Eisenhower Team Purple

Jayden Hanson	12
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Lucas Anderson	9

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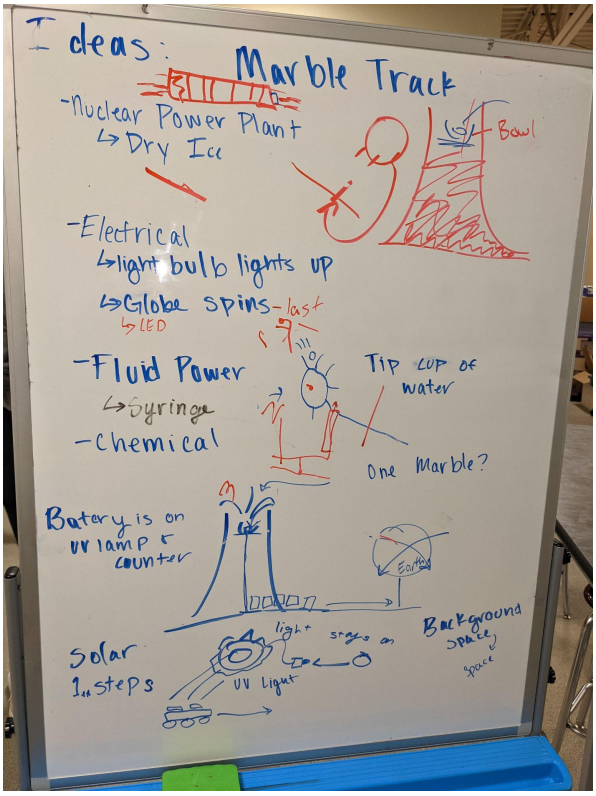
Initial Sketch & Description of Machine Design Planned

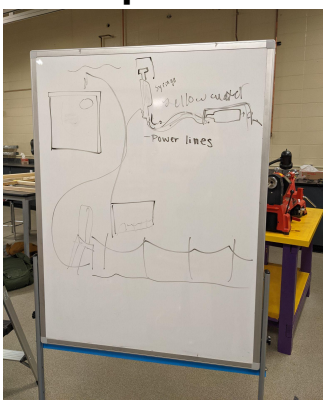
Initial Sketch



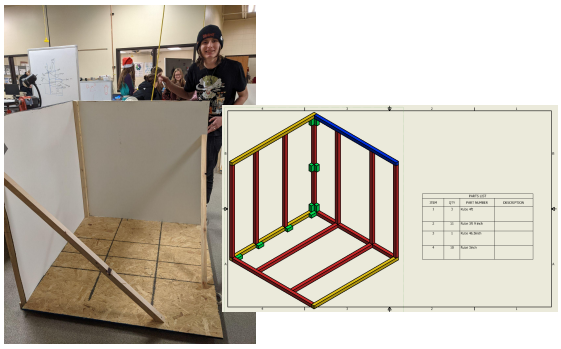
Initial Description

Our team started the design process by clearly defining the problem. We review the theme *Power the World* and made ideas for our machine. We started with big items. We want to have a nuclear power plant, a water wheel, and a globe. We discussed how we could ensure we include all the advanced steps. We then started building a strong base and had others start building the steps.

