The Brainiacs

Cotter Junior High School

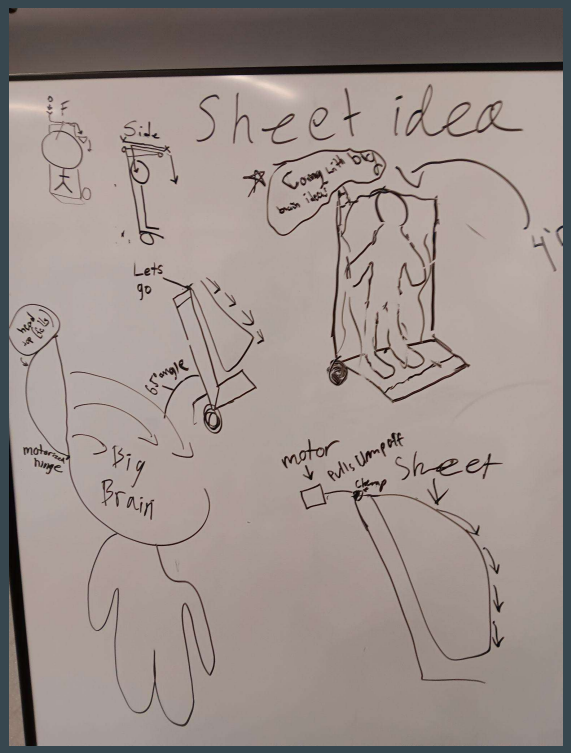
•••

Human to Tech Transfer: Advancing Technology by Reverse Engineering the Body

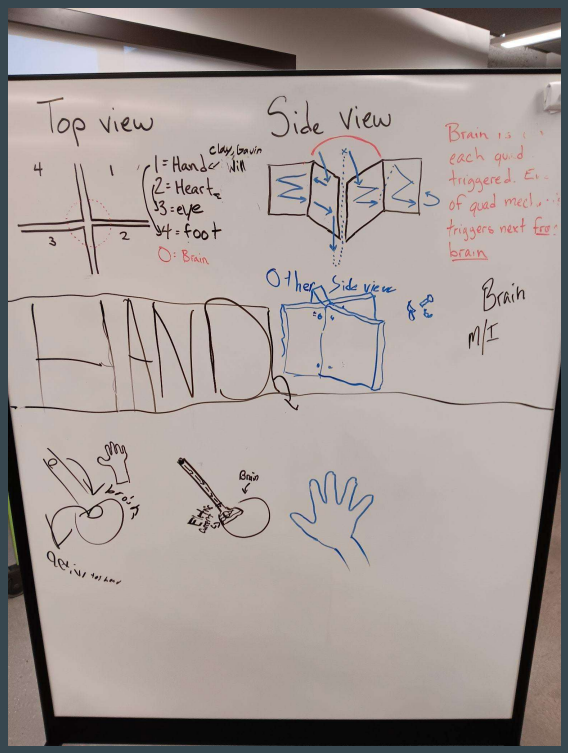
2024 Engineering Machine Design Challenge
Journal

Table of Contents

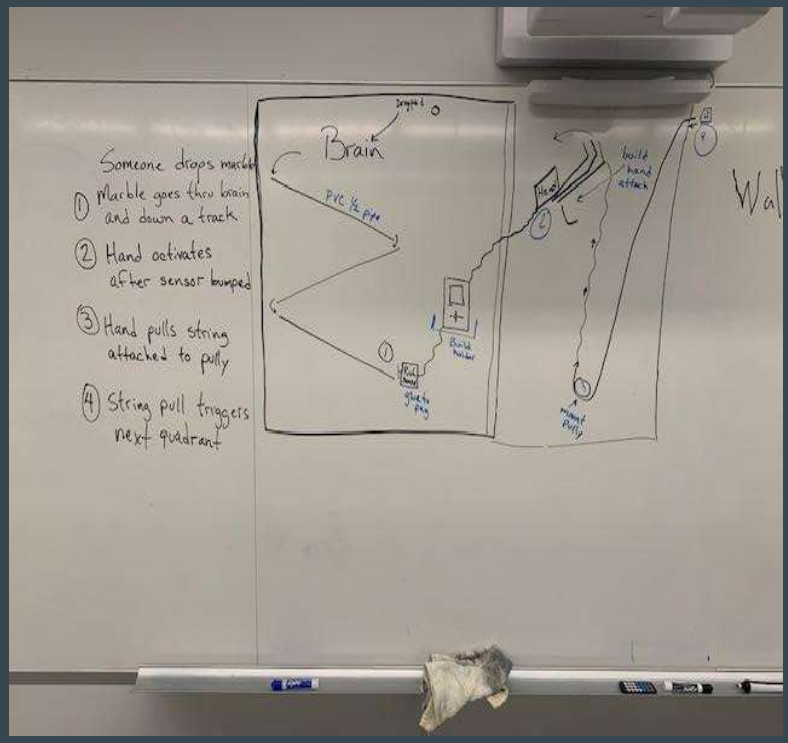
Planned Machine Design Sketches and Descriptions



Our first brainstorm. We dumped this idea.

