulic power part is steps five and six of our machine. In the previous step when the marbles drop into our plastic cup (Step four), the weight of the marbles falling in the cup causes our small syringe to push down, flowing the water through the tube into the partnering bigger syringe. This causes the secondary bigger syringe to extend out, pushing a button which activates our fan and leads the way into the rest of the steps. The marbles are just enough weight to trigger our hydraulics because since our first syringe is smaller than the second, less weight is needed from the marbles. More movement from the smaller syringe causes the bigger syringe to move just enough to trigger our fan.

Mechanical Action

Lever:
The ramp for the car is a second class lever. The fulcrum is at the far right end, and the resistance/load (the car) sits at the left end, above the balloon. As the balloon inflates from the chemical reaction, it rises up and acts as the effort to push up on the lever, tipping it up so that the car rolls down the ramp.

IMA = D(effort) / D(resistance)
The car (resistance) is placed almost directly above the balloon (effort) so the mechanical advantage is approximately 1.



Pulley:
The string that lifts the balloon works on a fixed pulley. The pulley is fixed in place on the board and as the string winds around the water mill from the previous step (force), it lifts the clothespin holding the balloon (resistance), releasing the baking soda ($NaCHO_3$) into the volcano filled with vinegar (CH_3COOH) and causing the chemical reaction.

IMA of fixed pulley = 1

Reflections of Entire Process

The past few months, as we have worked together as a team to build this machine, we have learned so much, not only as a team but also as individuals. As a team, we have learned collaboration, communication, and creativity. There have been multiple instances where our first, second, third, and even fourth try had not worked the way we wanted. Yet, we persevered and problem-solved to come up with new solutions. As individuals, we have learned different engineering skills from applying the engineering design process to using different tools for our builds.

What we have learned during this entire process will benefit all of us in some way, helping us prepare for the future. Even for the team members who do not plan on becoming engineers, they learned different life skills, such as team work and time management, that will help them succeed later. For members who want to become engineers, this experience has been particularly beneficial in not only learning these life skills but also learning engineering-specific skills, such as using the engineering design process and different techniques to make machines run smoother.

<u>**Document Word Count**</u>