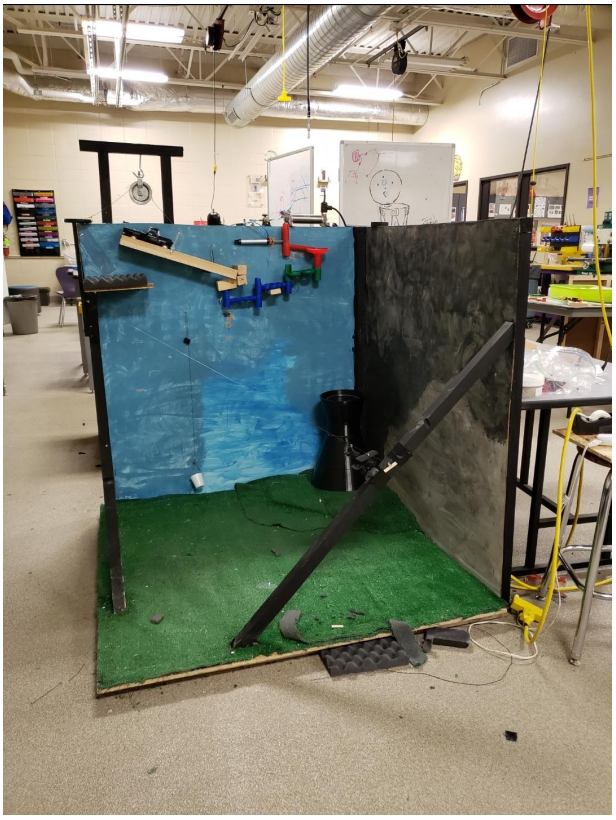
Advance Steps Initial Sketch



Initial Base Design and Build



Progress Photos



The Design Process

1. **Define the problem**
    - Investigate stakeholder needs
    - Justify the problem- is it worth solving
    - Identify design criteria and constraints
2. **Generate concepts**
    - Research prior solutions
    - Brainstorm Possible solutions
    - Select an approach
3. **Develop the solution**
    - Create a detailed design solution
    - Justify the solution path
4. **Construct and test**
    - Develop a working model
    - Plan and complete testing
    - Collect and analyze data
5. **Evaluate solution**
    - Evaluate solution effectiveness
    - Reflect on the design and recommend improvements
    - Optimize the solution
6. **Present Solution**
    - Finalize documentation of the project
    - Communicate the project

Written Description and Image of Final Machine Design

Right in front of your eyes today, a new city is being built. As you watch our machine, you will see the shipment come in from the truck all the way to the city being lit up. Once the weight is pulled you will see too, a new city.

The machine starts with a 1.25 kilogram weight dropping to release a plexiglass barrier. Without the barrier, a toy truck will roll down a ramp and run over a limit switch triggering a pneumatic system. The pneumatic system is connected to a piston, which releases marbles that roll down a marble track into a cup that falls with the added weight. The falling cup pulls out a dowel that allows a plane to travel down a zip line. Following the plane, it crashes into a weighted car that rolls down a hot wheel track, into a red solo cup. The cup falls, tipping over a glass beaker filled with about 30 mL of acetone. Acetone pours out of the beaker into a styrofoam cup containing a 1 kilogram weight. The cup melts, letting the weight fall into a cup that is connected to a fluid power syringe. As the syringe falls, a crane that holds a lego tower is lowered. The tower hits a lever covered in tin foil which completes the circuit connected to a bubble machine and lights up ‘the city’.

Machine Steps

1. Operator drops the weight pulling string
2. **String runs through the pulley changing the direction of pull ADVANCED STEP: MECHANICAL**
3. Gate lifts and releases truck down inclined plane
4. Truck presses the limit switch
5. **Electricity activates solenoid ADVANCED STEP: ELECTRICITY**
6. **Pneumatic piston pulls back releasing marbles ADVANCED STEP: FLUID POWER**
7. Marbles roll down inclined planes
8. Marbles fall into cup release pin
9. Airplane slides down the zipline knocking the car
10. Car rolls down the inclined plane into a cup
11. A string wraps around pulleys to change direction of power rotating a beaker
12. Beaker pours acetone into styrofoam cup
13. **A chemical reaction occurs between styrofoam and acid ADVANCED STEP: CHEMICAL REACTION**
14. The cup disintegrates dropping a weight
15. **The weight activates a hydraulic power transfer ADVANCED STEP: FLUID POWER**
16. **Hydraulics lowers tower onto lever ADVANCED STEP: MECHANICAL**
17. **Lever completes electrical circuit ADVANCED STEP: ELECTRICITY**
18. The city lights up and the nuclear power plant activates!

Cost of Machine & Percent of Recycled Materials

Throughout planning and building we made it a goal to use recycled materials. An estimated **75%** of the machine was recycled items. The total cost of bought and donated items was **$134.95.** See the itemized list below of all materials used on the machine.

