MN ENGINEERING CONTEST 2023

CHATFIELD HIGH SCHOOL

Journey to the 4th Planet

Team Members:

Captain/Artist: Claudia

Journalists: Mackenzee, Marianna, and Ella

Storyteller: Nick

Technician: Rachel and Charli

Mechanic: Aiden

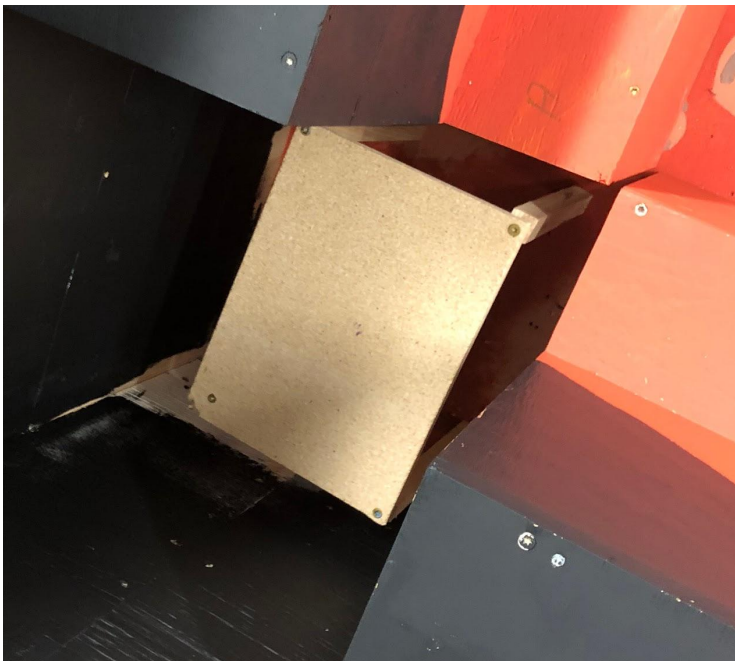
1. The Progress:

- Nov. 4 2022: Beginning pieces of machine walls and shelves made from scrap plywood

- Nov. 11 2022: Technical advisor Mr. Dietz & Rachel mounting removable shelves for added potential energy spaces

- Nov.11 2022: Shelves fully positioned & early start of astronaut arm lever

- Nov. 11 2022: Nick and early planning of the final step



- Dec. 21 2022: Fully painted machine. Table installed for the rocket in the back corner. Ready to attach the steps and ideas we've built up to this point!

- Jan.11 2023: The machine is coming together! A lot of ideas were just thrown onto the board to see what worked (and what mostly in the beginning, didn't.)

- January 22, 2023: some ideas have come and gone, we have our last step finalized and catapult built. The holes are being drilled for the lights!

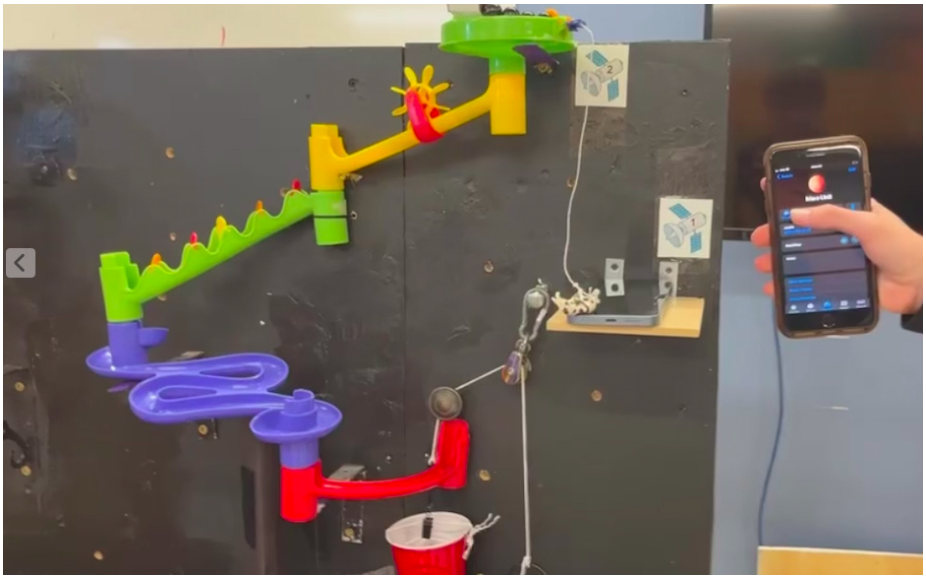
- January 29, 2023: Charli testing flying cow step

