Engineering Notebook

Team Number

Southland Physics

Team Name

Southland

School

Start Date End Date Book # of

VEX ROBOTICS

REC FOUNDATION

* = required components

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EMDC

Date of Competition: March 15, 2024

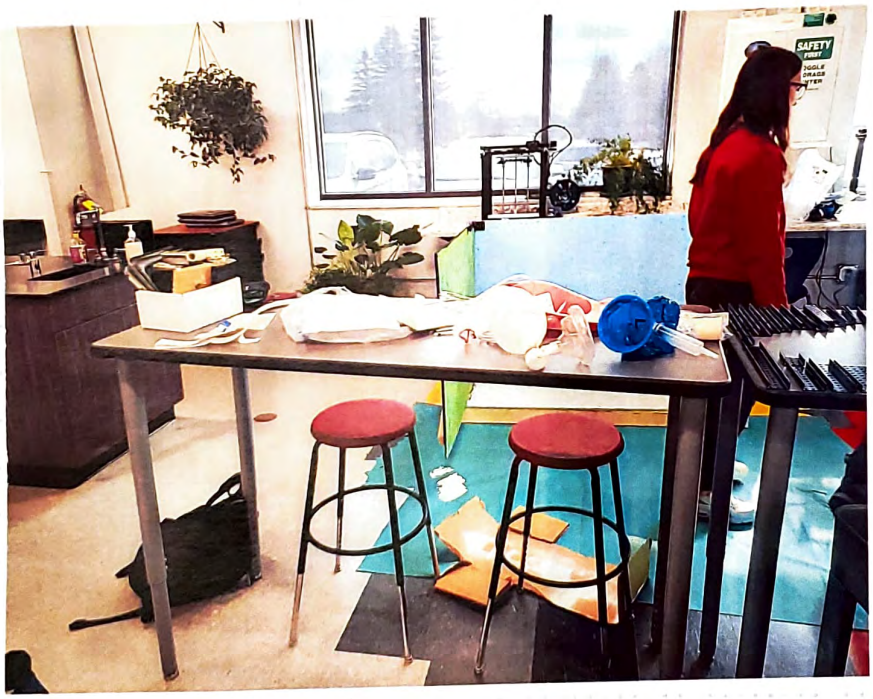
The objective of the project this year was to reverse engineer the human body.

This is what we developed for a timeline analysis based on what we thought would work for our timing as well as what has worked for previous classes.

- Friday 3/15 - Competition
- Thursday 3/14 - Take the machine apart, move it to the commons area and set up again, practice, and load the machine in to the trailer for transportation.
- Wednesday 3/13 - Practice the theme and presentation, fine tune the machine.
- Tuesday 3/12 - Finalizing the machine, no more new steps
- Friday 3/8 - Have 15 steps completed
- Friday 3/1 - Have 10 steps completed
- Friday 2/23 - Have 5 steps completed
- Friday 2/16 - Gather materials from basement and classroom
- Friday 2/9 - Finalize the theme and start brainstorming ideas.
  - Discuss design process
- Tuesday 2/6 - Brainstorm ideas for the theme

Gathering Materials

Picture of us putting the platform together before painting.



Picture of medical supplies that we brought in to help with our medical theme.

Brainstorming

Theme:

The theme for this project is reverse engineering the human body. We chose to do a medical theme for this because we already had multiple items already and had access to others. One of our classmates dad is a nurse so we were able to get some objects that way.

Items:

- Fake arms
- Kinex pieces
- Crutches
- Knee Brace
- Anatomy Model
- Cooler
- Books
- Glove Boxes
- Toy Ambulance
- Pill bottles
- Hot Wheels track
- PVC
- Syringes
- Golf Balls
- Fishing line
- Electrical Wire
- Wooden Dowels
- High Strength Shaft
- Kinex Motor
- Switches
- DNA Model (old classroom project)

This is a picture of some of the items we had in the classroom.

Brainstorming

Planned Machine Design

Chemical Step

Our idea for the chemical step was to do a vinegar and baking soda reaction to generate a gas.

Use some kind of container and inflate a medical glove?

Picture of the medical glove we plan to inflate.

We might use this as it is something found at the doctor.

An option for a container to hold the vinegar.

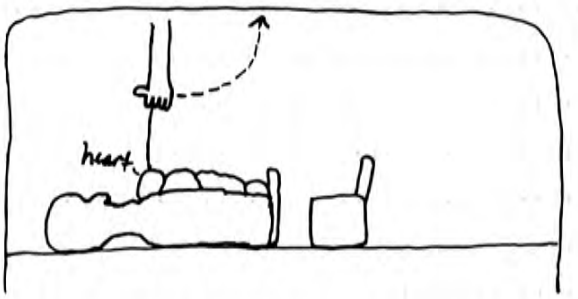
Brainstorming Planned Machine Design

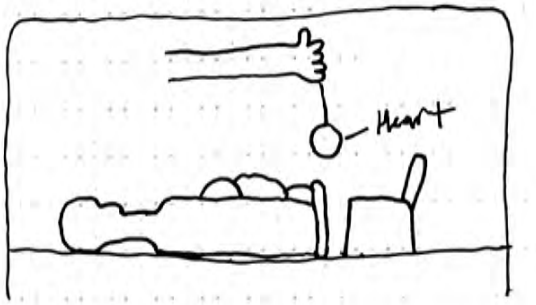
We came up with the idea to end the sequence with an organ being pulled out of the body and put into a container ~~body~~ SB ready to be delivered.

After further evaluation we decided to pull out the heart.

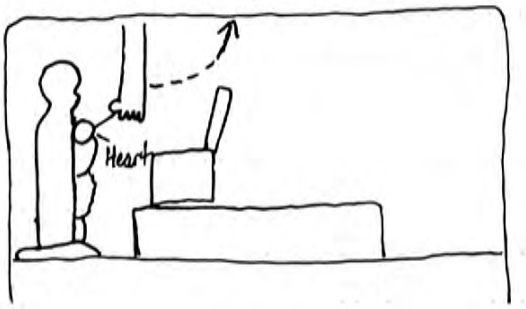
We cut a table that we had into two shorter tables to lift the cooler off of the ground to allow the heart to drop into it better.