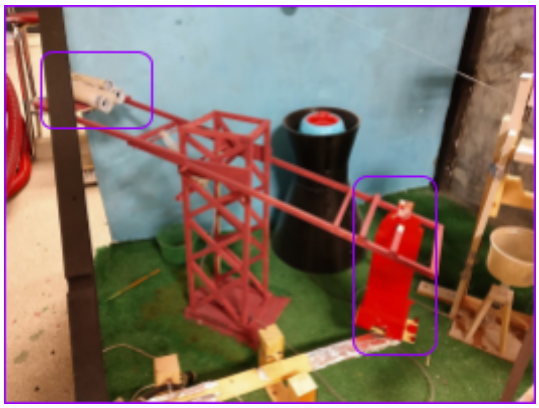
Quantity	Material	Procurement Source	Cost	Part of the machine
12	Wood 2X4	Recycled		Base
1	Particle board	Bought	20.00	Base
100	Screws	Bought	10.00	Base
50	Nails	Bought	5.00	Base
16^2 FT	Turf	Recycled		Base
10	Acrylic Paint	Donated	15.00	Base
1	Insulation foam	Recycled		Base
1	Sheet of clear acrylic	Recycled		Base
75	Hot glue sticks	Bought	35.00	
1	Plywood 1' x 1'	Recycled		Gate
1	Weight 1.25 Pound	Recycled		Gate
1	Soundproof foam 2x2	Recycled		Gate
3	Micro cord by foot	Recycled	0.50	Gate
1	Pully	Recycled		Gate
1x1 FT	Plexiglass	Donated	5.00	Gate
1	Wood track	Recycled		Gate
1	Model truck	Recycled		Truck
20	Rocks	Recycled		Truck
1	Wire	Recycled		Truck
1	Limit switch	Recycled		Truck
2	9v batteries	Bought	2.50	Truck
1	Selemoid	Recycled		Pneumatics
1	Reservoir	Recycled		Pneumatics
1	Regulator	Recycled		Pneumatics
1	3 way shut off	Recycled		Pneumatics
1	Linear actuator	Recycled		Pneumatics

Quantity	Material	Procurement Source	Cost	Part of the machine
3	Steel Marbles	Recycled		Marble
4	Marble track	Recycled		Marble
1	Paper cup	Donated	0.10	Marble
4	Fishing line	Donated	0.25	Marble
1	Dowel	Recycled		Marble
1	Wood	Recycled		Marble
1	3D printed Airplane	Bought	2.50	Airplane
4	Eye hooks	Recycled		Airplane
4	Hot wheel track	Recycled		Racetrack
1	Hot wheel car	Recycled		Racetrack
1	Plastic Sheet	Recycled		Racetrack
1	Plastic cup	Bought	0.10	Racetrack
2	Spool for pulley	Recycled		Racetrack
4	Miscellaneous wood	Recycled		Racetrack
1	Beaker	Recycled		Chemical
30ml	Acetone	Bought	5.00	Chemical
5	Styrofoam cup	Bought		Chemical
1	Paint can	Recycled		Chemical
1	Weight	Recycled		Chemical
1	Legos to make a tower	Recycled		Crane
1	Sand	Recycled		Crane
2	syringes	Bought	3.00	Crane
1	Wood	Recycled		Crane
1	Tin foil	Recycled		Lever
1	Wire	Donated	1.00	Lever
4	Battery	Bought	5.00	Lever
1	Lego City	Recycled		City
15	Leds	Donated	5.00	City
1	Particle Board	Recycled		City
1	3D printed nucular	Bought	10.00	City
1	Bubble Machine	Bought	15.00	City

Major Successes and Challenges

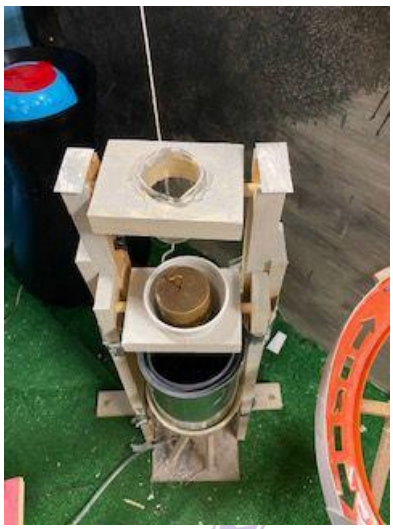
Counterweight & Fluid Power

One challenge that we faced with our fluid power step was that the weight of the tower was causing the crane to lower before a 1 kg weight was added into the paint can that started the fluid power step. Our solution to this was to add a counter weight to the crane. We adjusted syringes filled with sand to balance out the weight of the tower.