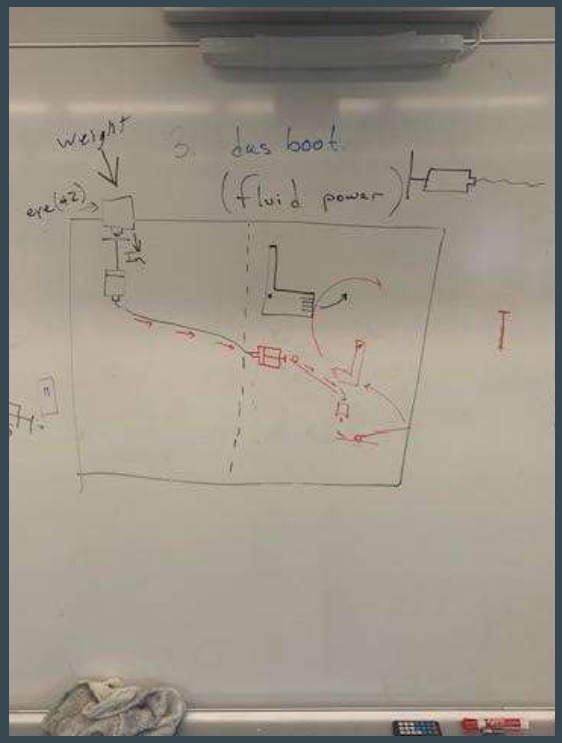


Our second brainstorm, using pegboard quadrants

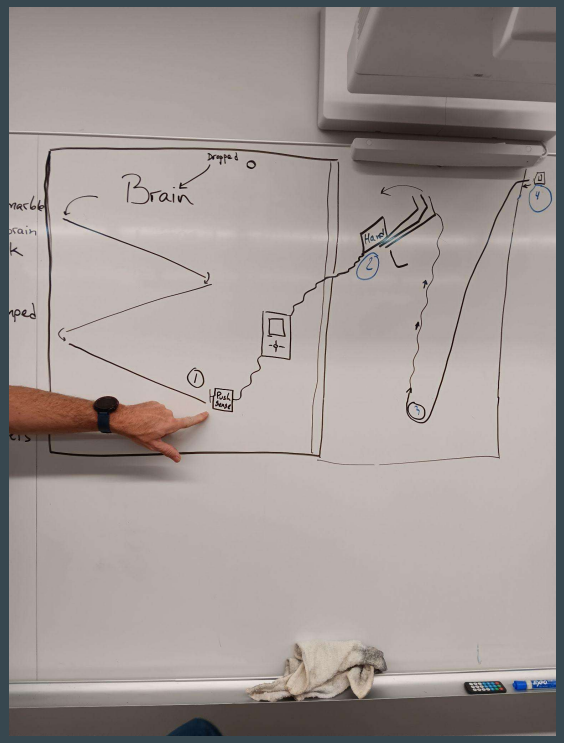


Brainstorm sketch of The Hand. We stayed with this idea.

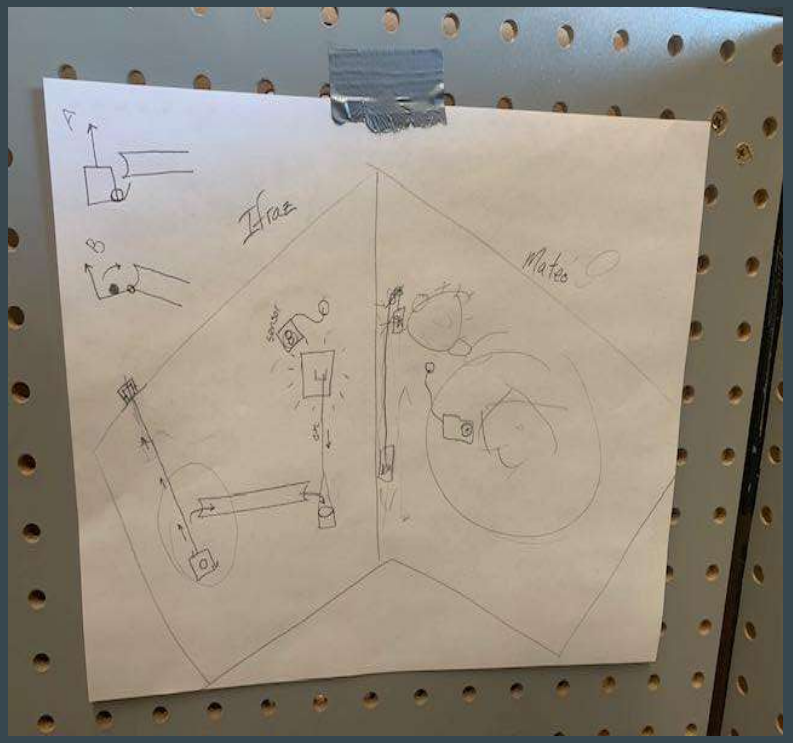
Planned Machine Design Sketches and Descriptions 2



The initial idea of The Foot. We modified this draft concept.