Our first idea was to take the heart out with the body laying down.

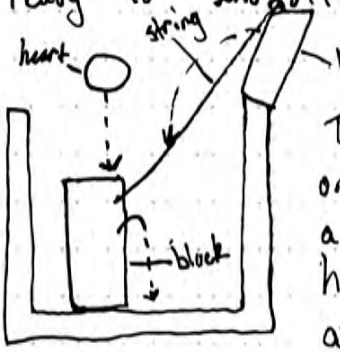




We decided that it was taking up too much room so we stood the body up.



We then decided to close the cooler lid like the heart was ready to send off for delivery.



The heart lands on a block on a hinge which has a string attached to the cooler lid which closes it when the block is pushed over.

Project Planned Machine Design
Date 2/14/24

Name Samuel D. Brae

Brainstorming! Design Process of Heart Removal

1st idea for set up to take out the heart

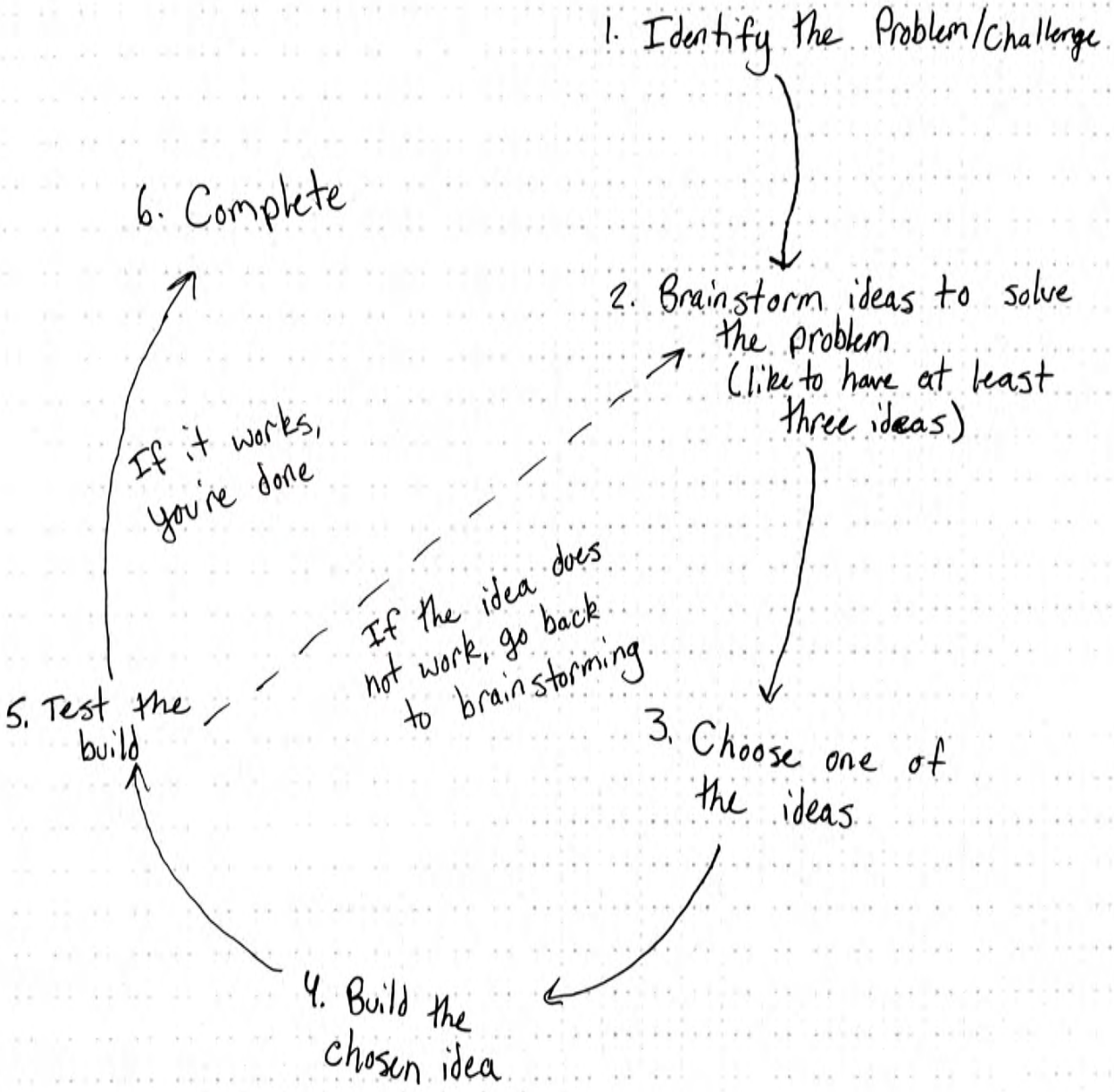
We didn't like the first plan because it was too far of a drop so we cut the table in half.

The final setup to remove the heart.

Design Process

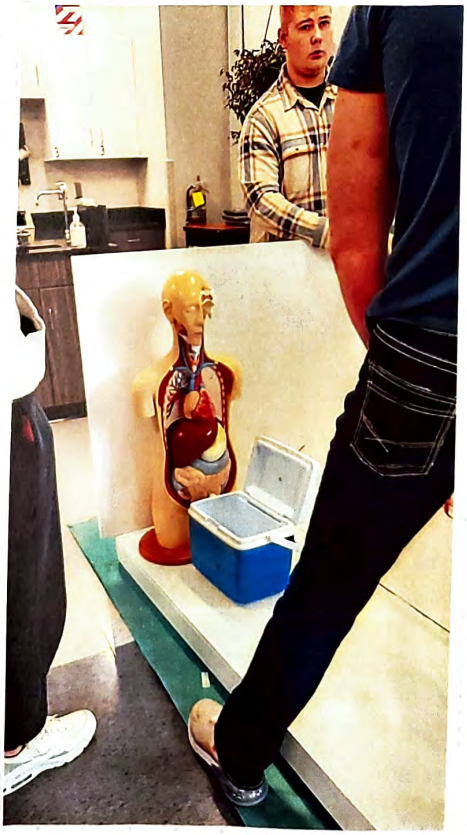
Applied STEM Process

The design Process is an important factor when solving problems and improves the quality of the solution.