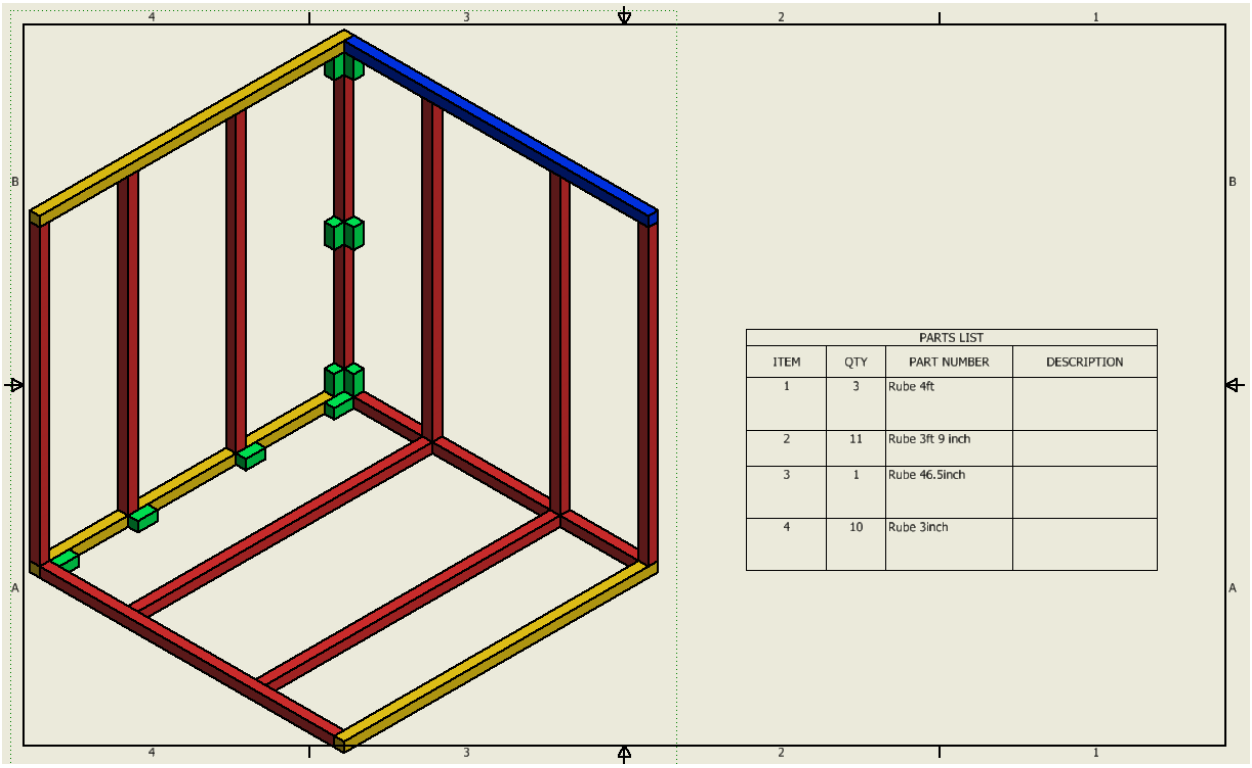
Chemical reaction

A challenge that we faced with our chemical reaction step, was stopping the acetone from spilling and missing the styrofoam cup that it was supposed to go into. The acetone came out of the glass beaker as we tipped it, just like we planned, but the distance was too large between the acetone and the styrofoam cup so the acetone missed the styrofoam cup, and didn't start the next step. Our team solved this issue by duct taping the two parts of the wooden structure together(Shown in images below). The duct tape pulled together the glass beaker and the styrofoam cup, so the distance between them was smaller. Because of this the acetone went directly into the styrofoam cup and set off the next step as planned.



CAD drawing of the base

Designing a CAD drawing helped the planning and designing process by having a clear plan outlined and ready. The CAD drawing helped outline a base cost of our machine. With the plan we could build quickly and efficiently.

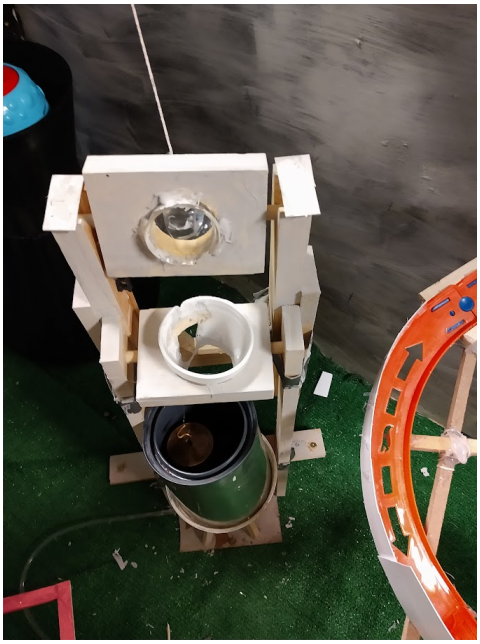


PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	3	Rube 4ft	
2	11	Rube 3ft 9 inch	
3	1	Rube 46.5inch	
4	10	Rube 3inch	

