ENGINEERING
MACHINE DESIGN CONTEST

Advancing Technology By Reverse Engineering The Body

West Hancock High School- Britt, Iowa

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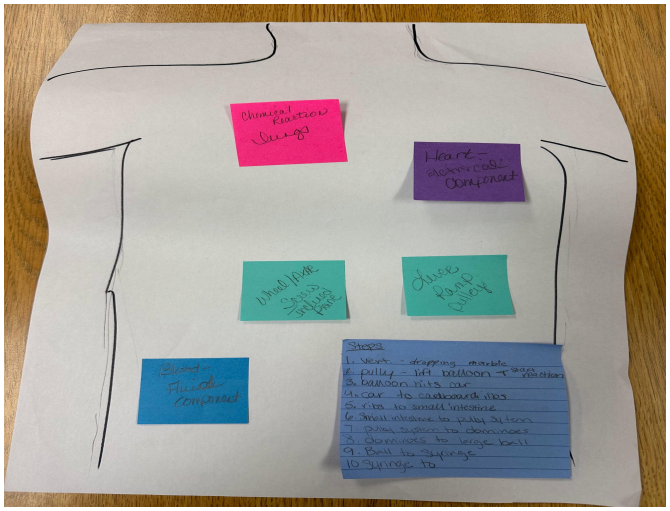
Planned Machine Design Sketch and Description

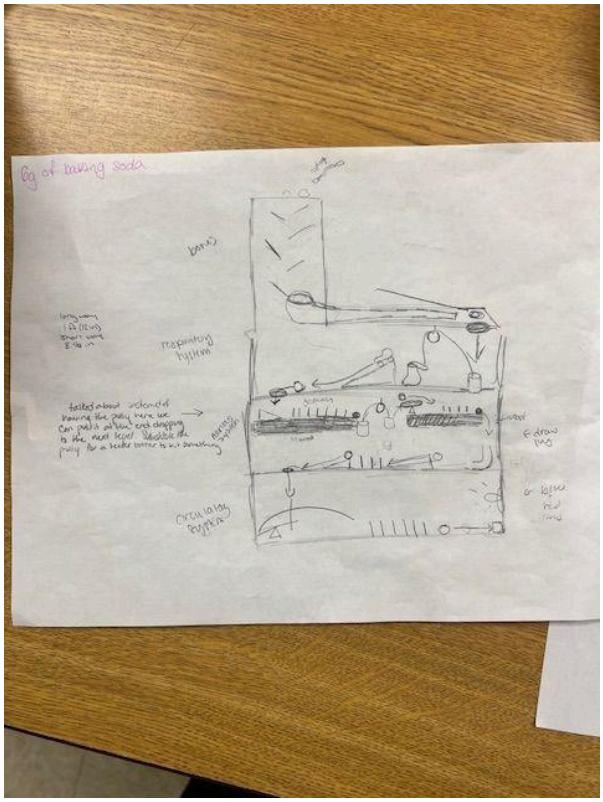
As a group, in the middle of October, we collaborated on incorporating the human body into our machine. We created lists of parts of the body, materials to use, and steps that we could build. After watching YouTube videos to get step ideas, we found four main components we wanted to include in the machine, and we worked from those four steps first. The lungs would be represented by a red balloon being inflated by a chemical reaction of baking soda and vinegar, the heart by a red light bulb being switched on, the "blood" represented by fluid in syringes, and a pulley to represent the mechanical component. The group then worked as pairs to complete steps before and after the four main components, which allowed us to create more connecting steps.

Our First Design



While the human body is made up of complicated parts, many of those parts can be replaced with advancements in technology. Being able to understand how the human body works allows for parts of the body to be replaced through the use of technology. The story of our rube goldberg machine is that it represents the human body. The red balloon inflates as the lungs do with the intake of oxygen for the body to sustain life. The red liquid flows through the syringes like blood through the arteries and veins carrying that oxygenated blood in the arteries to the various organs in the body away from the heart and carries the oxygen-poor blood in veins back towards the heart to release the carbon, and the heart is represented at the end of the machine by the light that is turned on. The wooden blocks represent the spine, and the ribs are represented in the cardboard tube carrying the marble.

