

Engineering Machine Design Contest

Machine:

The Digestive System

Team:

Engineer Pioneers

Spencer Moore

Alaina Larson

Michelle Ebnet

Bella Qual

Elijah Cordes

Josiah Lukes

Cade Olsen Canton

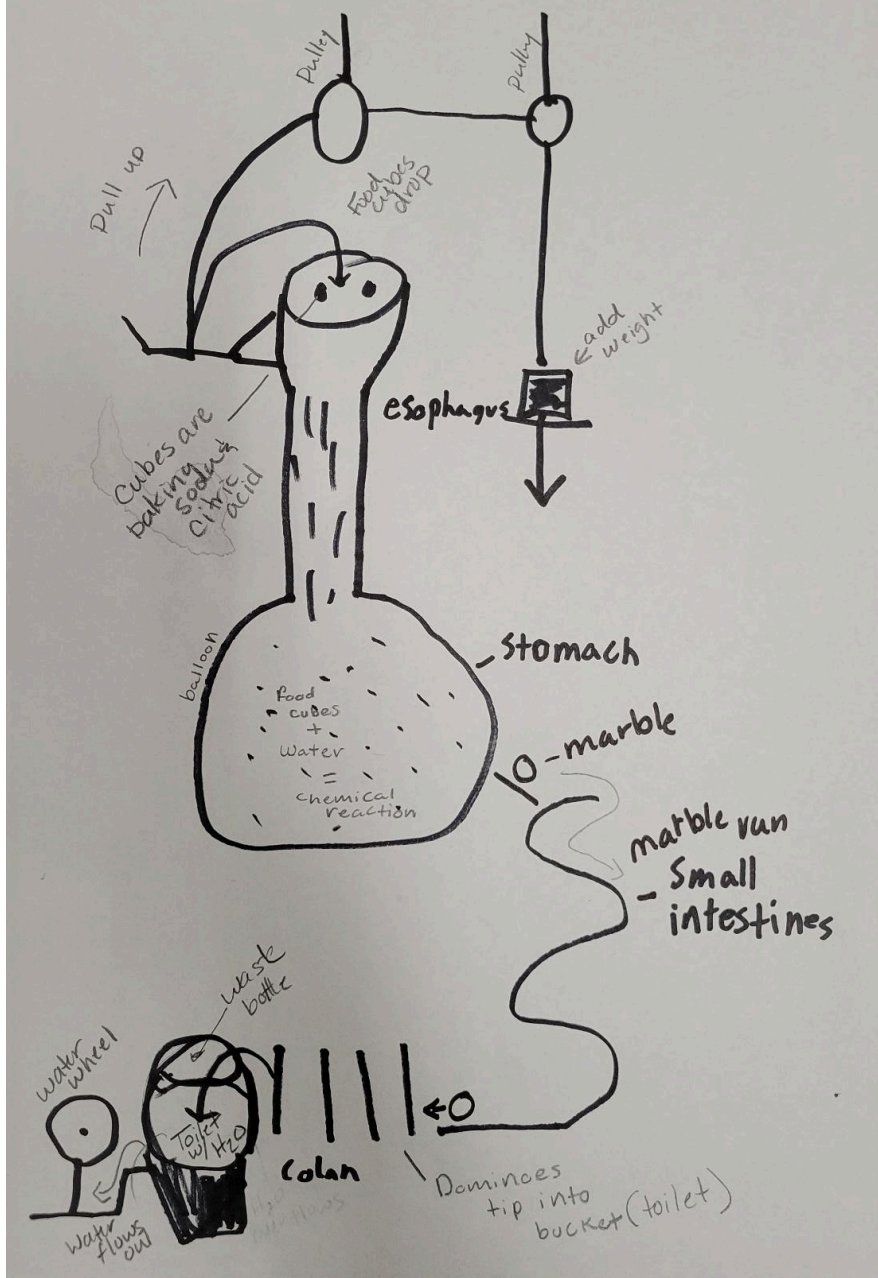
Griffin Bugher



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First



Original Machine Design Sketch

Original Machine Description:

A weight is added to a bucket that descends and pulls a string connected to a flap. The flap flips up and drops “food cubes” (citric acid and baking soda) into a funnel (mouth).

Food cubes travel down a connected tube into a balloon filled with water.

Food cubes react with the water creating a gas that blows up the balloon.