Advanced Components

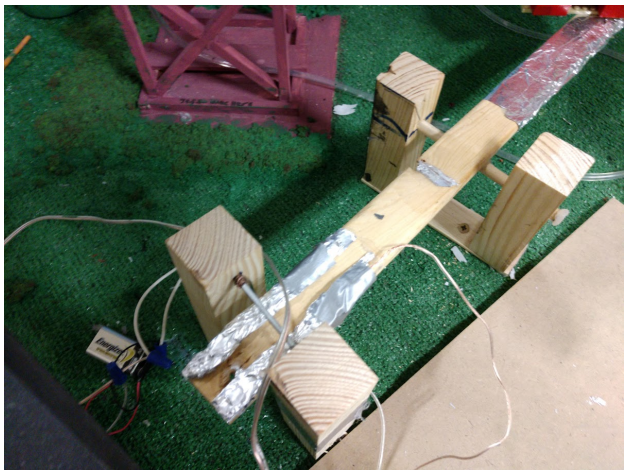
Chemical Reaction

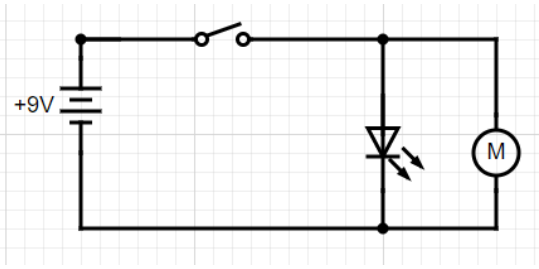
During the Chemical Reaction phase, our car runs into a Solo Cup and triggers a pulley. The pulley pulls over a beaker full of acetone which pours into a styrofoam cup with a 1,000g weight in it. The Acetone reacts with the styrofoam cup causing the cup to dissolve. This makes the weight fall into a paint can which triggers the Fluid power step. The chemical reaction during this step is the Styrofoam cup dissolving because of the Acetone. Acetone is a solvent. Styrofoam is a polystyrene. A solvent can dissolve certain materials, such as the styrofoam cup. The acetone splits up the long chain of molecules, and the air disappears, causing the volume of the styrofoam cup to shrink.

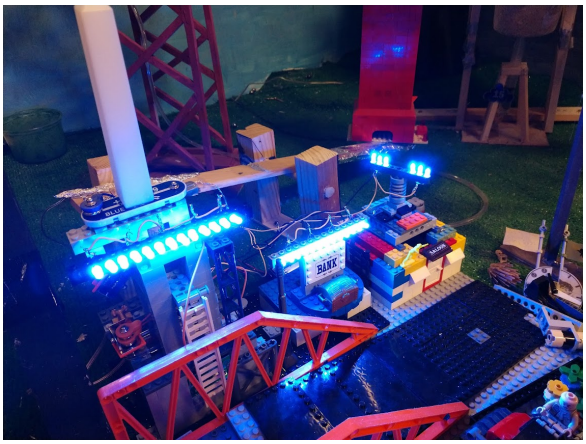


Electrical Step

During this step the weight drops onto the switch this in turn completes the circuit with the wire that is coiled around the metal pole. This allows for the 9v battery to deliver power to the array of blue LED lights put throughout the lego city we created. The LEDs are soldered in a parallel circuit. A parallel ensures the same amount of voltage across each LED. Also on the switch we have a bubble machine connected. The bubble machine has a motor in it