- February 11, 2023: End of a long Saturday spent cooped up as a team running the machine. Tons of process made in days like these (and a lot of Taylor Swift blasting on speakers!!)

- February 22, 2023: The machine has some new additions like the mars garden and asteroid dominos. So much progress happened in the last couple weeks, one thing just kept getting finalized after another.

- February 22, 2023: Although a lot of things have been added, some had to be taken away. This was the conveyor belt prototype that just wasn't consistent enough to stay on our machine

- March 4, 2023: Replaced our conveyor belt with american themed downspout and old film reel wheel system. This is ALMOST our final machine. We have yet to add final decorations and ended up changing the first step shortly after this photo was taken

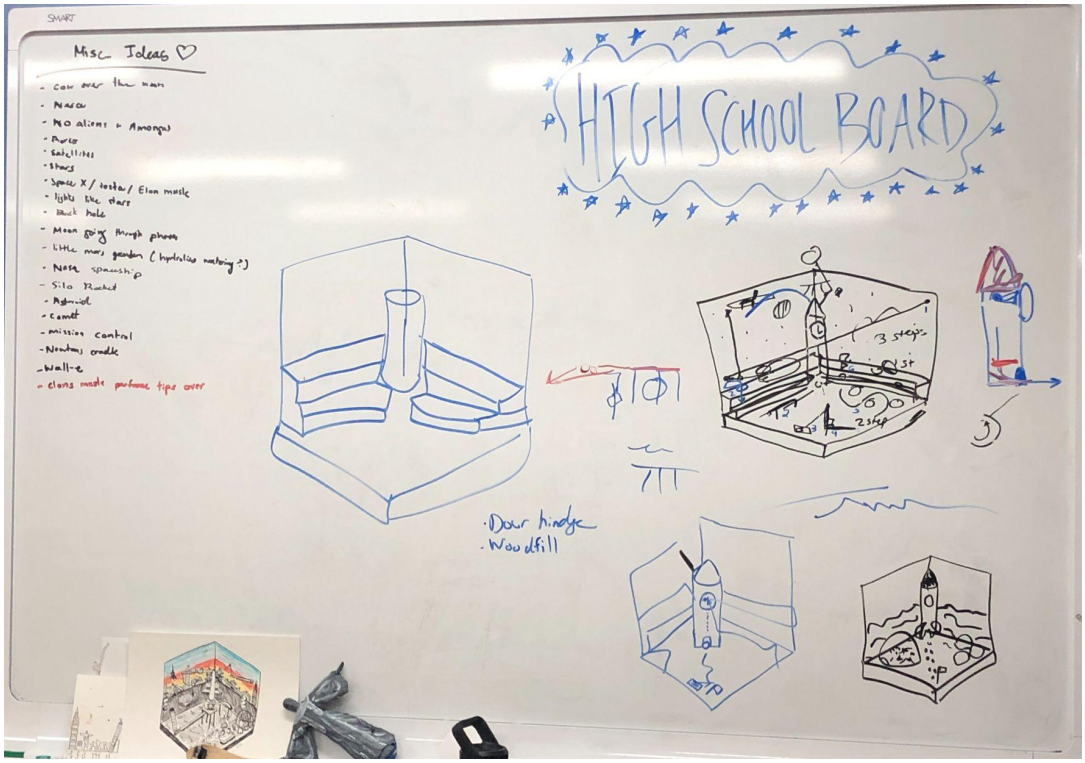


- March 9, 2023: We added this step after realizing that our lighting up the stars alone wouldn't be enough for a true electrical component to our liking. This is one of our favorite steps as the call from mission control vibrates a cow off the phone while simultaneously playing the original batman theme (I know right? AWESOME)

- With this first step altered and decorations (small flags and labels added) we now had the completed back of our machine!