Brainstorming: Design Process + Planned Machine

Discussing where to place the body and DNA model.



First idea that we had but the placement didn't work because of the hand.

Brainstorming: Design Process ✓ Planned Machine

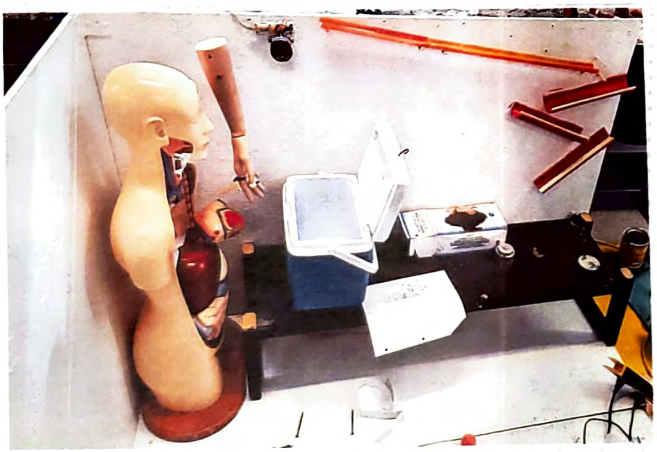
We moved the body close to the wall so we could connect the arm to the wall

Also started the first steps

The holder that was built to remove the heart. The heart drops back out by gravity which makes for a consistent, simple design.

Brainstorming: design Process ✓ Planned Machine

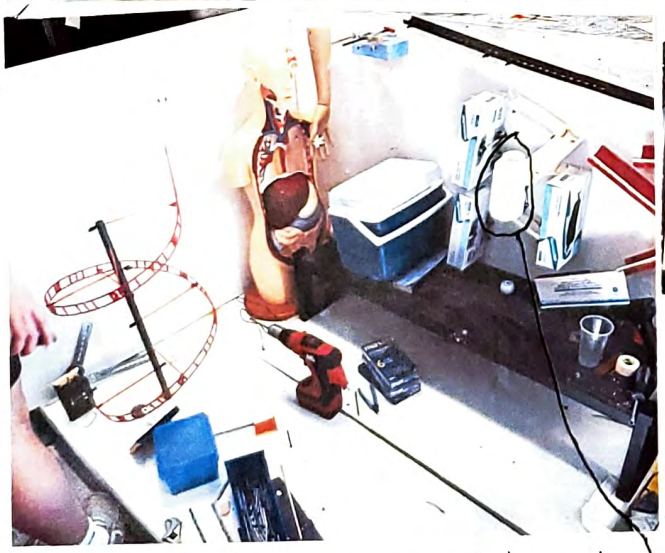
The final setup complete.



The heart removal complete with the first set of ramps set up too.

Brainstorming: Design Process

Luka working on the reverse ramp using medical glove boxes.



Using rubber bands which are elastic potential energy to hold up the bottle.

The reverse ramp complete and starting to work on the DNA model.

Decided not to use this as pouring out the water was too risky and it was very touchy to balance the bottle.

Project Applied STEM Process: Ramps

Name Samuel O. Brae

Date 2/9

Chemical Component

Stoichiometry

(baking soda) Sodium Hydrogen Carbonate + (vinegar) Acetic Acid → Sodium Carbonate + Water + Carbon Dioxide

$$NaHCO_3 + HC_2H_3O_2 \longrightarrow NaC_2H_3O_2 + H_2O + CO_2$$

84.01 g 60.06 g 18.02 g 46.01 g

$M = g/mol$

$M = \frac{mass}{\#\ of\ moles}$

Na - 1	Na-1
H - 5	H-5
C - 3	C-3
O - 5	O-5

$d = 1.87\ kg/m^3\ CO_2$

$V = 235\ mL + 205\ mL = 440\ mL$

$m_H = 1.01\ g$

$m_{Na} = 22.99\ g$

$m_C = 12.01\ g$

$m_O = 16.00\ g$

$D = \frac{m}{V}$

$m = D \cdot V$

$d_{CO_2} = 1.96\ g/L$

$$m = \frac{1.96\ g}{\cancel{L}}\left(\frac{440\ \cancel{mL}}{1}\right)\left(\frac{1\ L}{1000\ \cancel{mL}}\right) = 0.8624\ g$$

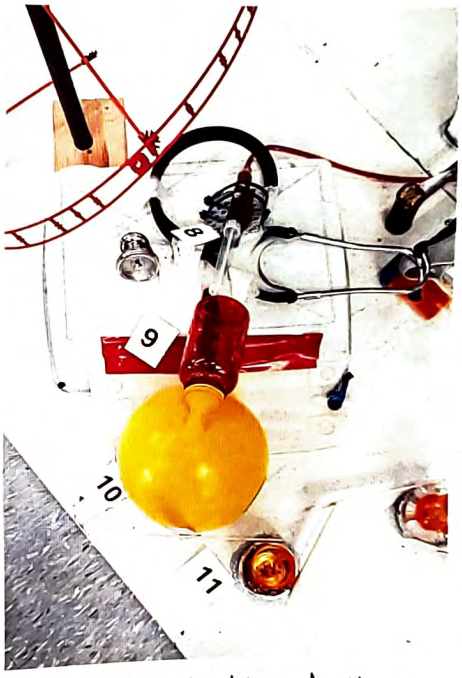
$$0.8624\ \cancel{g\ CO_2}\left(\frac{1\ mol\ CO_2}{46.01\ \cancel{g\ CO_2}}\right) = 0.01874\ mol\ CO_2$$

Chemical Component

$$0.01874 \text{ mol } CO_2 \left(\frac{1 \text{ mol } NaHCO_3}{1 \text{ mol } CO_2}\right)\left(\frac{84.01 \text{ g } NaHCO_3}{1 \text{ mol } NaHCO_3}\right) = 1.5743 \text{ g } NaHCO_3$$

$$0.01874 \text{ mol } CO_2 \left(\frac{1 \text{ mol } HC_2H_3O_2}{1 \text{ mol } CO_2}\right)\left(\frac{60.06 \text{ g } HC_2H_3O_2}{1 \text{ mol } HC_2H_3O_2}\right) = 1.1255 \text{ g } HC_2H_3O_2$$