Our Final Design



Following the theme of the human body, our five tiered display represents the functions and processes of the body. Continued from the old design, the red liquid flows through the syringes like blood through the arteries and veins carrying that oxygenated blood in the arteries to the various organs in the body away from the heart and carries the oxygen-poor blood in veins back towards the heart to release the carbon, and the heart is represented at the end of the machine by the light that is turned on. The vertebrae are represented by the staggered jenga blocks. By making the connections, we can demonstrate the relationship between mechanics and the human body.

List of Machine Steps

1. We push a syringe full of red-dyed water to represent blood flowing through the veins. The syringe will push a ball down staggered Jenga blocks glued to a wood panel, representing the vertebrae with gpe, where the ball will fall into a pvc pipe representing a rib. (fluid step)
2. The ball will then fall into a lever system using gpe where the balloon with a magnet inside will attach to another magnet attached to the top of the shelf and inflate. The chemical reaction will represent the inflation of the lungs when breathing and demonstrate elastic potential energy. (chemical/mechanical step)
3. The balloon will fill with carbon dioxide and it will then push a car.
4. The car will slide down the ramp using gpe to hit a marble and that will fall down the tube.
5. The marble will exit the tube and fall through a hole where the ball will roll down another ramp and hit dominoes
6. The last domino will hit a marble which will fall onto the end of another lever activating it. The other end of the lever will life and send another ball down a ramp
7. The ball will roll down the ramp and down another tube where it will exit out the end of a pvc tube.
8. The marble will roll out of the tube and on a ramp where it will hit a series of popsicle sticks releasing ping pong balls.

9. The final ping pong ball will roll down the ramp and hit a set of dominoes where they will fall.
10. The final domino will hit a marble and send it down a ramp where it will fall to the final level
11. The marble will hit a teeter totter which has a domino at the end. The lever will tilt up hitting the domino, sending multiple dominoes falling.
12. The final domino will hit a ball which will activate the light switch.
13. The light will turn on representing the heart. (electrical step)

Cost of Machine and Percent of Recycled Materials Used

95.76 % of items used on our machine are recycled or repurposed materials. The total cost of the machine is $26.40.

Purchased:

Item	Cost
Balloons	$5.00
Batteries	$14.02
Vinegar	$4.79
Baking Soda	$1.59
Hot Glue Stick	$1.00
Total Cost	$26.40

Recycled:

Item	Quantity
Large cardboard box	1
PVC pipe	2
Clear Tube	1
Magnets	2
Command hook	3
Cardboard Box-Small	1
Dominoes	30
Ping Pong Balls	2
Marbles	5
Popsicle Sticks	2
Switch	1
Bulb	1
Sound Tube	1
Wood pieces	12

Alligator Clips	3
Plastic Cup	1
Cardboard Tube	2
Matchbox Car	1
Race Track	4
Masking Tape roll	1
Wooden Ramp Pieces	4
Metal	1
Jenga Block	4
Bookcase	1
Cardboard slice	2

Applied STEM Process

Fluid Step: The fluid aspect is water with red dye that is representing blood. The water is in a syringe that is connected to another syringe by a clear tube. One of the team members is going to push on the plunger of one of the syringes. It's going to cause the water to flow through the clear tube into the other syringe. The plunger of the opposite syringe is going to hit a marble that is going to start the project.