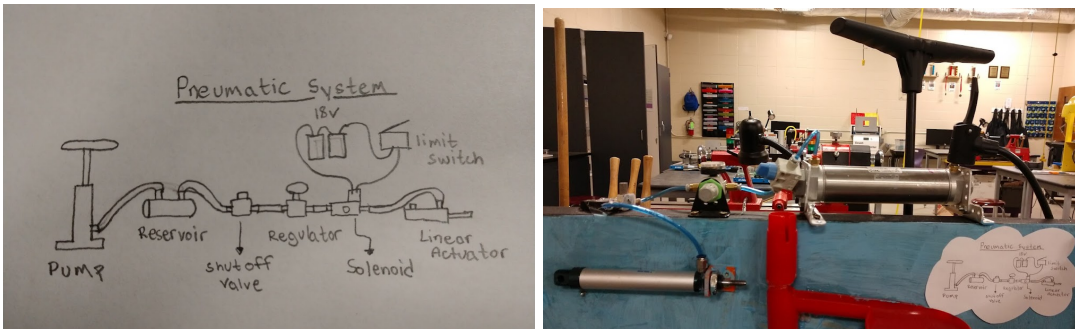




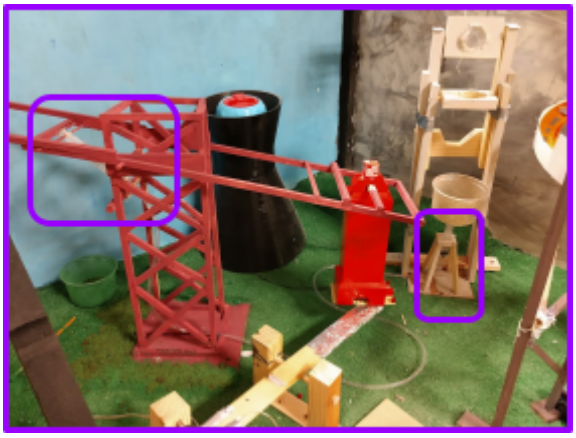


Fluid Power

Our first fluid power part uses pneumatics. Our pneumatics design uses a reservoir, regulator, three way shut off valve, solenoid, and a linear actuator. The reservoir stores the potential energy as compressed air, the shut off valve isolates the stored compressed air, the regulator maintains the pressure, the solenoid electronically controls the air flow and the actuator converts the compressed air to mechanical energy. **This is different from the syringe fluid power because it uses a gas (air) instead of water or fluid.** We used fluid power to transition from the chemical step to lighting up the city. From our chemical step a 1 kg weight is dropped into a paint can, this paint can is sitting on top of the first syringe. The first syringe presses down as the second syringe extends. The syringes represent hydraulics. The fluid power lowers the tower attached to the crane onto a lever which completes the circuit to our city.



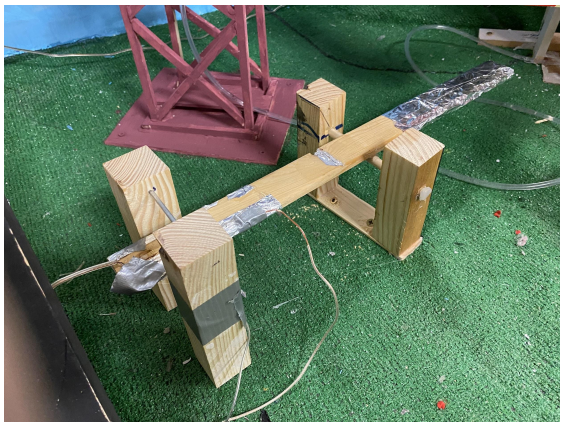
Pneumatic System

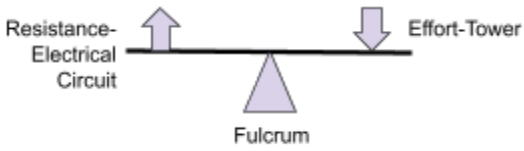


Hydraulic System

Mechanical Action

After the chemical reaction step, the acetone that melts the 1,000 gram weight initiates the fluid power because the weight presses down on the syringe. The syringe then pushes up on the wooden crane which has a Lego tower connected to it. The Lego tower is lowered down onto the lever, which has tinfoil wrapped around it, completing a circuit. Lastly, when the circuit is completed the bubble machine and motor start running. The step below shows a first class lever. We selected to use a first class lever to change the direction of force. The ideal mechanical advantage of the system is 1 as both sides are equal.





Reflections of the Entire Process

As a team we have learned many things from start to finish, some of these things are

- The ability to coordinate each task to specific team members and give them and necessary outline of the task to be completed
- The understanding of each others abilities so that we know each other's strengths and weaknesses
- How to collaborate as well as change the ideas on the project, making it better as well as putting every members incorporation of their idea into it
- How to meet a set deadline.

Each team member has grown in their ability to learn and adapt to the situations as more and more problems arise, our problem solving strategies have sharpened due to the point where we have an understanding of a broad variety of situations. Finally the skills we have learned here will last us a lifetime in our own respective careers, so that we each may have an opportunity to grow and advance in the world. For example, I (Becca) want to be an engineer. As an engineer I will need to use the design process over and over again.

Document Word Count