Sodium Hydrogen Carbonate



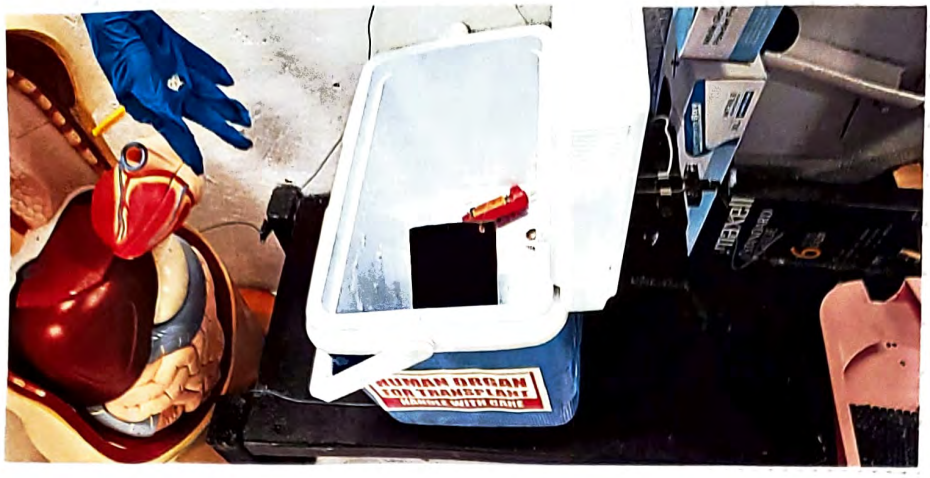
Picture of the balloon after the chemical reaction.

Project Chemical Component

Name Samuel A. Bae

Date 2/20

Applied STEM Process

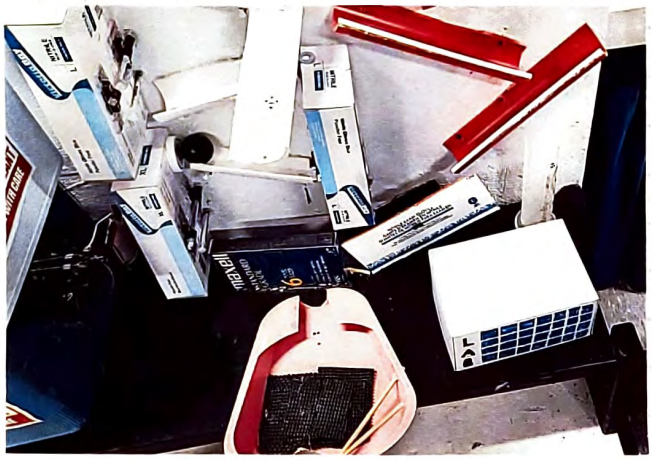


The final design of the cooler.

The final design of the reverse ramp.

Added another VHS tape because we we having trouble triggering them before so this made it easier for the tounge depressors to hit it.

Applied STEM Process



Adding decorations to make the machine more appealing

Project Applied STEM Process

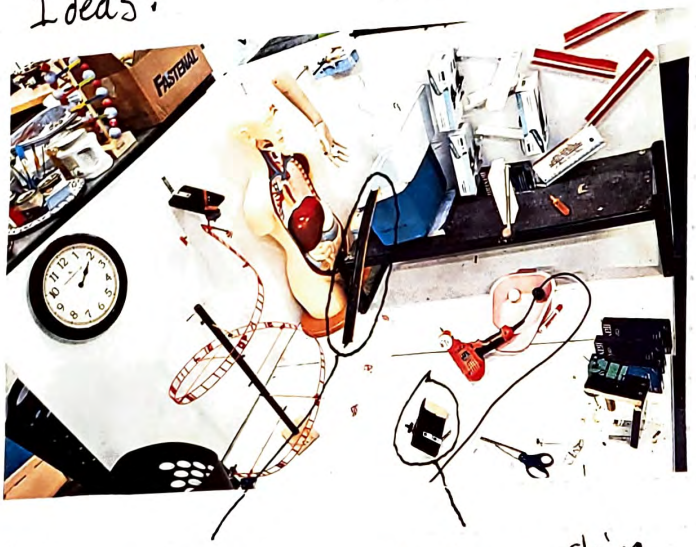
Date 2/20

Name Samuel J. Brau

Design Process: Turning the Circuit off

Problem: Need to turn the motor off after the heart drops.

Ideas:



1. Use a car on the ramp to open a switch

(Too inconsistent and don't know how to keep car on platform)

2. Have a string and a pulley so it pulls in the right direction to open it.

(Uses too much room)

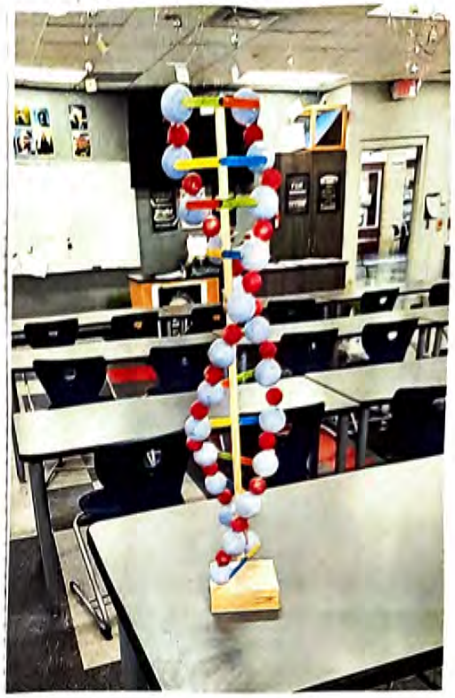
3. Have switch right by cooker with string attached to lid.

(Is simple and reliable).

Test: After testing + building each idea we decided idea three was the best + most practical.

Brainstorming Ideas Design Process

We had the DNA model in a classroom the we wanted to use. there was a problem though, it was too steep for a ball to stay on it.



