Reverse Engineering the Human Body:

Restart the Heart

The Crazy Cardiologists

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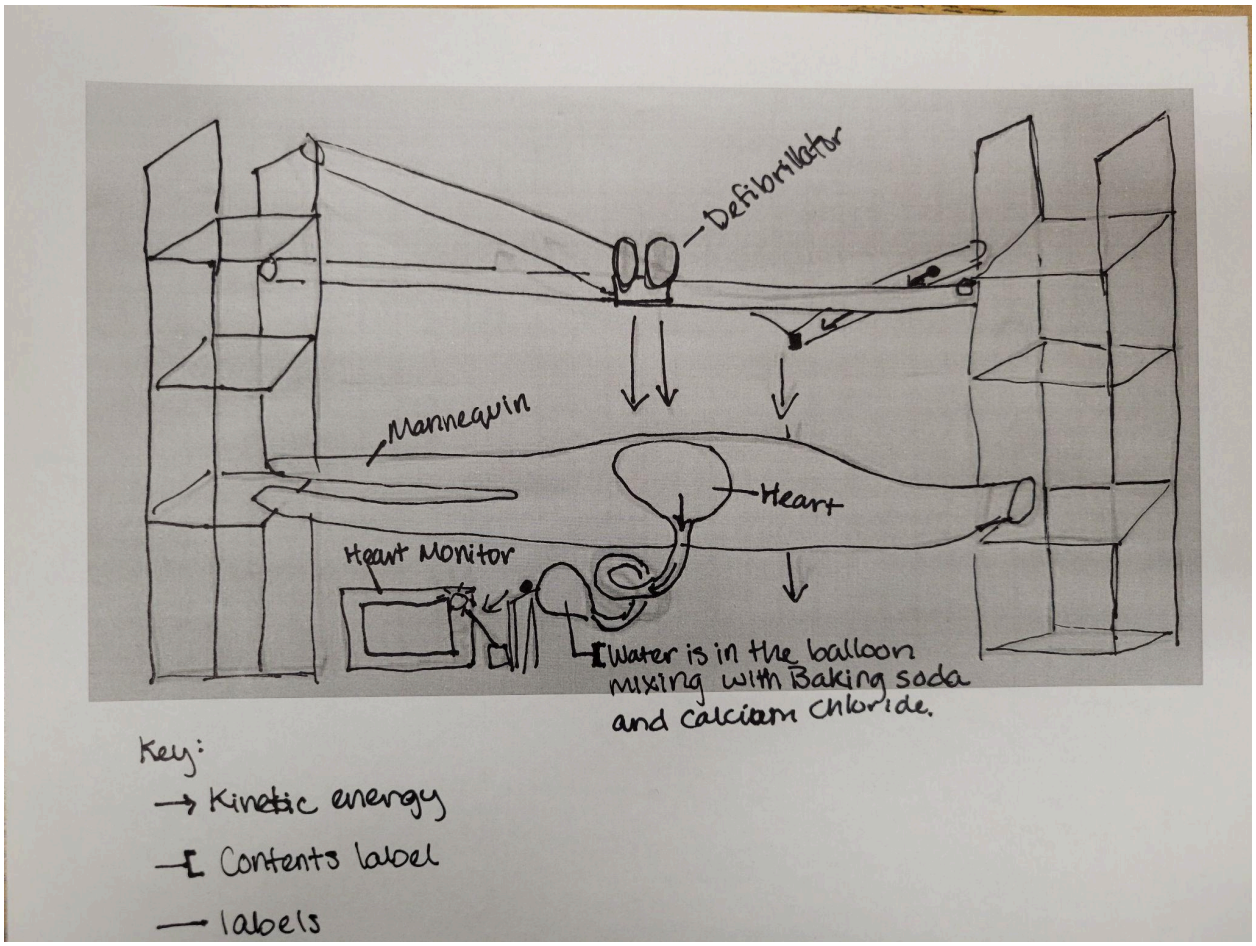
Planned Machine Design Sketch:



Our original plan was that we would place a ball on a track and it would roll down then hit a weight off the end of the track. The weight was wound through a pulley and on the other end was a barricade like platform, that when the weight falls the barricade was pulled from under our defibrillator. The defibrillator would fall and compress our balloon heart which had H2O in it. The water would then travel down a tube into another balloon with the powders calcium chloride and baking soda in it. A chemical reaction would occur, inflating the second balloon. The second balloon would then inflate and hit a ball into a cup where the bottom had a button. The ball would hit the button and sound an alarm and then fall out the backside of the cup. The ball, attached to a string, flips the screen of the heart monitor.

Final Machine Design Image:

The first step, we release elastic potential energy by pressing the clothes pin, releasing the rubber band. The rubber band transfers kinetic energy into a bouncy ball, which then rolls down a ramp (a mechanical component). The ball's kinetic energy is then transferred to a weight which is pushed off of the ramp. The falling weight is attached to a string run through a pulley (another mechanical component as well as a simple machine). The pulley reverses the force and shifts the arm of the scientific glasses off of a seesaw (a mechanical component). Next the seesaw becomes unbalanced and tilts the opposite direction, releasing a defibrillator. The defibrillator falls onto the heart of Manny, the defibrillator is also attached to a string, looped through a pulley (a mechanical component). On the other end of the string, we have a balloon filled with calcium chloride that when the defibrillator falls and reverses the force, the balloon lifts and dumps its contents into a glass bottle of water and baking soda. The resulting exothermic chemical reaction (an advanced component) creates a gas that inflates the balloon. The inflated balloon then lifts one end of a seesaw (another mechanical component) which drops a small weight. The weight flips the heart monitor screen (another mechanical step) and the seesaw also drops two circuit cords into a glass of saltwater. The saltwater completes a circuit with the cords and sounds an alarm (an electrical component).

Materials	Price	Recycled
Pulleys	None	Yes
Piping Insulation	$1.09	No
String	None	Yes
Balloons	$0.09 per run	No
Closet Organizer	$3.00 -purchased used	Yes
Mannequin	None	Yes
Snap Circuits	None	Yes
Cardboard	None	Yes
Paper	None	Yes
Hot Glue	$0.50	No
Glass Bottle	$0.99 -purchased used	Yes
Weight	None	Yes
Clasps	None	Yes
Coffee Table	$5.00 -purchased used	Yes
Toy First Aid Kit	None	Yes
Plastic Cup	None	Yes
Meter Stick	None	Yes
Foam Board	$1.78	No
Calcium Chloride	$0.25 per run	No
Baking Soda	$0.10 per run	No
Total Cost	$12.80	
Percent Recycled	71%	71%

List of Steps:

1. A rubber band slingshots a marble down a ramp.

2. The kinetic energy of the marble rolling down the ramp is transferred to the weight. (This is a Inclined plane, or mechanical step)

3. The falling weight is strung through a pulley which changes the direction of the force removing the arm of scientific glasses. (The pulley and the glasses [a hinge] are another example of mechanical steps)

4. The removal of the arm of the glasses tilts the seesaw (The seesaw is another example of a mechanical step) that then releases the defibrillator.

5. The defibrillator falls and lifts a balloon using a pulley to reverse the direction of force. (The pulley is another mechanical step)

6. The lifted balloon releases calcium carbonate into a bottle filled with baking soda and water causing a chemical reaction.

7. The resulting exothermic chemical reaction, which is an advanced component, releases a gas which makes the balloon expand and inflate. (This is our Chemical reaction step)

8. The inflated balloon lifts one end of the seesaw (The seesaw is another example of a mechanical step), dropping a small weighted pouch, making the screen of the heart monitor flip (Another mechanical component).