The expanding balloon pushes a marble down a marble run (small intestine).

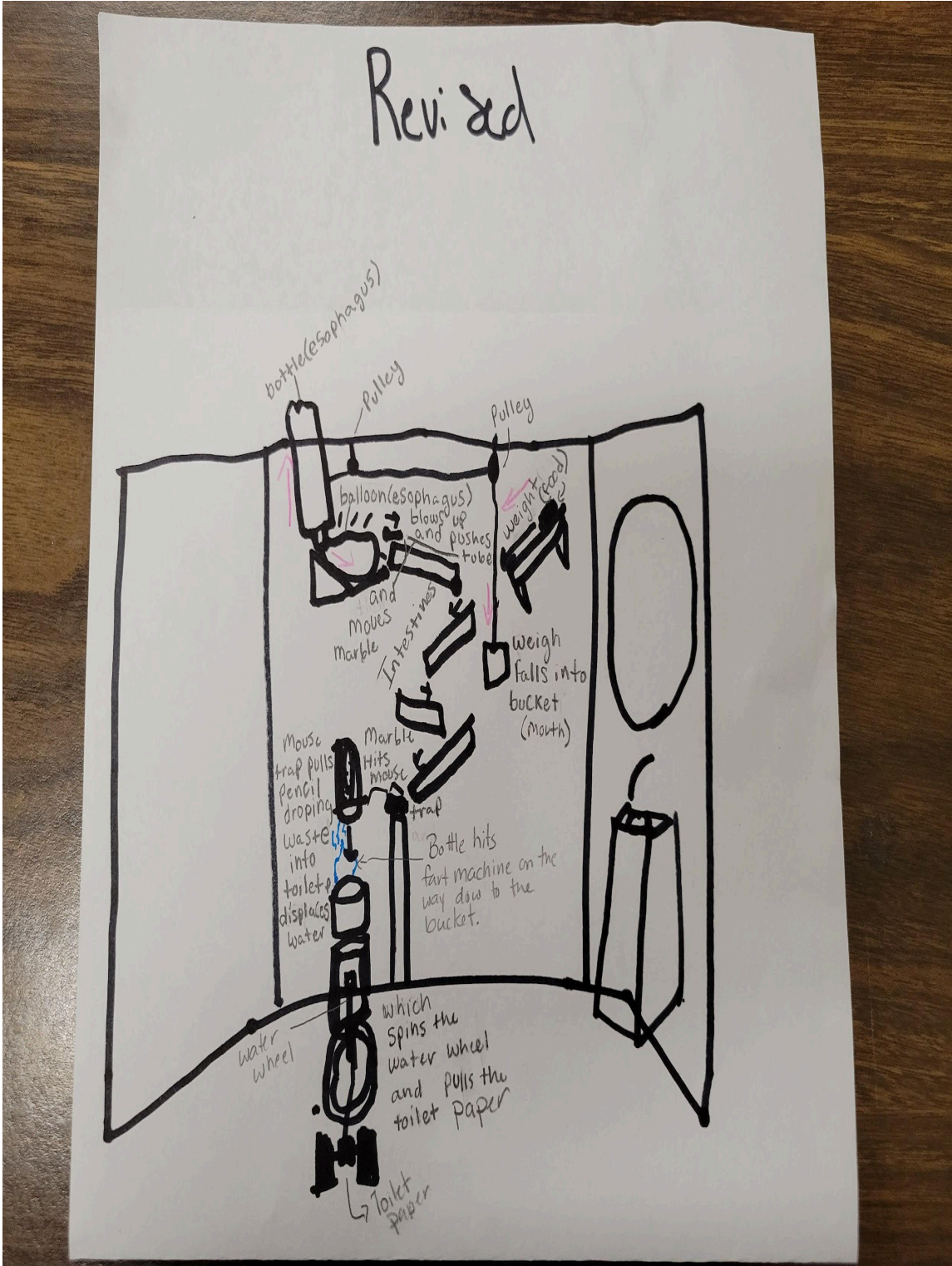
The marble knocks down dominoes in the large intestine.

The dominoes knock the bottle (waste) into a bucket (toilet) filled with water.

The overflowing water is channeled into a stream that turns a water wheel.

We had numerous problems with this design and made many changes. You can see how many changes we had to make when you look at our final design on the next page!