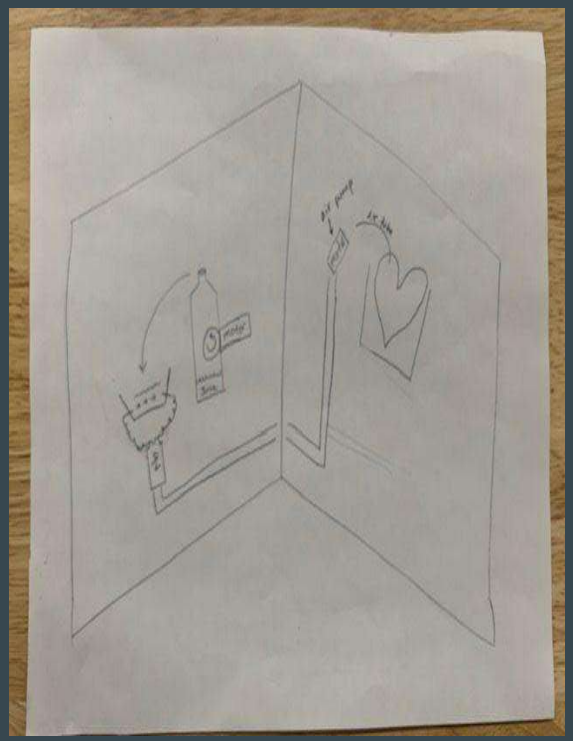


Further work on The Hand idea

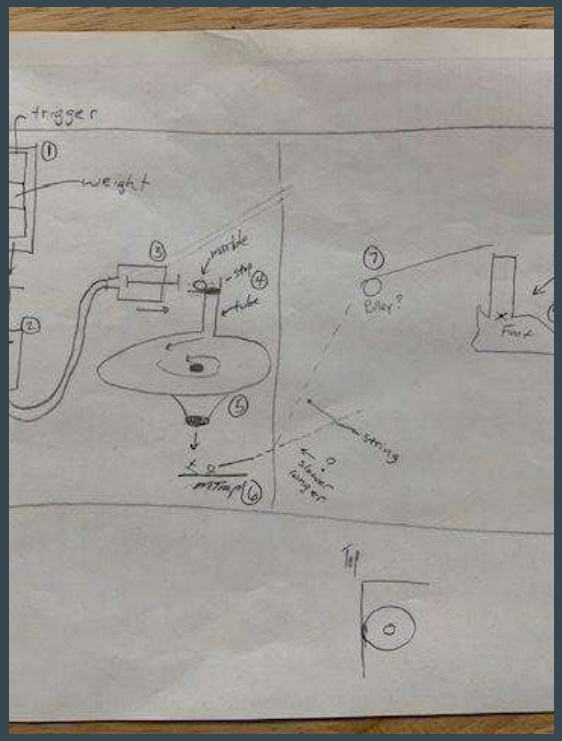


Our most ambitious quadrant, The Eye.

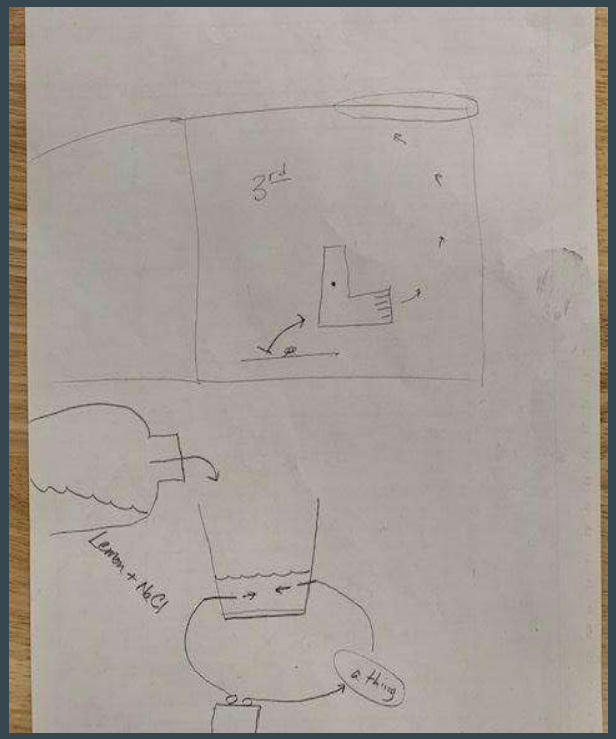
Planned Machine Design Sketches and Descriptions 3



Quadrant 4, The Heart. We mainly stayed with this prototype idea.