We had three options on what we could do to incorporate this:

1. Use it as it is.
2. Put a guard on it so it could travel in only one spot
3. Build a new one that is not as steep out of Kinex

Pros:

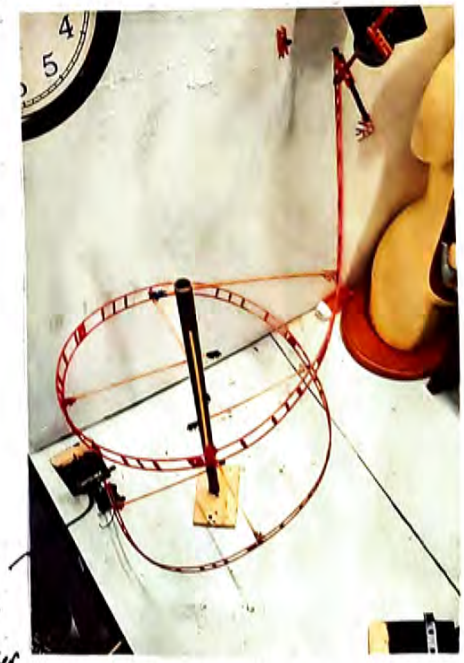
1. Already built, looks cool
2. Easy add-on, still looks good
3. Little chance of failure

Cons:

1. Too steep, won't work well
2. Still a high chance of failure
3. Isn't an exact replica, have to build whole new thing, doesn't look as good.

We choose the third one as it was the most consistent and worked much better. Safer option.

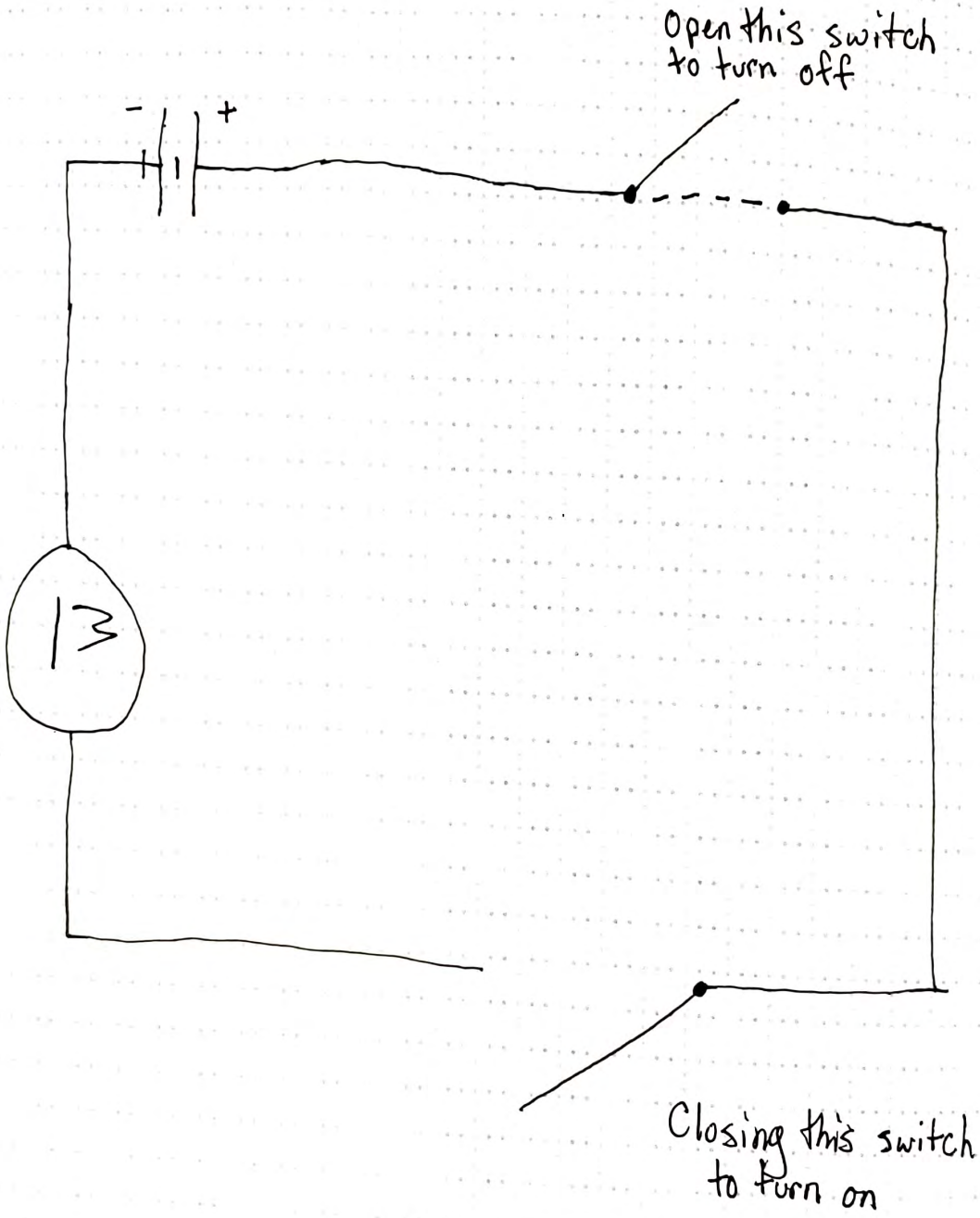
We built it and tested it over and over to make sure it would work everytime.



At first we had it hitting closer to the hinge but there wasn't enough force. Hitting farther out made more torque allowing it to close.

Electrical Component

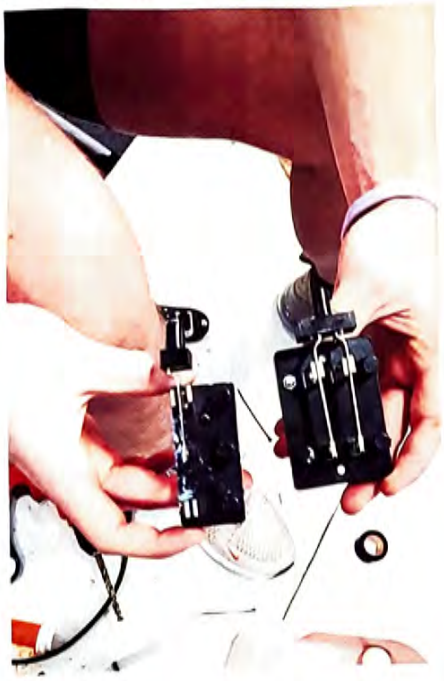
Schematic Diagram



Project Eletrical Component : Schematic Diagram Name Samuel D. Bae

Date 2/24

Electrical Component



These are two switches that we pulled out to look at how we needed to wire it.