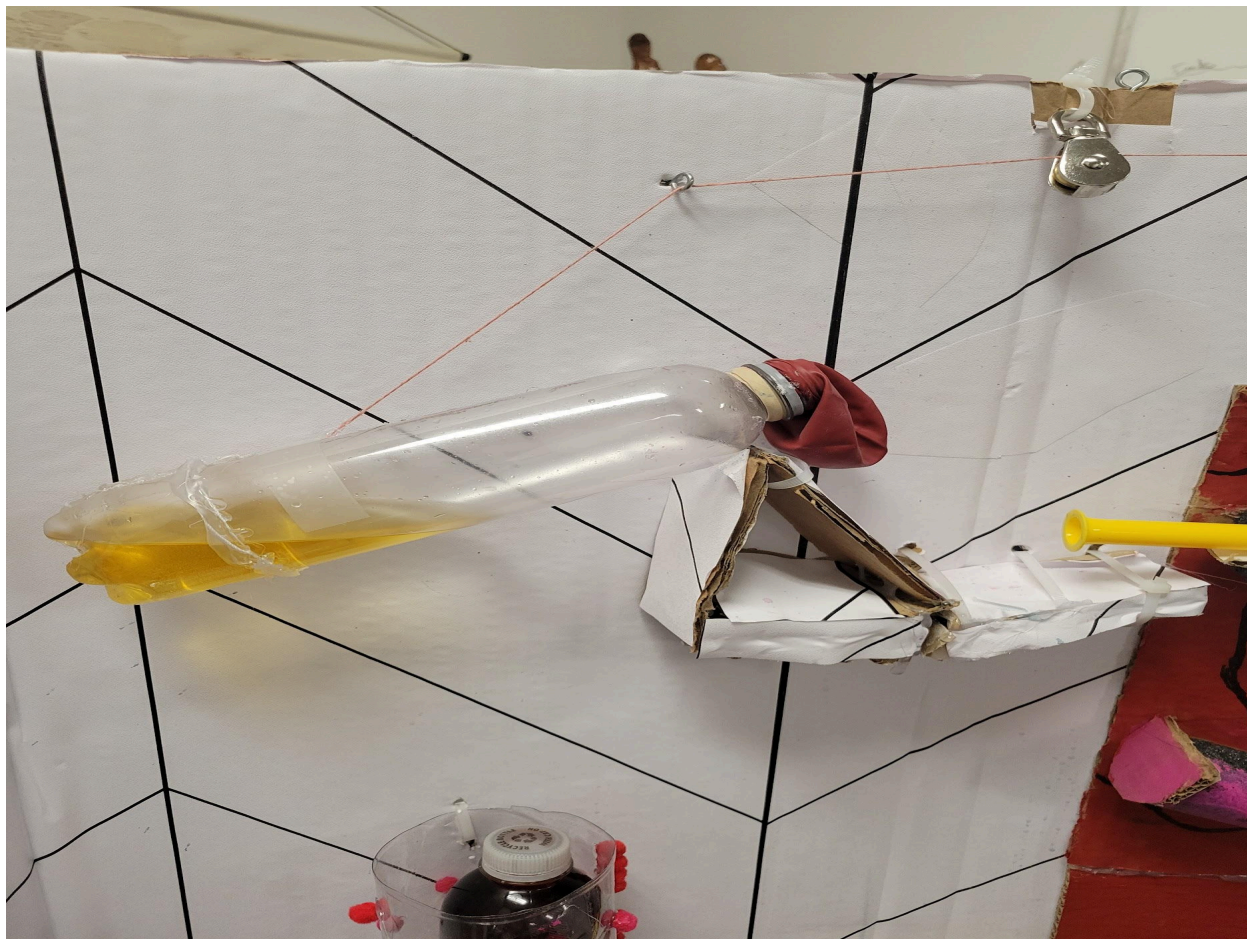
Final Machine Design Sketch



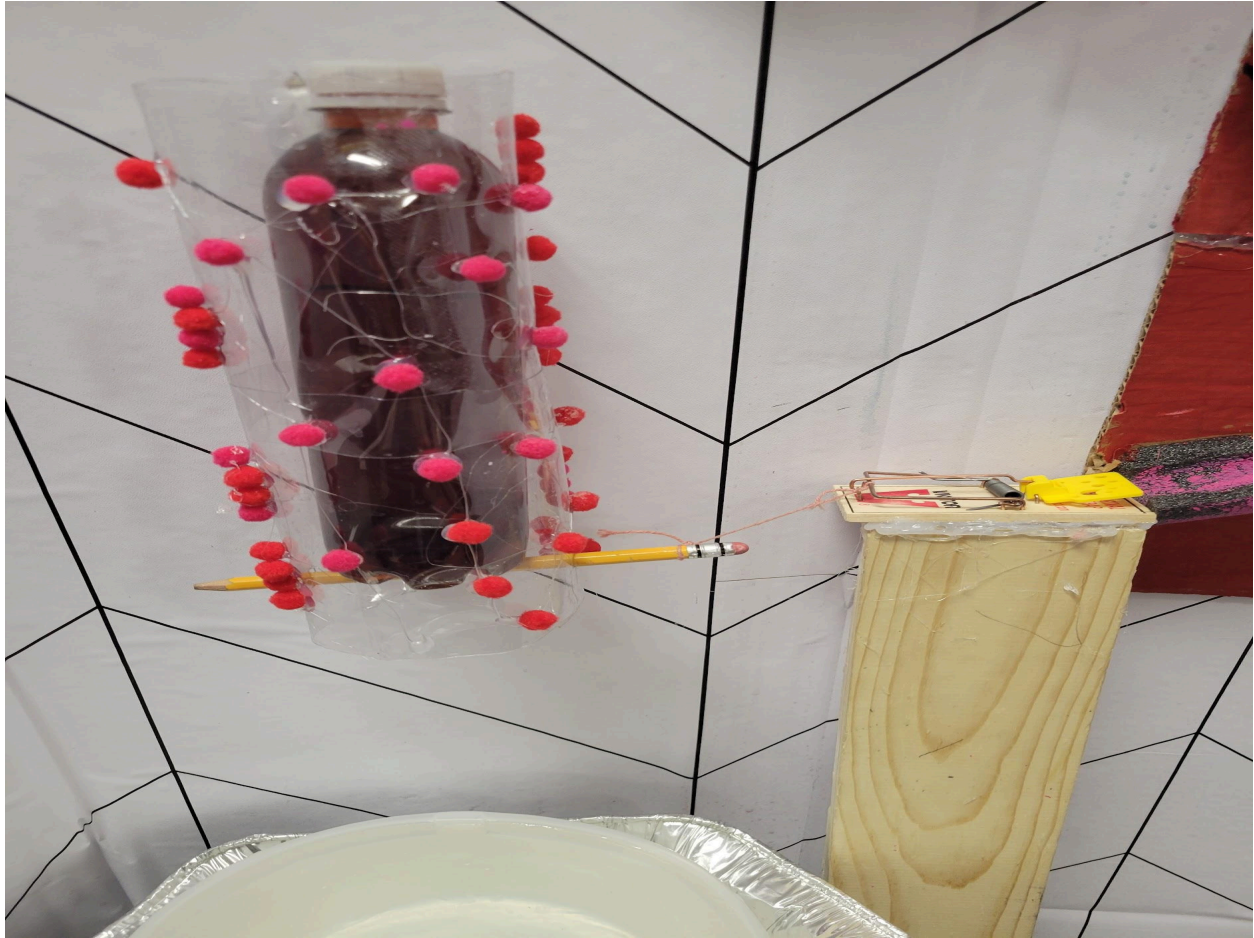
Final Machine Design Steps

1. Barricade is removed, launching a weight (food) down the ramp into a bucket (mouth), which is a transformation of potential energy to kinetic energy.
2. The ball falls into a bucket causing the bucket to descend and pull a string that is run through a pulley, a simple machine, to reverse the direction of the force and lift a bottle (esophagus).
3. The lifted bottle releases citric acid into the attached balloon (stomach) filled with baking soda.
4. The baking soda and citric acid react creating a gas that inflates the balloon. **Chemical Reaction Component**
5. The inflating balloon pushes a plunger into a marble.
6. The marble runs down the ramp and sets off a mousetrap.
7. The mousetrap, a good example of elastic potential energy, pulls a pencil when it is tripped releasing a bottle (waste). The bottle falling is a transformation of potential to kinetic energy.
8. The bottle (waste) falls and hits a fart machine causing it to make a flatulence sound. **Electrical component**
9. The bottle (waste) falls into the bucket of water (toilet) and displaces the water.
10. The displaced water flows into a funnel and turns a water wheel. **Hydropower**
11. The turning water wheel pulls out some toilet paper.