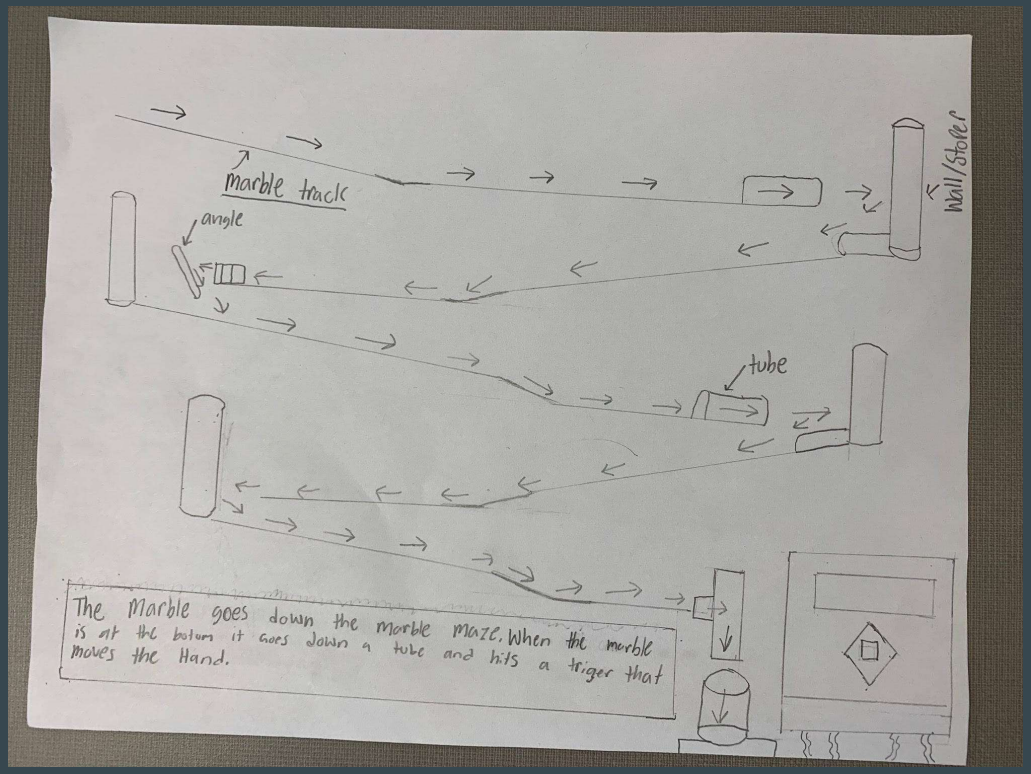


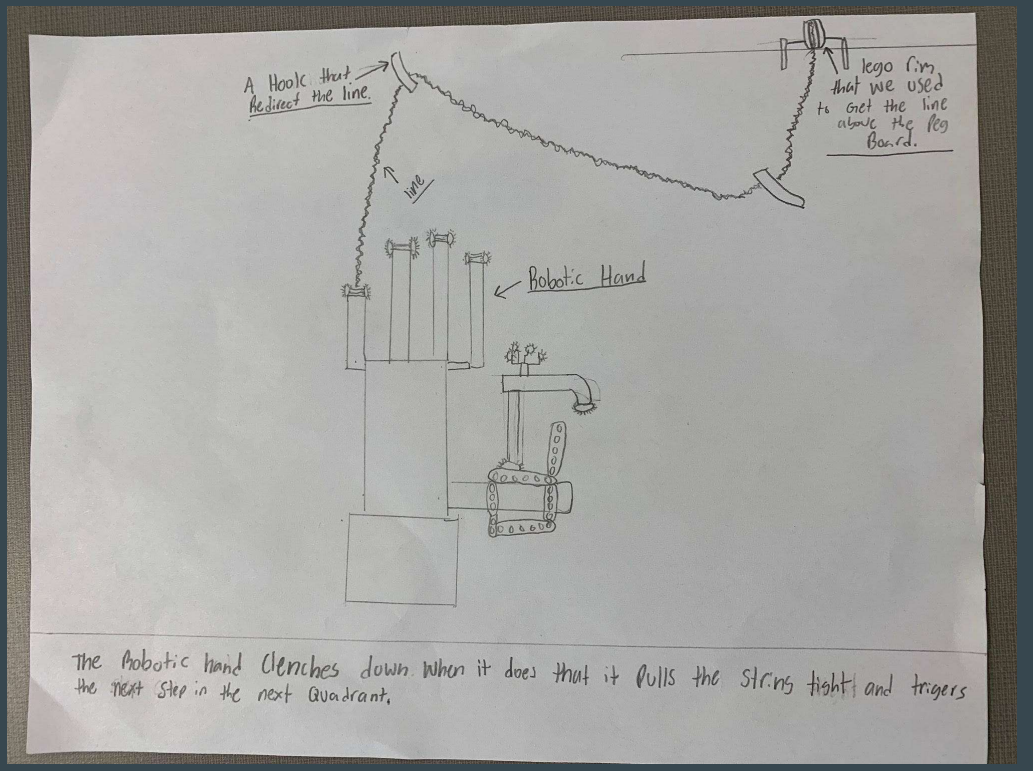
Further development of the ideas for The Foot.



Looking closer into the ideas with the electrolytic fluid concept.

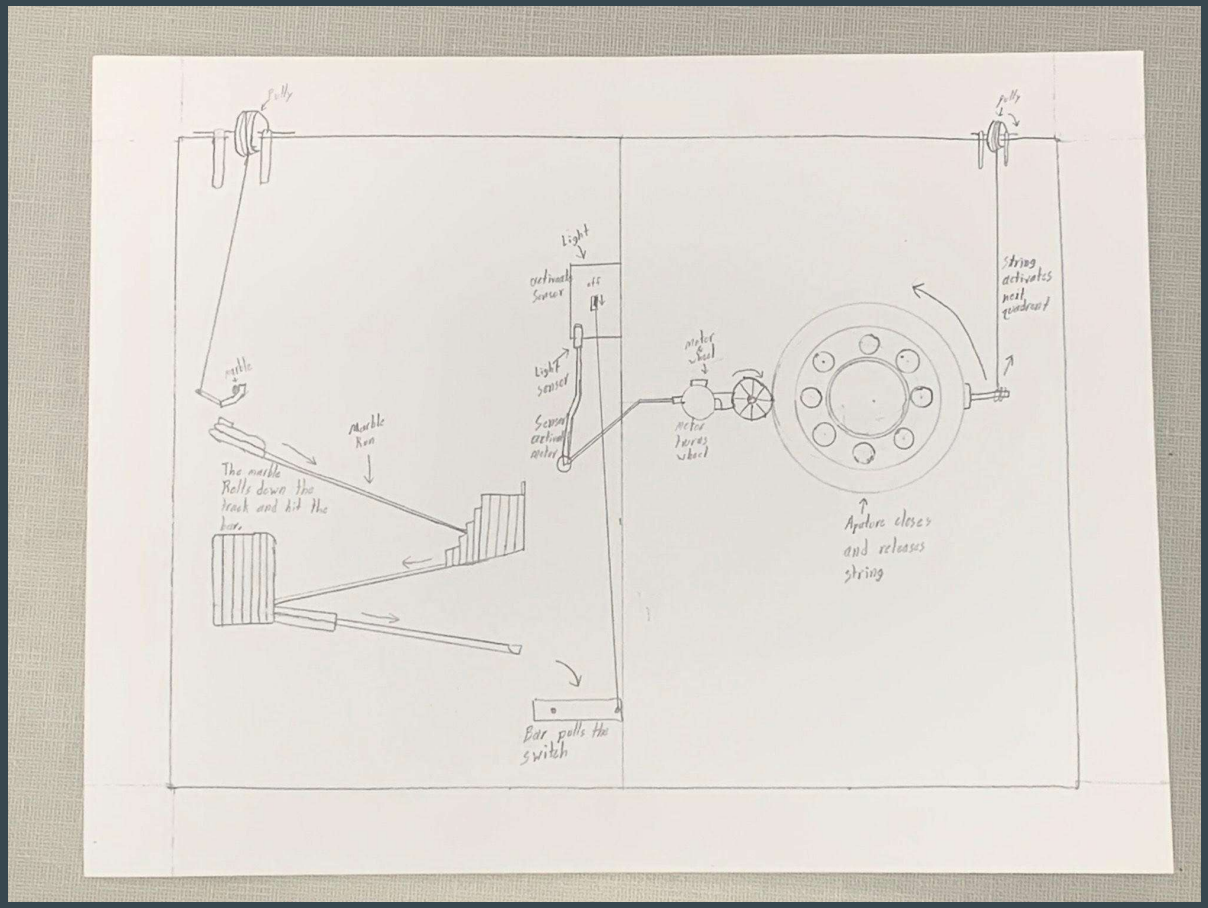
Final Machine Design Images and Descriptions 1: The Hand