Looking at the bottom showed us better how double throw switches actually work.

Correct one

We wired the circuit up wrong the first time. We were confused as to why it wouldn't work and the we looked at the bottom of the double throw switch again and realized we hooked it up to the wrong port. It was a good learning moment.

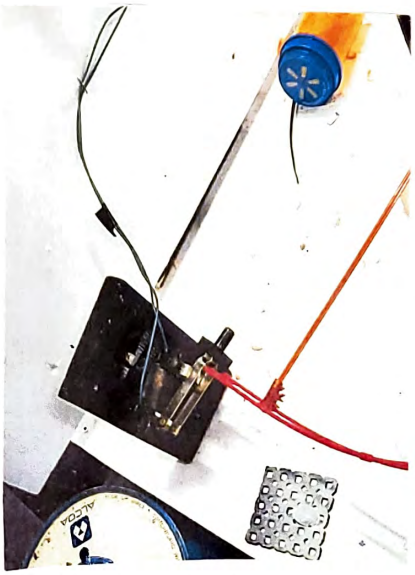
Wrong one

Electrical Component

The location of the motor and batteries for the circuit.

At first we planned to mount the batteries on the wall but thought it was a good idea to hide them in the cooler.

This motor is also on the project on it's own circuit as it has internal batteries.

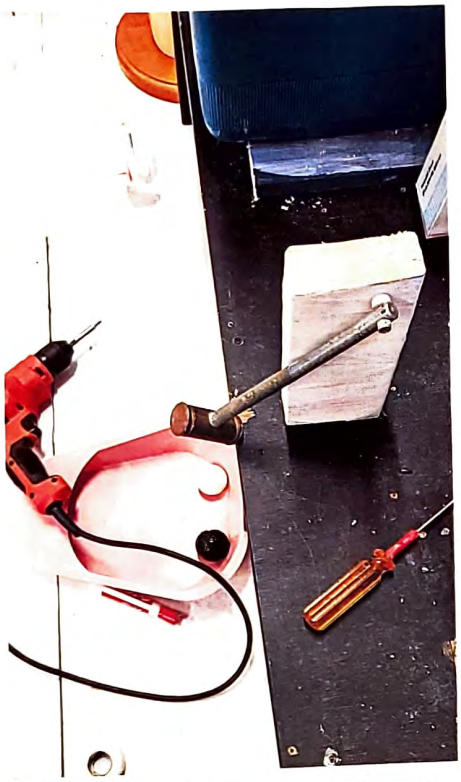


The switch that is used to close the circuit and turn on the motor.

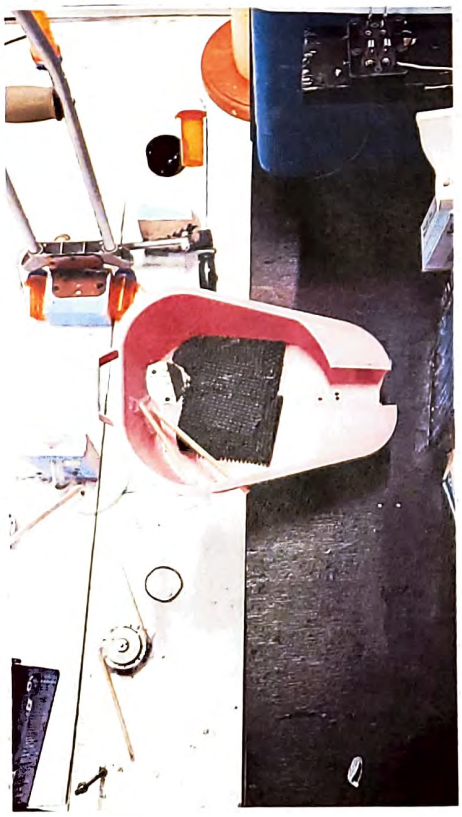
Applied STEM Process: Lever

Mechanical Component

The problem was to figure out how to start the Fluid Power component.



Our first idea was to use this hammer to trigger it but it is too inconsistent.



Our second idea which works more consistently and involves a medical object.

Here is a bigger view of the first idea.

Applied STEM Process: Lever

Mechanical Component

The falling ball triggers this lever

When the makes the hammer (new location) fall over and push the crutch over

(Portion of Knee brace)

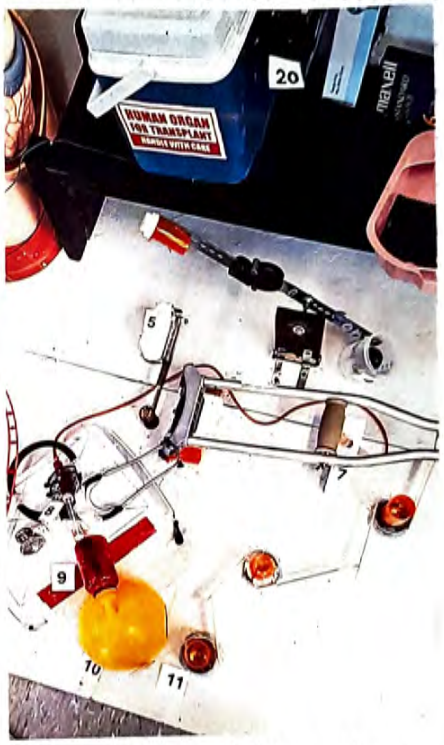
The crutch falls over and pushes down on the syringe to do the fluid power.

Fluid Power

This is the last step we completed and were having trouble coming up with ideas.