Applied Stem Processes



One way we applied Stem Processes was including a chemical reaction. We had to ask questions on how to get it to work. We had to imagine it. We had to plan it. We had to create it. We had to test and experiment. We also had to improve it many times. We made citric acid and water in the bottle. We placed baking soda and red cabbage powder in the balloon. When combined the balloon or stomach inflates from the gas created by the chemical reaction.



Here we used elastic potential energy found in the spring to release the bottle. The marble falls down the marble run and hits the mouse trap using elastic potential energy. The mouse trap pulls the pencil from the plastic tube (colon) releasing the waste bottle which is using potential energy that transforms into kinetic energy. We had to ask, create, plan, experiment, and imagine how we could get this to work. While building this machine we also had to improve everything.



This is a water wheel we designed out of wood and plastic cups. This is our final design after many different prototypes. We funnel water into it to make it turn. We are using hydropower to turn it. We had to use the whole stem process in order to be successful.



We used stem processes throughout our whole machine.
Energy travels from our first step to the very last.

Journal Entries

January 18

Today we got a lot done. First we came up with a team name. We decided on the Engineer Pioneers. Then we finished our design Idea. We started doing the simple things like cutting cardboard, making the instructions, and figuring out what we needed. We got a lot done and worked really hard.

January 22

While some made the bath bombs, everyone else got the base of the cardboard boxes ready to build on. They also connected the funnel to the cardboard. We found bouncy balls, stuff for the water wheel, and a marble track to use. We decided to use books that get larger and larger as they fall so it will have more force, instead of dominos. We made a lot of progress today.

January 24

We tested a lot of different ratios of bath bombs to water and we think that only a little bit of water to about ten bath bombs gets the best reaction. We also got the funnel attached to the cardboard base and made a cover for it. After testing a lot we think that either a bread bag or a plastic sandwich bag will work better than a balloon because we can't get the balloon to blow up. Instead the gas just comes back up the tube.

January 26

Mrs. Aamold brought sandwich bags and other things to use on our machine. We built most of the water wheel today. There was a lot going on. We attempted to use the sandwich bags to test the bath bombs in but it failed big time and just made a huge mess. So next we are going to try using jumbo clear balloons and we are hoping that that will work way better

January 30

Today was extra busy. Our teacher brought confetti balloons because they were the only clear balloons at the store so we had to pick the confetti out of the inside and we have confetti all over our whole school now. We connected the balloon with bath bombs in it to the other end of the bottle with water in it so that when a weight falls into the bucket it will pull the string that is attached to the bottle and the balloon will expand. It actually works! Yeah!!! Finally we got something to use as the esophagus and it works! We also attached another pulley so the bucket does not mess things up with the marble. And we built a marble run instead of using a track. Anyways we got so much done and our team is finally starting to feel like we are readyish for the competition.

February 1

We finished the water wheel and tested it out. It works great but we still need to figure out how to connect the toilet paper to it. We had our team artist paint a few things and now that that is mostly done we can start connecting more things to our base of the machine. Our teacher told us that there are only six work days in class until the competition so we will probably end up doing a lot of after school work sessions to get our machine up and running. Our presentation specialist started researching costumes for our team to wear but most likely we will just design matching t-shirts. We got stuff done today and with little time left if we continue to do what we did today I think that we could get it done in time if we work hard enough.

February 5

Today we set up the whole pulley system with a better larger bottle and got the platform for the marble set up. We fixed our drain platform and we are hoping that we did not make the hole too big for the water. Our team artist finished painting a few things for our machine and we added to the list of objects that we need. We are moving fast and it is a good thing to because we only have five more in class work days to get our whole machine done! Overall our team is very stressed about getting the things we need to get done on time for the competition.

February 7

Today we made another batch of bath bombs so that we don't run out with all of the test runs that we are going to need to do. We also painted a bottle brown to use as the "poop" in our design. We made sure that the marble run was stable and figured out where to put that. Our whole team is nervous for the competition that is coming up and everyone is trying their best to get things done before then. Our teacher is also setting up days that we can stay after school to work on our machines. All in all we are working hard as a team to get things done.