- March 17, 2023. The team got together on St. Patrick's day to tye-dye our costumes (shown in plastic bags) and go out to eat as a group to celebrate the final pieces of our machine and presentation coming together.

2. Initial Sketch and Design:



This is how our board starts out each year. We figure out the basic layout of the machine and the things we need to build such as rebuilding our base and adding our stair-like shelves. We saw the theme and immediately thought of having a rocket as a centerpiece during a brainstorming session. We had the idea of putting our civilization on Mars considering Nasa's efforts to go there, so we could really play around with the Technology based theme. We all agreed immediately, and it all really took off. We wanted to start at the top to maximize potential energy, and we included elements that benefited us in previous years.

3. Advanced Components:

Electrical step: the electrical component is bolded

Our electrical step comprises a **cell phone and the vibration** from a call. As a result of the unbalanced motor rotating rapidly the phone vibrates. This is called Eccentric Rotating Mass. Our team member Marianna and our Advisor Mrs. Gathje had a brainstorming session and came up with the phone falling and pulling off a clip releasing a ball. This didn't end up working so Nick and Claudia came up with the idea we are currently using. Our last step also has an electrical element as it uses a **button to turn on a set of string lights** representing the stars in the galaxy. We came up with this step last year but because of the 9-volt

battery limitation we couldn't utilize it. When we saw the change to the rules this year, as well as the theme, we knew we had to add lights in somehow.

- **Electrical steps videos below**

https://youtu.be/27UNehjcEN0
https://youtu.be/7Qz9T_cRsO8

➔ **Mechanical step:** Every member of our team has taken engineering 10 and Physical science and applied this to the machine. Levers are vital, such as the astronaut arm. We utilize spring on several occasions, most notably in the mouse traps. These are a few of numerous examples.

➔ **Hydraulic step:** Our hydraulics are pushed down by a heavy weight. We learned last year that pulling the hydraulics was less reliant than pushing force onto them, and the heavier the better. We also put antifreeze in the tubing, as recommended by a judge last year, as our hydraulics froze during transportation.