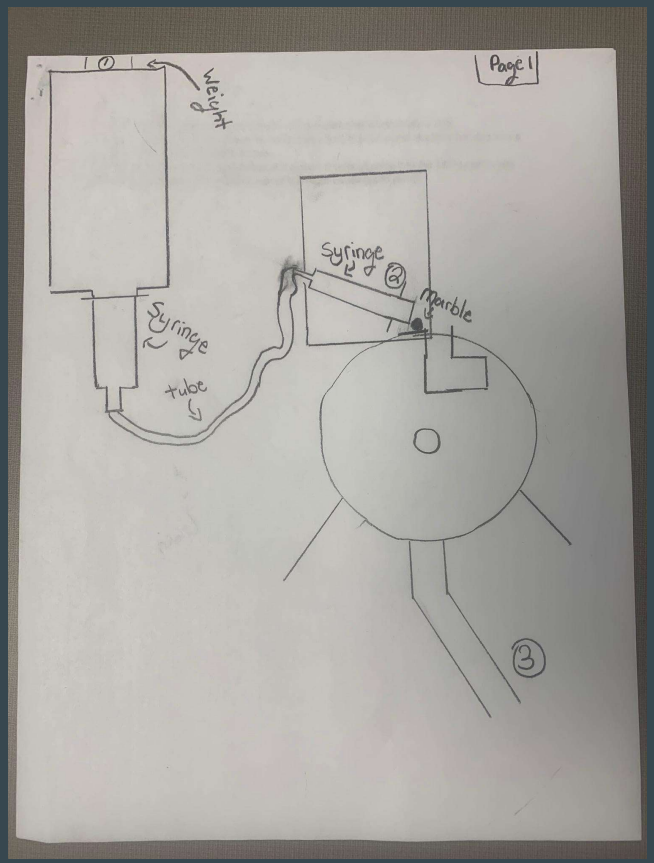
The marble does down the marble maze. When the marble is at the bottom it goes down a tube and hits a trigger (touch sensor) that moves the hand. The robotic hand clenches down, when it does that pulls the string tight and triggers the next step in the next quadrant.

Final Machine Design Images and Descriptions 2: The Eye

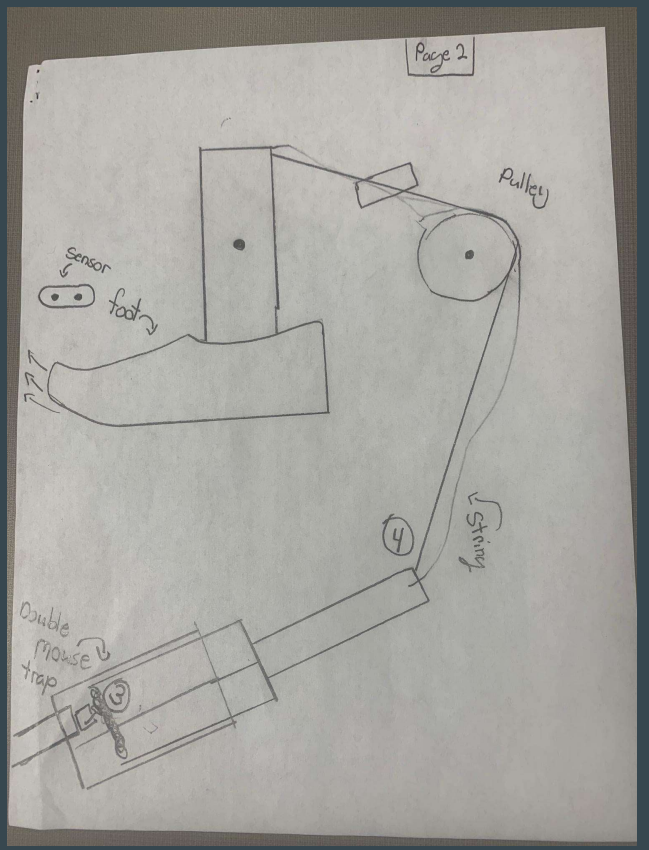


The hand in the previous quadrant pulls a string which moves a lever with a marble on it. The marble travels down a track and hits a lever. The lever drops and pulls a string. The string pulls a light switch (from EMDC, 2023!) that turns on. The light activates a sensor that starts a motor. The motor turns the outer bowl part of The Eye. When the outer bowl turns, the aperture dilates. The turning bowl releases a trigger into quadrant 3.