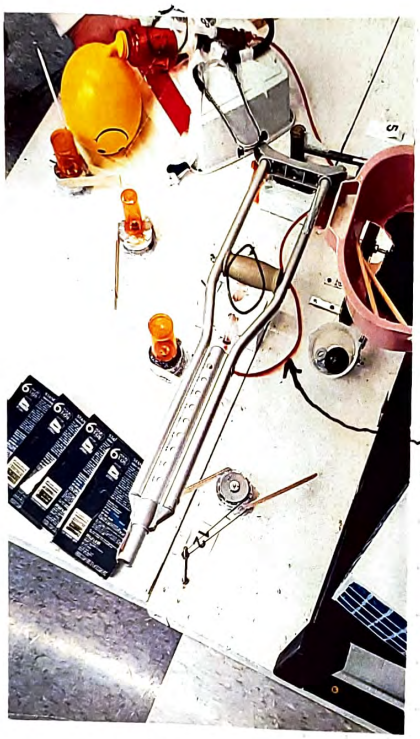
We decided to use syringes because of our medical theme.

Example of syringe we used.



We used tubing to connect two syringes and when one syringe is pushed down the other pushes out displaying fluid power.

Fluid Power



We died the water red so it is visible and it looks like blood.

This shows the crutch pushing down the one syringe and the water pushing out the other syringe setting off the chemical Reaction.

Testing

Engineering Machine Testing Phase

One key thing that seems to keep going wrong is the ballon not setting off the tongue depressors. We have to be very careful of the placement of the balloon.

Another issue is the cooler lid not always closing. We have to be careful the string is always attached.

The way to fix these problems is to have a checklist and make sure everything is setup perfect with certain people being in charge of certain steps.

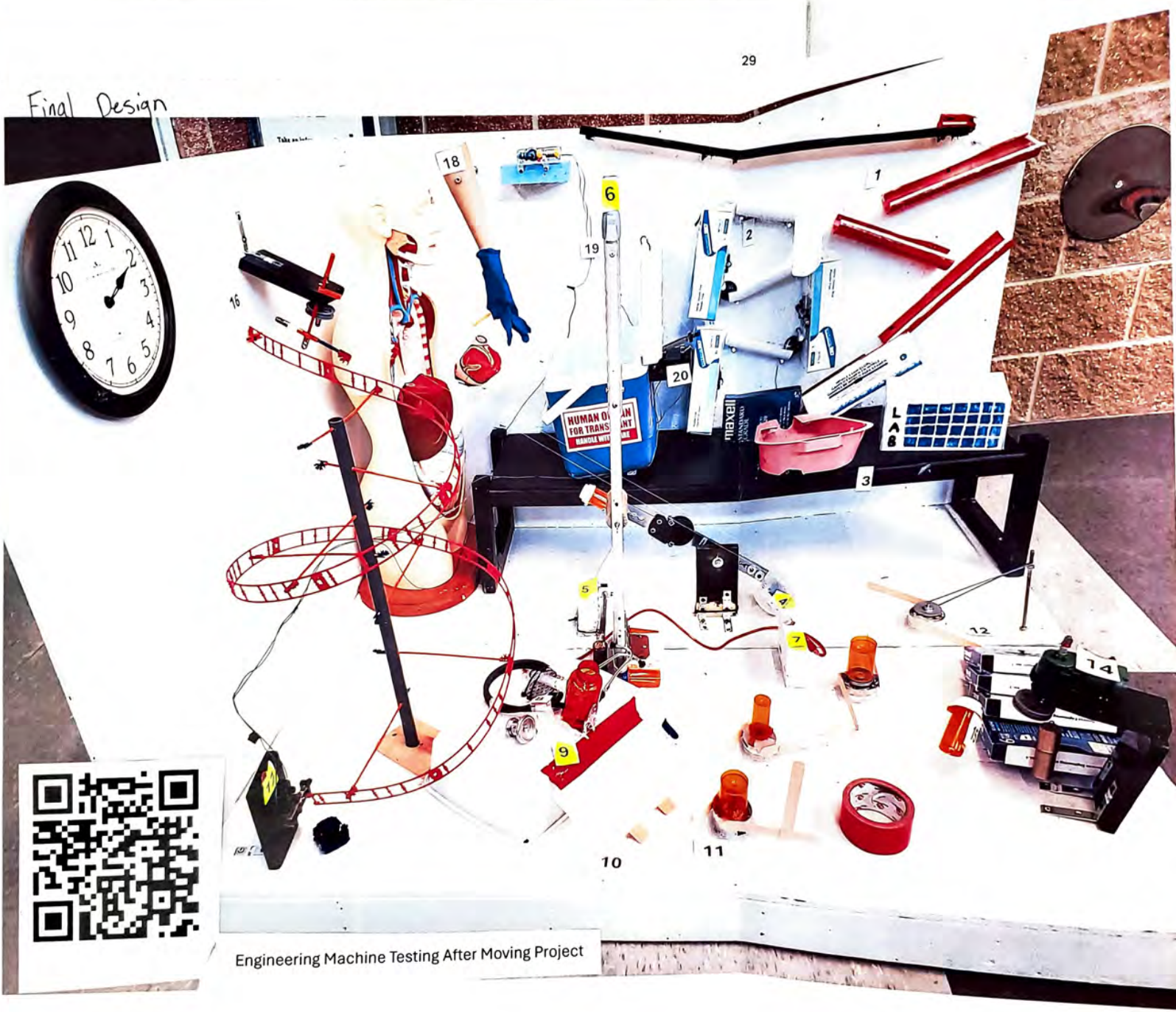
Steps of EMDC

GPE – Gravitational Potential Energy KE – Kinetic Energy EE – Electrical Energy

CPE – Chemical Potential Energy

1) GPE to KE Ambulance and eyeball going down the ramps
2) KE to GPE Ball in the reverse ramp
3) GPE to KE Ball falls in the bedpan lowering it
4) KE Ball landing in the beaker turns to KE of the pill bottle-type 1 lever
5) KE As KE of pill bottle knocks over the hammer that has GPE
6) GPE to KE GPE of the hammer turns to KE and hits the crutch with GPE
7) GPE to KE GPE of the crutch changes to KE pushing on the hydraulic syringe
8) KE Opposite end of syringe KE pushes over pill bottle
9) KE to ~~GPE~~ CPE KE of pill bottle released vinegar to CPE
10) CPE to KE Chemical PE turns to KE as balloon expands
11) KE Balloon expanding pushes on tongue depressor series
12) KE The tongue depressor series pushes over the VHS training tapes
13) KE The KE of training tapes knocks over heavy weight that has GPE
14) GPE to EE The GPE of weight pulls on switch to go to electrical energy
15) EE to KE to GPE EE causes pulley system with the pill bottle to move
16) GPE to KE Pill Bottle knocks over car on DNA helix
17) KE to EE DNA helix car rolls and closes switch
18) EE to KE EE of that circuit moves arm that pulls out heart and drops into cooler
19) GPE to KE GPE when the heart drops turns to KE, it shuts the cooler-getting heart ready for transport
20) KE When the cooler closes it opens the switch to shut off the motor