- **Hydraulic step video below**

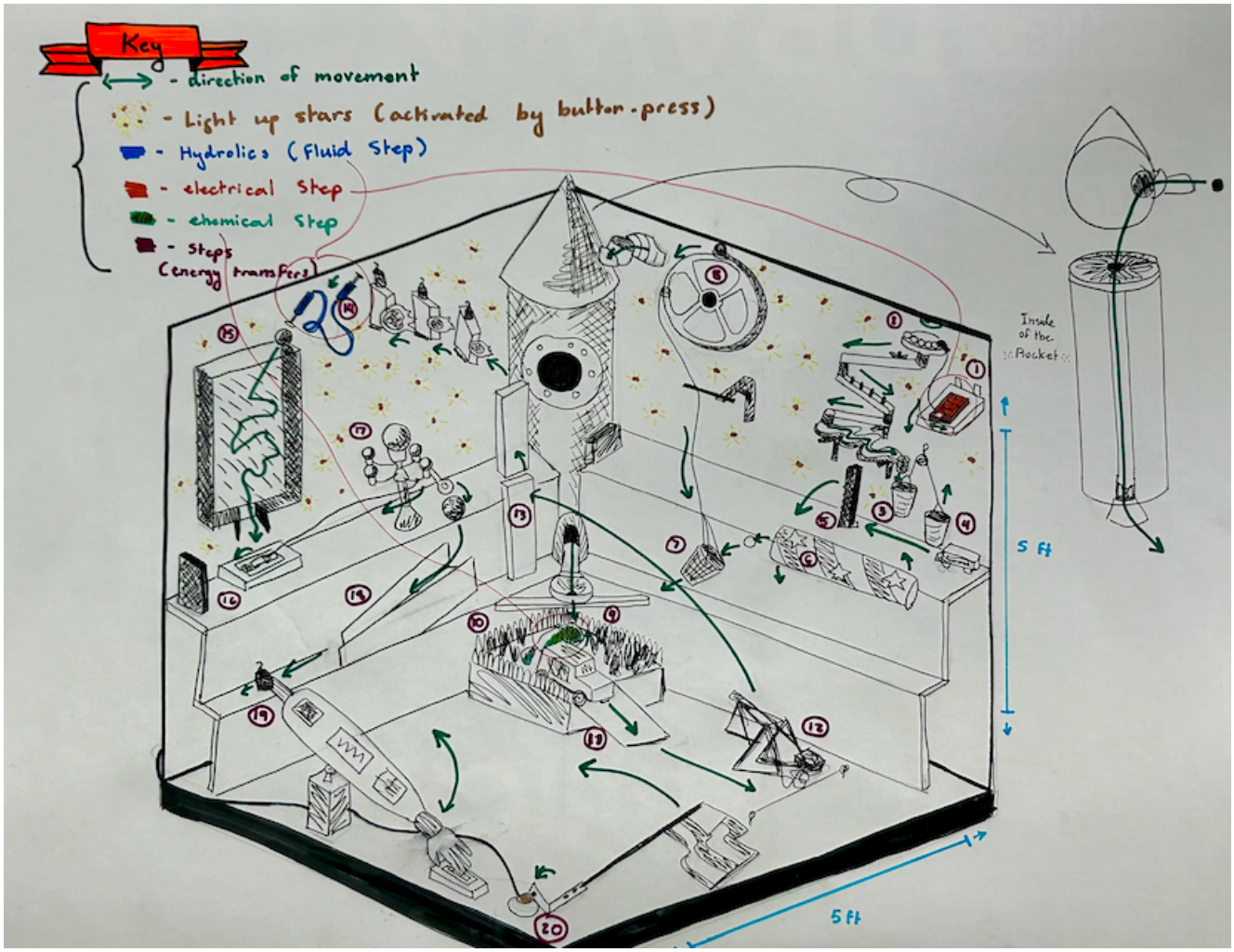
https://youtu.be/-wch92mWUew

➔ **Chemical step:** To make a safe and reliable chemical reaction we used baking soda in a balloon and vinegar in a bottle. We placed baking soda into a balloon. The bottle is lifted, spilling vinegar in the balloon, creating a gas that fills the balloon and nudges the car forward.

- **Chemical step video below**

https://youtu.be/DrNQ6UKDesg

4. Final Machine Drawing and Photo Description:



- *This is our final machine sketch drawn by Claudia. It labels what way the direction of the machine is flowing, our advanced components and a diagram of what the inside of our rocket looks like. Our steps are labeled in purple.*

- *What's our story?* America has established a colony on Mars, utilizing the water, cultivating a space garden to grow produce, and using the most up-to-date technology to thrive on the red planet. It
- all begins as you (acting as Mission Control at N.A.S.C.) send a call to the Mars Unit to raise the American flag on the new frontier. Take a ride on a rover, travel through a rocket, and fantasize getting to one day explore our solar system with us as we journey to the 4th planet.