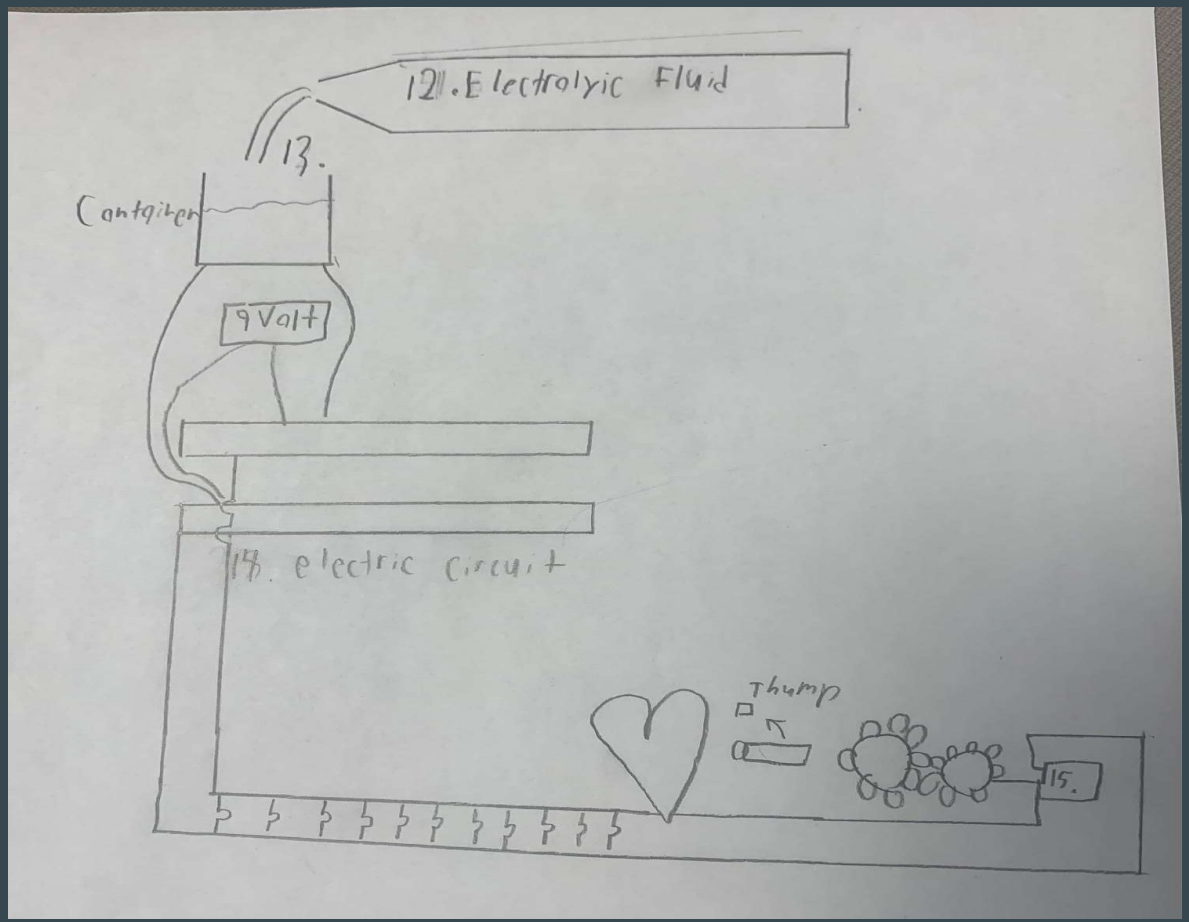
Final Machine Design Images and Descriptions 3: The Foot



The pulled string from quadrant 2 lowers a weight onto a pneumatic piston. The piston is pushed in which then pushes out the second piston that knocks a marble into a spiral bowl. The marble travels down and activates a mousetrap. The mousetrap pulls a string when activated and that string makes a foot swing in front of a motion sensor.



Final Machine Design Images and Descriptions 4: The Heart



The foot sensor activates a motor that pours a container filled with electrolytic fluid. The electrodes at the bottom complete the circuit and directs voltage/current to the LEDs and motor. The motor turns a whirlygig that hits a drum, causing the heart to have the sound of a heartbeat.