Mechanical Step: We have three levers throughout our machine. The first lever is used to balance the balloon containing our baking soda. When a ball is activated, it drops through the hole and hits the end of the lever. This sends the balloon upward dumping the baking soda into the flask. The second lever is used to activate a ball. We have dominos set up on a higher platform, and once they are activated, the last one falls onto one end of the lever, lifting up the other end which hits a ball on its way up. This then activates our next step. Our last lever is on the very last level of our bookshelf. This lever is lined up underneath a hole in the fourth level. A ball will drop down from the fourth level, landing on one side of the lever. On the other end of the lever, a domino stands very closely so that once the end raises, it hits the domino activating many more dominos.

Chemical Reaction Step: The chemical reaction is our third step. The balloon contains sodium bicarbonate (baking soda) and a magnet, and the flask contains acetic acid (vinegar). We measure out 6 grams of sodium bicarbonate and 75 mL of acetic acid.The balloon is resting on a lever. When a ball is dropped onto the other side of the lever, it

pushes the balloon up, and the magnet is attracted to another magnet on top of the shelf. The baking soda is then dropped into the flask. This mixture produces carbon dioxide, inflating the balloon. Once the balloon inflates, it activates our next step.

Electrical Step: The electrical step is the final step of the machine. The electrical component is triggered by a light switch. A marble is hit from a previous step and falls down a wooden ramp. When the marble hits the light switch, it will turn the light on. The light is colored red to imitate the heart lighting up.

Daily Log Entries:

1. Our team began by looking at the requirements for this year's competition and brainstorming ideas for the contraption. We created ideas to demonstrate body functions and anatomy. The ideas were in the range of a ramp designed to look like a rib to a chemical reaction that would imitate the inflation of a lung. These ideas were written down and drawn out by many of us. After coming up with ideas, we then split into groups and designated each group to create their own piece. This created efficiency in our beginning process of building the machine.

2. We ran into a few issues when we first began to put together the machine. When the ball would roll down the ramp (rib), it would fall out of the cup due to too much momentum. To solve the issue, we placed tape along the ramp to slow down the marble as it rolled down. Another issue we ran into was getting the jenga blacks and dominoes to hit each other every time. We tried to place a paper under each block and trace them to see if we could find the perfect placements for each and every time. This was difficult as our boxes and machine would adjust every time we put it together. We decided to ditch the idea as we were not able to get it to work and figured we would use our time better by trying something new. By trial and error, we were finally able to master the placement. We also placed blocks along some parts to keep the blocks from falling in the wrong direction. By

adding these improvements, we were able to look at the other steps and focus on making those work.

3. Working on the rube goldberg machine has improved our work ethic and attitudes. We started out very stressed and did not work very fast on going from step to step. As we kept pushing through and working together each day, you could slowly see the improvements of not only our machines, but also ourselves as teammates. We all have a passion for human anatomy and enjoyed putting our love into a rube goldberg machine to present.

Reflection

After attending the regional competition, our team observed many great machines and realized that our work is not our best possible. Coming together the next day, team members thought out a plan to make the project improved. Amelia came forward and said she had an old shelf sitting in her barn that would be the perfect prop for our steps to sit on. After cleaning the shelf off and painting it black, we were able to begin the process of setting our machine up and to make changes where they were needed. We implemented levers, pvc tubes, and more levels to the machine to add contrast to the steps. We continued the idea of implementing body functions into the machine and agreed to make each step a part of the body.

We ran into some issues at the get go because we couldn't get the balloon to inflate how we wanted and hit the car. This was the same issue we ran into with our last design. After brainstorming, we came up with the idea to put a magnet into the balloon and attach another to the top of the shelf. This fixed our issue momentarily until we soon realized that we needed to have the exact measurement each time for it to hit the car otherwise it wouldn't fill properly. Another struggle that we had was getting the levers to work consistently. On the first lever we had to add a wood block underneath a side to keep the cup where we needed it for the lever to work. It was a situation where we had to do trial and error to get it to work. The final struggle we had was getting our journal updated as we did not know what to add. We had looked at the judge response sheets and the website to find tips for how to improve our work. By working together and collaborating ideas, we were able to add many new thoughts and ideas to the project.

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