9. The seesaw drops two circuit board cords off.

10. The cords fall into a cup of saltwater, sounding an alarm (An electric step).

Use of STEM Process:

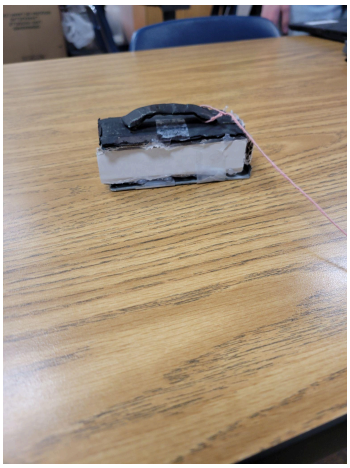
Ask: First we answered the question: what are the criteria and constraints?

Imagine: Then we began brainstorming and came up with the idea of the Crazy Cardiologists and making a defibrillator.

Plan: Next we began making lists of the materials we needed as well as creating a rough draft sketch and list of our steps.

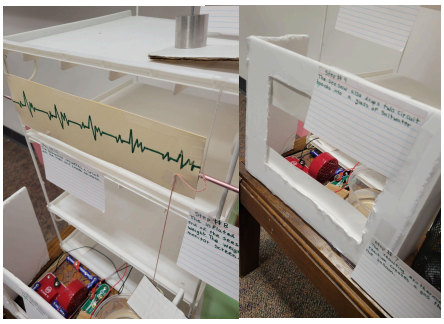
Create & Improve: As we worked on creating our machine we ran into several issues and ended up improving as we created.

The Defibrillator:



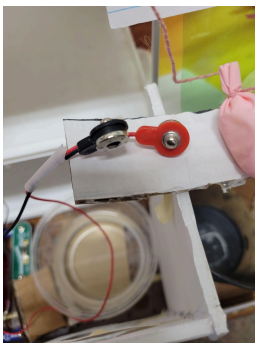
Originally our defibrillator was going to be dropped from a barricade being removed beneath it. Then it would drop onto a balloon and compress the water out of the balloon and down a tube. We soon realized that we could not figure out how to remove the barricade as well as make the defibrillator drop with enough force. To solve this, we used the STEM process. First we asked: what is the issue? Then we imagined or brainstormed different ways to do these steps and came up with the idea of a tube that could slowly drop it so that it had enough force. Next we planned and gathered the new materials like plastic bottles. Then we created the new plan, constructed it and tested it out. Again, it did not work so we had to do the process again. We asked what the issue was, then came up with the new idea of using a pulley to pull a balloon up and dump the contents, rather than compressing a balloon. Next, since we already had the materials, we began to create our new plan. Finally we worked to improve that to the best of its ability.

The Screen on the Heart Monitor:



For the heart monitor we originally planned to use cardboard as our base and use pipe cleaners to flip the screen. But it did not work. Using the STEM process we asked ourselves what the problem was and how we could solve it. We came up with moving the heart monitor screen up higher so the circuit board steps could be visible as well as making it easier for us to flip the screen, with a knitting needle. Next we gathered the supplies we needed and started to carry out our new plan.

The Circuit Cords:



Near the end of our construction we realized that the new seesaw was not dropping circuit cords into the saltwater like it was intended to. First we asked ourselves why this was happening? Then realized we had the circuit board too far to the right so we moved it over to where it needed to be. This was an easy fix but the STEM process still helped us.

The Balloon:

Our original plan was to have two balloons that when the defibrillator drops it would compress the first sending the water down a tube to the second balloon causing the chemical reaction and resulting in the expansion/inflation of the second balloon. We soon realized that with little space provided, both balloons inflated and the water wouldn't reach the second balloon. First we asked why this was happening and then we brainstormed ideas to fix it. We came up with using just one balloon and having the water and baking soda in a glass bottle (that is shaped like a heart). We put the calcium chloride in the balloon and the water and baking soda in the bottle. Using a pulley system to pull the balloon upward we released the contents in the balloon to the bottle where the chemical reaction would occur. Once again we struggled to get the balloon to be pulled up. First, we asked what the problem was: the pulley was too far to the right and was not high enough. Then we imagined and came up with the idea of using a meter stick and placing it across the top of our machine. Next, since we already had a meter stick, we constructed, or created, it and tested it out. It worked!!! :) Finally we improved by making the meter stick permanent.