List of Machine Steps

1. **Quadrant 1, "The Hand"** -The marble is released by hand into the brain on the top of the machine. It travels down a marble track and lands on a touch sensor
2. The sensor activates a motor that causes a mechanical hand to squeeze
3. The squeezing mechanical hand pulls a string that moves through a pulley and into quadrant 2
4. **Quadrant 2, "The Eye"** -The string going through the pulley moves a lever that has a marble resting on it, the marble moves down a marble track and hits a falling lever
5. The falling lever pulls a string that is attached to a EMDC 2023 light switch, and activates that then lights up
6. The light is sensed by a light sensor, which activates a motor that turns the aperture of "The Eye"
7. The motor that rotates the eye also pulls a string and moves the energy into quadrant 3
8. **Quadrant 3, "The Foot"**- The pulled string lowers a weight onto a pneumatic piston
9. The piston is pushed in which then pushes out the second piston that knocks a marble into a spiral bowl
10. The marble travels down and activates a mousetrap
11. The mousetrap pulls a string when activated and that string makes a foot swing in front of a motion sensor
12. **Quadrant 4, "The Heart"**-The sensor activates a motor connected to a container of conductive fluid, lemon juice with salt in it.
13. The motor rotates and causes the conductive fluid to pour out of its container and into a reservoir with electrodes at the bottom
14. The electrical circuit is completed and directs 9 volts of current to the LEDs and motor
15. The motor moves a whirlygig on a motor that makes a thumping noise and an LED light illuminates the heart

Advanced Components

Simple Machines

Steps 1, 3, 4, 5, 6, 11

(lever, pulley, inclined plane, wheel/axle)

Fluid Power

Step 8

(pneumatic pump)

Chemical Power

Step 14

(conduction through lemon/salt solution)

Electrical

Steps 2, 3, 5, 6, 12, 14, 15

(sensor/motors, conduction- copper tape/wire)

Cost of Machine and Percent of Recycled Materials Used

$13.00 - 16 ft/sq pegboard

$5.00 - 9ft 1" PVC - recycled item

$3.00 - Hot glue sticks

$12.00 - 8 brackets to hold pegboard corners - recycled item

$300.00 - Lego NXT robotics kit - borrowed/recycled from the school

$3.00 - 50 craft sticks (approx count)

$2.50 - Large steel nuts, ¾ dia (used for weight on quadrant 3) - recycled item

$3.00 - Needleless syringe and tubing - recycled item

$16.00 - 2 Large water bottle jugs - recycled item

$1.75 - Mousetraps (4pk)

$3.00 - Various pulleys - recycled item

$10.00 - 2" PVC 90-degree elbow - recycled item

$2.50 - 2" PVC pipe - recycled item

$1.50 - 20oz plastic drink bottle - recycled item

$3.00 - copper tape

$3.00 - LED bulbs

$2.50 - 9V battery

$1.50 - 9V motor - recycled item

TOTAL COST

(-) recycled items = $29.25

PERCENT OF RECYCLED = %85

Applied STEM Processes #1: Mateo's and Ifraz's Eyeball

Aperture prototype

Mateo:
What were some of the 1st ideas?
How did you get to the eye idea?
What research did you do to get started?
What were the first prototypes like? What were they made of? What went wrong?
How did you solve the problem of how it was not working well at first?
Why did you decide on your final design?

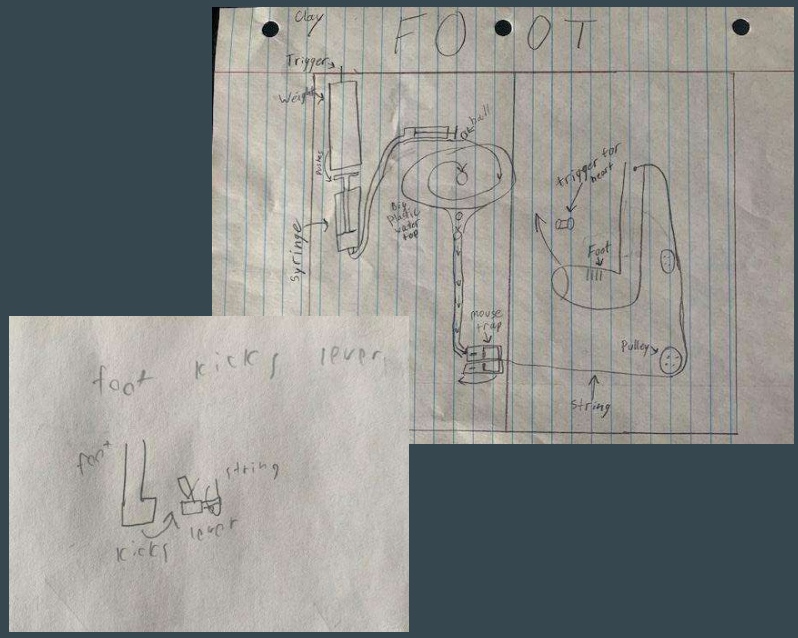
Applied STEM Processes #2: William's Electrolytic Fluid

A highlight of my learning and growth is when I figured out how to make the heart beat. This class helped me with my problem solving by making me work through things and figuring out what works or doesn't work. I think my mechanical skills had some improvement because I am making some pretty cool things. My teamwork is pretty good, I help people and communicate with them and they do the same. My failures were good because I learned to fix/work around them. This helped with my creativity because I had to learn about new things and think of things to make/fix.