FULL RUN VIDEO BELOW
https://youtu.be/u0OdvSxOwxE

5. List Of Machine Steps:

Please note: The red word in each step indicates which object has the energy
Blue is the hydraulics step
Green is the electric steps
Orange is the chemical reaction
The underlined word refers to the simple machines used to create the mechanical energy transfers

1. Our trip through the 4th planet starts with a phone call from mission control. When the phone is called, the vibration (electrical step) makes the cow on a string fall off the shelf,
2. releasing a barrier that holds 6 marbles that roll down a set of marble works inclined plane paths, falling into a red solo cup.
3. When the marbles make one cup go down, the other cup on the pulley is lifted,
4. releasing the blue pullback Volkswagen wheel and axle.
5. The Volkswagen hits a piece of wood on a hinge, a third class lever, causing it to fall forward.
6. The falling wood lands on the end of the downspout, a first-class lever, tipping it and releasing a
7. blue marble to roll down the downspout ramp and falls into a basket
8. The basket that releases a golf ball off of the wheel and axle
9. into the rocketship ramp and rolls into a red solo cup pulley system.
10. The weight of the cup raises the other side of the pulley system raises causing the vinegar bottle to tip forward, enter the balloon and mix with the baking soda. The chemical reaction produces carbon dioxide which inflates the balloon.
11. The balloon inflates pushing the Jeep down an inclined plane
12. The Jeep hits a tripwire releasing the catapult and launching Corey the cow
13. Corey the cow hits a set of dominoes, all on first-class lever hinges
14. The last domino falls on the plunger of a hydraulic syringe system, forcing water to lift the other end of the syringe using fluid pressure.
15. The fluid pressure of the hydraulic syringes pushes the green golf ball, which falls down the Plinko board landing on a mouse trap.
16. The mousetrap lever pulls a wound string on the
17. candelabra, which is a wheel and axle, causing it to spin.
18. The candelabra hits the planet which then falls down the blue inclined plane
19. The planet hits the weight off the astronaut's arm, a first-class lever
20. The other end of the astronaut's arm falls triggering a mouse trap lever attached to a string and raises the American flag turning on the lights and lighting the skies of Mars.

6. Machine Costs and % recycled materials

The majority of our machine is made either from recycled or donated materials. We acquired these materials from departments in our school, our own homes, or what was left in the old Chatfield Rube Goldberg Team Room. The only thing we purchased was paint. We were given a budget of 20 dollars for paint so, **the total cost of our machine was 20 dollars.** 44/45 items on our machines are recycled or donated. This makes our machine **97% recycled.**

Paint- $20
Paint brushes- Donated by Claudia
Paint rollers **-** Donated by the former Chatfield Rube Goldberg Team
Wood fill - Donated by the Shop Teacher Mr. Willette
Hydraulics syringes- Recycled
Hot Wheels track- Donated by Nick
Phone- Borrowed from Claudia
Plastic cows (Corey and Dairy QUEEN)- donated
String and Fishing Line- recycled from homes
L-brackets- donated by the science department
K'nex- Borrowed from the science department
Weights- Borrowed from the science department
Eye hooks- Found in the room we used
Marbles- recycled
Film reel- Donated by the school
PVC pipe- donated by the science department
Rocket materials (duct-tape, paper, tubing, wooden ramp)- donated by Claudia
Golf Balls- Recycled
Plastic toy marble runs- found in the Chatfield Rube Goldberg Area
Mousetrap- donated by science department and Makenzee
Astronaut arm- made from recycled materials
Candelabra- recycled
Miscellaneous balls- recycled or donated by the former Chatfield Rube Goldberg Team
Scrap Wood- Recycled

Bottle- Recycled
Toy jeep- donated
Solo cups- recycled
Garden plants- recycled from old felt
Garden grass- recycled from old turf
Garden fence- recycled from old ping pong table net
Paper- Donated by the school
Spoon on candelabra- Recycled
American flag- Donated from school D.C. trip
Pull-back volkswagen- donated by Claudia
Balloons- Recycled
Pulleys- Donated by the Science Department
Funnel- Donated by the science department
Hot glue sticks and hot glue guns - Donated by the science department
Popsicle stick- Recycled
Plastic- recycled
Christmas lights Button- Donated by Nick
Christmas lights- recycled from homes
Bolts- Leftover from the year before
Nails- Leftover from the year before