Journal Entries:

1st Day-(Jan. 5) Today we figured out our team roles and what our machine would do. We planned out our main idea and our first few steps.

2nd Day-(Jan. 8) This morning we started brainstorming what would happen on the machine and completed writing out our steps.

3rd Day-(Jan. 10) To start work on the machine today we created a drawing of our machine, figured out our team name, and started building the machine with the materials we had so far.

4th Day-(Jan. 12) As we began constructing our first few steps of the machine we worked on creating a list of materials we needed for the other steps.

5th Day-(Jan. 16) Once we had all of the materials needed, we began building the other steps.

6th Day-(Jan. 18) Today we ran into a little trouble with our defibrillator step on how we can release it and how it will compress the balloon heart with enough force.

7th Day-(Jan. 22) As we worked on fixing the defibrillator step we started working on the beeping sound that we want to use for sounding off an alarm which makes it seem that a heartbeat is sensed. We also worked on creating the heart monitor and a flippable screen attached to it.

8th Day-(Jan. 24) Today we worked on creating our presentation and making walls and supports for the steps already built.

9th Day-(Jan. 26) The first thing we did today was work on the Heart monitor and continued building the first few steps of our machine.

10th Day-(Jan. 30) Today we worked on our defibrillator and our fourth step (the pulley weight). We also experimented to measure the amounts of ingredients we would need for the balloon chemical reaction.

11th Day-(Feb. 1) Again today, we worked on our balloon chemical reaction and tested it to make sure it worked. We also worked on our heart monitor (10th step).

12th Day-(Feb. 5) We decided to address the defibrillator problem today as well as work on our heart monitor and how to catch the ball. In the end we decided to drop the ball idea and use a circuit board instead where all we had to do was drop two circuit cords into a glass of saltwater.

13th Day-(Feb. 7) Today we did a lot of painting and we worked on making our project look better while we brainstormed how to solve our problem with steps 4-6-ish.

14th Day-(Feb. 9) As we continued brainstorming we worked on hot gluing things, painting our background, and working on writing in our team journal.

15th Day-(Feb. 13) Still brainstorming different ways to do steps 4-6-ish(the defibrillator steps), we continued working on the presentation and neatness of our machine.

16th Day-(Feb. 15) Today we worked on our machine by compromising and finding a different way to do the defibrillator steps.

17th Day-(Feb. 20) Once our new plan had finished forming and we got some new needed material, we worked on constructing the – new– steps 3-8. We found a more efficient way to start the chemical reaction by using a seesaw and weight..

18th Day-(Feb. 22) As we worked on our new plan for steps 3-8 we found another problem of how to drop the circuit cords into water as well as removing a small piece of cardboard that is covering a light.