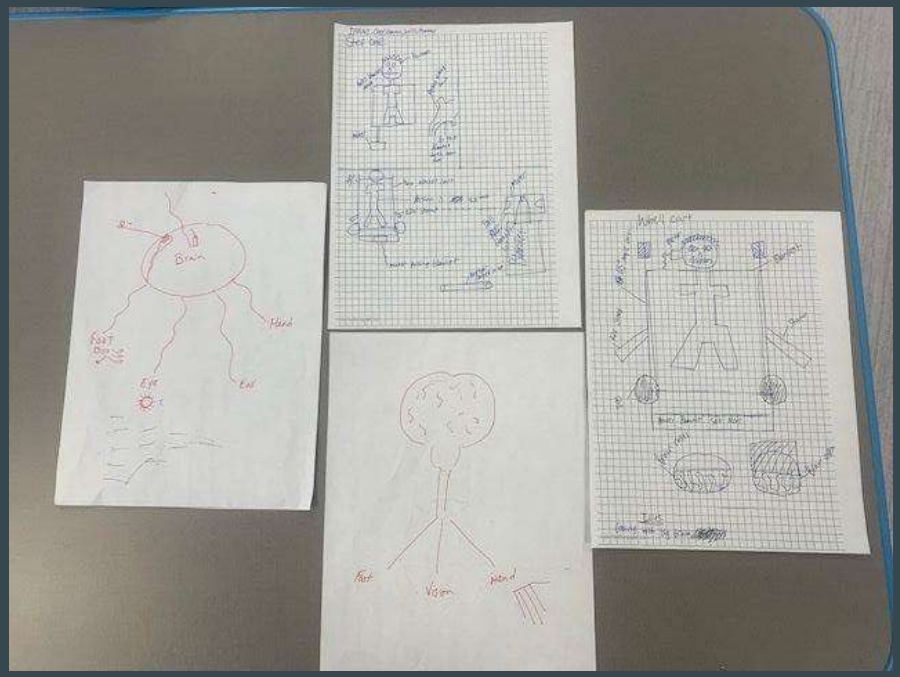
I see work like this benefiting my future by helping me get an engineering degree/job and just having the general knowledge.

Applied STEM Processes #3: Gavin's and Clay's Foot

Our first prototype idea for the foot was to build it entirely out of packaging foam. Our next prototype was a PVC pipe that we were going to put an actual shoe on. This proved to be too heavy. After we tried other, crazier ideas, we settled on something simple... we cut a shoe shape out of foamcore and drew a "Hey Dude" shoe on it. We tried to make the pistons in this quadrant easier to slide but ended up making them worse! Later on we found that coconut oil was a better solution than the chain lube we were using. The mousetrap started as a dual-mousetrap powered one, but it was so strong it broke a little each time we tested. To fix this, we put extra weight to counterweight the foot and that made it possible to use a single mousetrap since we did not need as much power.

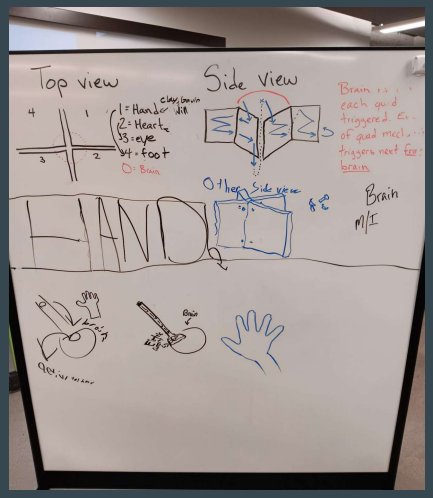


Applied STEM Processes #4: Brainiac's Machine Structure



Our first ideas. After thinking about how to simplify building as well as add more space in the machine to create we decided on the pegboard-quadrant idea.

The idea for the pegboard-quadrant idea was our best choice because a veteran team at our school used it so we were able to see theirs and understand how we could try the same thing. We also thought it was good because we had four different ideas: a hand, a eye, a foot, and a heart.



Reflection

359 words

Our team, The Brainiacs have developed a lot of engineering skills. We formed a team without really knowing each other. We argued a bit on how the project should go, and how the design should be. After all the struggles of teamwork we became an awesome Rube Goldberg team. One way we grew was we discovered it was better to take a step back when there were problems and look at the full picture. It was sometimes better to restart than to waste time on an unattainable goal. We learned how to properly use machines like hot glue, powered saws and drills, Dremels, foam cutters and bench grinders. We also learned to protect our bodies and our equipment. EMDC will affect our future careers by teaching us how to use machinery, problem solve, design and create solutions.

The challenge of the aperture was that we did not know the specific shape of the blades and so went off of a photo and crude measurements. By outlining the length and height of the blade in the photo we then used graph paper to graph points and draw the exact shape. We also discovered that by using hard flexible plastic we could slide the aperture better. About 40 hours of work was involved.

The mousetrap was a challenge because we did not know the right amount of power that we should put into the foot. After many hours of work trying to make the double mousetrap work we cut it out of the machine, filled the hole that made, and started over with the single mousetrap. That was a great example of re-setting a problem instead of continuing to build on that problem. We also weighted the foot and that helped us use less power.

The challenge of the heart was some circuit issues that cost some time. We kept adding more light which was too much resistance for the 9V battery to run the motor and the lights. We realized the motor was using too much power because it was a big one. We went to a smaller motor and removed most of the lights so that it could work.

Bibliography

Eye aperture research website:

"Wooden Aperture", Autodesk Instructables, https://www.instructables.com/Wooden-aperture/?amp_page=true

Hand design and assembly ideas:

https://ideas.lego.com/projects/7f34c820-4eea-453c-9d4e-0313de63f5a4, LEGO Ideas, "Hand Replica" .jpg, 11/15/23

Machine design ideas - various youtube videos:

www.youtube.com/watch?v=VpLDfkLBJ0Q, www.youtube.com/watch?v=6FzUx2EFk8s , www.youtube.com/watch?v=zPVH2admAuw

Conductive Fluid research:

"The addition of lemon juice to water makes it conduct, true or false?", Vendantu, https://www.vedantu.com/question-answer/the-addition-of-lemon-juice-into-the-water-makes-class-9-physics-cbse-5f80cb1493ca24529275b6e9