7. Reflection

Our team experienced a growth in companionship and in applicable scientific knowledge. Firstly, it must be noted that certain team members worked on steps for days (even weeks) for the rest of the team to ultimately remove it. One team member, Marianna, worked hard on a Conveyor-belt made of Knex, but she didn't have the resources to succeed. We all understood the importance of height for more potential energy. Several team members attempted a solution, but it wasn't found until a film reel–which could perform a similar function–was installed in its place. While this was an instance of overcoming an obstacle, it could be argued that the most gargantuan hurtle we surmounted was that of our catapult (or, rather, Corey the Cow's attempt to fly over the moon.) This step was unreliable for the first 3 months of its conception. Rubber bands were changed, weights were added and subtracted, and even dominoes were added. In the end, a solution was found between all these adaptations, where a domino was added (so that Corey had a greater likelihood of hitting it), strings were pulled more taut, and the releasing mechanism was simplified. This showed us that there are multiple right answers to a problem. Lastly, many hours were spent on the first step. How does one let a shaking phone start a machine? The answer was found

in another cow and some tracks for marbles. This came after attempting other solutions that failed, one of which showed us the phone needed to be lying down (and that the majority of a phone's vibration occurs at the base of it.) We applied this with a cow (a plastic one, mind you, not the real kind) and we had a wonderful interactive first step. This team has grown so much as a community since fall. We have learned to work together and listen to each other, which can be hard for teenagers (and some adults, we suppose.) We have learned simple concepts are always at work, such as friction slowing down a ball or that an object's mass has a direct relationship to it instigating (or stopping) the reaction of another step.

- Just to truly show how much our machine has gone through the ups and downs, we've included a video below of the machine NOT working, how much fun we all had together laughing over our mistakes and failures. (P.S. this video was taken 24 hours before we got our first full run of our machine, which really shows how unpredictable the process can be)

Word count: 424

Failure video:
https://youtu.be/XYktweMlgos

8. Bibliography:

Allan, Stephen. "Which Materials Carry Sound Waves Best?" *Sciencing*, 2 Mar. 2019, https://sciencing.com/materials-carry-sound-waves-8342053.html.

- **Used when we were experimenting with our first step, we originally wanted the phone to be vertical rather than horizontal. However, we decided that horizontal was more practical (and more importantly, safer for Claudia's new phone!)**

Baker, Sandra "Mechanical Performance of Rat, Mouse and Mole Spring Traps, and Possible Implications ." *PloS One*, U.S. National Library of Medicine, 2012, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3387155/.

- **We wanted to look into just how much power a mousetrap had and if it would break our strings when it snapped back or be too weak to put them back far enough.**

Egby, Farah, director. *Medium*, Everyday Science, 20 Feb. 2020, https://medium.com/everyday-science/what-makes-your-smartphone-vibrate-9f3670e74759#:~:text=As%20the%20voice%20 coil's%20 magnetic,frequency%20 specific%20to%20the%20device. Accessed 20 Mar. 2023.

- **This was watched when we were trying to build our first step and was trying to decipher if this would count as an "electrical component"**

"Isopropanol Based Freeze Protected Water Solutions." *Engineering ToolBox*, https://www.engineeringtoolbox.com/ispropanol-water-d_988.html.

- **On the way up to competition last year our hydraulics (filled with water) froze. This chart was used to see if rubbing alcohol would be ok in the trailer overnight and ride up to Mankato without freezing and bursting**

"Newton's Laws of Motion - Glenn Research Center." *NASA*, NASA, 27 Oct. 2022, https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/newtons-laws-of-motion/.

- **We researched this to refresh our memory on Newton's Laws of motion and how they applied to different steps of our machine.**