19th Day-(Feb. 26) Today we tested a different way to do steps 3-8 and are continuing working on running the machine all together (specifically the defibrillator step).
20th Day-(Feb. 28) Finally, today, we got our new plan for steps 3-8 to work.
21st Day-(Mar. 1) We hit another rough patch with steps 7-10 and we worked on brainstorming an idea to fix it. We also worked on our team journal. We ended up deciding to add another seesaw so that when the balloon inflates it lifts one end of the seesaw and drops the circuit cords and cardboard light cover.
22nd Day-(Mar. 5) As others worked on completed steps 7-10 some of us worked on our team journal.
23rd Day-(Mar. 7) Similar to our last class day, we continued working on our team journal as well as running the whole machine through without intervention.
24th Day-(Mar 11) Again today we worked on our team journal and the construction of the new idea for steps 7-10.
25th Day-(Mar. 13) Once again we ran into trouble with our light and our newly added seesaw step and decided that the light wasn't going to work so we got rid of that. As our designers were hard at work our artist cut out letters for a sign on the back wall. We also worked on adding a step to the beginning and finishing up the team journal.
26th Day-(Mar. 18) As we near the end of construction time, we worked extra hard today on our team journal, presentation and a smooth run through of the whole machine.
27th Day-(Mar. 20) Today was our final day to work on our machine before the competition in Anoka. We made it so we could do some run-throughs to make sure everything was in order and fix anything. We also finished up and edited the team journal and added anything we needed to. The balloon chemical reaction was causing trouble so that was our main focus point today.
28th Day-(Mar. 28) As we start work and improvement for the championship we once again started the STEM process. To start off we just did: ask, in which we asked what went well and how we could improve, as well as imagine, where we brainstormed ways to fix the stuff that didn't work and potentially add more steps.
29th Day-(April 2) Since the championship is in Rochester, MN we wrote letters to local Alexandria engineering companies asking for support through sponsorship.
30th Day-(April 3) Today we worked at organizing our supplies bin as well as doing a couple run throughs with a new change. Instead of having the second pulley on the closet organizer connector, we put it up higher on a meter stick. We also got our first full run through without intervention, ever!!! :)
31st Day-(April 4) As yesterday we finally got a full runthrough, we had a team group meeting and made the new pulley bar permanent as well as reinforcing some other spots that had broken down. We also did three run throughs after school and they went well, as we found some small things that needed renovation.
32nd Day-(April 8) In class we did a couple run throughs and we got one full run through without intervention, we also worked on our presentation script. After school we did some more run-throughs, pre-prepared some calcium chloride balloons and worked on our journal.
33rd Day-(April 10) Today was our final day to work on our journal! Therefore this will be the LAST journal entry. We finished packing everything today and we ran through the machine once. We also worked on making our machine look good and we redid the letters. We feel a lot more prepared than the last contest!

Reflection (510 Words):

We had a great number of challenges, success, and we have grown so much through the process of Reverse Engineering the Human Body.

We had many challenges while working on our machine. One challenge was trying to come up with unique original ideas that we haven't already used in our design like pulleys and seesaws. Another challenge we faced was our 5th step, which was the defibrillator. It was very difficult to pursue because we couldn't figure out how to drop the defibrillator and then compress the heart with enough force. We also had troubles with our balloon chemical reaction steps. Our original idea included two balloons connected by a tube and we only wanted one balloon to inflate. However, both balloons inflated, due to the gas diffusing throughout the small space provided, so we decided to use a small heart-shaped glass bottle instead and only one balloon. Using the bottle forced the gas to expand the balloon to its full capacity. Something that was also challenging to construct was one of our last steps which was getting the heart monitor screen to flip. The plan was that we would implant a flippable screen, made out of paper and pipe cleaners, into our heart monitor and use a string to turn the paper. We soon learned that the pipe cleaners needed a great amount of force in order to turn the screen fully and to the desired angle. We solved that problem by moving the flippable screen to a different location so that the action behind the monitor could be seen. Then we switched out the pipe cleaners for a knitting needle. We also had issues with our circuit board cords, which was an easy fix of just moving the glass over. These challenges made the result, that is our machine, more superior because we got through that hardship.

Through the challenges we overcame, we faced success together. In the process of engineering it was incredible to see our class come together and make a working machine using a slim range of materials. In the beginning we were each assigned a team role and it was funny how each role kind of matched each person's personality. We all had a part to play and it was up to us to do it to help our team. It was an immense amount of work but when we worked as a team, somehow, in the end, it all came together. Though there was a time during the construction of our machine, where we all thought it was going to fail, we pushed through and used the aspects of compromise and improvement. In order to create our machine in a proficient way, we knew we needed to use communication and teamwork, so that's what we did.

In the end, we experienced growth in many ways. In our communication and teamwork, in patience, and in our perseverance. These are skills that we will continue to carry throughout our lives, even if we don't go into a science career. If we do choose to go into a science career, in which this experience has inspired some of us to do, these skills will be especially helpful as engineering requires lots of teamwork, trial and error, and perseverance. As Thomas Edison once said "Genius is 1% inspiration and 99% perspiration".

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