Final Design



Engineering Machine Testing After Moving Project

Project Final Design

Date 3/14

Name Samuel D. Brac

VEX ROBOTICS

PROPRIETARY INFORMATION

Cost Analysis	Price($)	# of How Many	Total for Item
Kinex track	0.15	13	1.95
PVC pipe	1	5	5
Box of Gloves	10	3	30
Golf Balls	0.7	3	2.1
VHS Tapes	0.5	5	2.5
Pill Bottles	0.1	8	0.8
Syringes	0.1	5	0.5
Bedpan	0	1	0
Crutch	30	1	30
Knee Brace	800	1	800
Fake Arm	10	1	10
Motors	10	2	20
Anatomy Body	1000	1	1000
Baking Soda	6	2	12
Vinegar	4	2	8
Axles	0.1	8	0.8
Wood	100	1	100
Screws	0.25	30	7.5
Cooler	25	1	25
Clock	5	1	5
Switches	6	2	12
Turn Tables	50	4	200
Wire	0.1	2	0.2
Hinges	1	8	8
Stethiscope	30	1	30
Graduated Cylin	2	1	2
Urinary bag	10	1	10
Bronze Hammer	15	1	15
car	1	1	1
Eye	6	1	6

Total 2345.35

All was recycled from old projects

Bibliography

"Baking Soda and Vinegar Experiment." *Primaryconnections.org.* https://www.primaryconnections.org.au. Accessed 5 Mar. 2024.

"Electrical Engineering and the 4-H Engineering Design Challenge Level 2." Minnesota 4-H Stem Program. https://engineering.mnsu.edu/wp-content/uploads/2020/03/Electricity-4H-Engineering-Design-Challenge-handbook-level-2-2018-2.pdf. Accessed 7 Mar. 2024.

"Fluid Power and the 4-H Engineering Design Challenge Level 2." Minnesota 4-H Stem Program, https://engineering.mnsu.edu/wp-content/uploads/2020/03/Fluid-Power-4H-Engineering-Design-Challenge-handbook-level-2-2018-3.pdf. Accessed 7 Mar. 2024.

Walker, James. *Torque.* Pearson, 2014.

Project Reflection

Name Samuel G, Brae

Engineering Machine Design Contest Reflection-Learning or Growth and Major successes/challenges:

Sam- One of the largest areas of growth was a complete application of the design process and thinking about how engineers do that every day with their projects. The robotics kids on our team are used to doing that all the time, but I've never had to do the entire process multiple times and record. The engineering journal was a new step for me. Each step seemed to have so many failures with testing, and working our way through that process helped us organize better. We thought about how documenting the steps as we went impacted us and we were able to look back and reflect on what scientific applications helped. One example would be the DNA helix step where the car shuts a circuit. We couldn't get the car to shut the circuit when we first placed the switch on the project but thought about Torque and having a longer lever arm. When we realized we made the lever arm longer by moving the switch to the left, it made sense that the car was able to then move the lever better. One major challenge for me in this project was managing my time and getting everything accomplished. I am in sports and also work a half day for our family business as I take a lot of PSEO classes. Another challenge I faced was problem solving, having to change an idea if it did not work properly and not to be stubborn and only stick to the first idea. It was also a challenge having to document the design process as it was my first time having to do that and all of my classmates had to do that previously in robotics.

Jessie- Last year we learned stoichiometry in Chemistry, so when we had to apply it this year in an actual situation, it helped solidify that in our brains. I was a bit rusty, so when I looked up the reaction and had the teacher show a similar example of a problem we did last year, it all made more sense. A challenge for us was to figure out how to activate the chemical step. We originally wanted to use a glove, but we could not quite get it airtight for the reaction. We instead decided to use a balloon and that has worked well for us in our runs.

Cody- I learned the most in the electrical circuit. We haven't done electricity yet in Physics, and we hardly had any time with it in physical science in 9th grade. So, the teacher brought up our practice with the schematic diagram and how electrical engineers use that to communicate with each other. It was interesting to get it to work and we learned it again for this project. Some major challenges for this project were trying to get all the steps to integrate with each other. Another challenge was trying to figure out how to get ideas to work and work consistently. Some successes were the training videos dropping the mass allowing turn on a motor and continue to the next step. I will use all the problem-solving skills I have applied here to help with my college degree as a mechanical engineer and in my job to fix problems we have. These skills are something I will use daily and will come in handy.

Luka- it was hard for me to think of how to change directions on the machine when multiple steps were there. When something is falling one way, then to get it to go a different way drove me crazy. I learned a lot with the fluid power step as I had to get it right to connect the beginning to the end steps and I just needed to use tubing from my dad's work. Doing this project gave me a refresher on how the energy transfers take place. For example, the change from gravitational to kinetic when the golf ball falls to the bedpan to then make the lever turn. I also learned a lot about how hydraulics work. It was very interesting to learn how pressure in the tubes can transfer almost the exact amount of force that is applied to it. Some other things that I was also able to learn was how to work with a team better.

Jack- my biggest growth happened when I had the circuit wrong and realized the two switches were different on the bottom. Once I looked at the extra two switches to see how they were connected with the conductor, I figured out what I did wrong. One thing that was a major challenge was to combine all of the steps in the middle. As noted, we started with the beginning few steps and the end few steps at the same time. This made it difficult in the end to combine all the steps. There were many different ideas that needed to come together and then we also had to change some steps to accommodate the other steps. This also served as a refreshed for the energy transfers.

855 Words

Project
Date

Name