February 9

Today we tested to see if "poop" will be heavy enough to displace water and sink. However we could not get it to sink even after we stuffed it with wood chips. So we decided to scrap that idea and make a huge brown clay ball. It makes a good amount of water displace from the "toilet" and it makes the water wheel spin at least three full times around. We also talked with our teacher and she said that the competition that we were planning on going to got canceled so we have to go to one that is a little farther away. That also means that we get another month to work on our machines until the competition! Our team is so happy that we are getting things done and that we have time to do it.

February 15

Today we barely got anything done because we hit a roadblock in our idea. We don't know how to get from the marbles to the dominoes to the "poop" falling in the water. We spent a ton of time brainstorming new ideas for our machine. Other than that we mostly made sure that things were secure on the machine.

February 20

Today we made another "poop" using a thinner bottle that we filled with water so that it would sink and then we put a lot of food coloring in it until it was a brownish color. We are using this thinner bottle in our slightly new design. Instead of the whole thing with the dominoes we decided that the marble will come down the marble run and land on a set mouse trap that is attached to a string that will pull a pencil out when the trap goes off. The pencil will be holding up the "poop" then that will drop into the "toilet" which displaces some water and from there it is the same as the original plan. Other than that our presentation specialist started writing the script and came up with costumes for everyone. We tested our new idea and it works! Our team is excited and nervous and we have the time to do good so we are hoping that nothing else will go wrong.

February 26

Today we had a zoom call with potential sponsors. It went pretty well other than some technical difficulties. It was also the first time we ran the machine all the way through. It failed a few times but it was only our first run through so we have time to improve. After the zoom call we tested more and more and we also spray painted the "toilet" white. Everything is going pretty well.

March 1

We worked on taking everything off the base and putting up wallpaper to make it look like a bathroom for most of today. Then we put everything back on the base and started on other things like the sink, vanity, and the mirror. The bathroom looks amazing so far and everything is going so fast.

March 5

Today we had an engineer who is the small engines teacher at our school come in and watch our machine. She helped us fix the bucket that we used as the mouth so that the weight is more likely to fall in it. We also fixed the marble stand into a syringe so the marble can be pushed by it and go down the marble run. We are going to start spending less time in class to work on the machines. However our machine works pretty well.

March 13

We have mostly been trying to perfect the test runs and improve the machine parts. Other than that we have decided to scrap the bath bomb idea and use citric acid water in the bottle and baking soda mixed with red cabbage powder in the balloon(stomach). That idea is a lot easier and it has a better chemical reaction.

March 21

Today is the last day before the competition. For whatever reason everything started going wrong and breaking. We were trying to keep things at least a little organized so we asked an older kid to help pack things while we were trying to fix the machine. We eventually got things cleaned up and ready to go to the Engineering Machine Design Contest.

March 27

We won 1st place!!! We couldn't even get our machine to work half the time when we practiced. And we won 1st place!!! Our machine kept accidentally going off because it wasn't stable. Our team was very surprised that we even made it to the final round. Then we did amazing in the final round. And because we did so well our teacher bought us ice cream and told us that we did the best over all! However, that also means that we are going to the championship. Our team started improving our machine and now we are very nervous again.

April 8

We stopped working in class unless we get done with our lesson early so we have been staying after school more. We only have 11 days until the championship. We decided to add a few steps to the machine. We are for sure going to add a fart machine as an electrical component. We tested it out and it still needs some tweaking but we have the general idea down. Our machine has come far and we think it works well. Let's just hope it works well enough at the championship.

Machine Costs

Equipment	Recycled or not	Cost
Box/Frame	yes	Free
zip ties (15)	no	\$0.2 a Zip tie
rulers	yes	\$1.00
String	yes	Free
Small Bucket	yes	Free
Pipe Insulation	no	\$2.80
Plastic Bottles	yes	Free
wood	yes	Free
mouse trap	no	\$.50
Bucket	yes	free
tin bowls	yes	free
funnel	yes	free
wallpaper	yes	\$3.00 purchased at thrift shop
pulleys	no	\$0.80
quilt batting	yes	free
medicine syringe	yes	free
paint brushes	yes	free
masking tape	yes	free
paint	yes	free
dominoes	yes	1.00 purchased at thrift shop
funnel	yes	free
box	yes	free
oval roaster	yes	free
weights	yes	free
balloons	no	.10 each
Citric acid	no	.10 a run
Baking soda	no	.10 a run
Fart Machine	yes	free

Percent Recycled: 75% **Total Cost: \$9.70**

Reflection

During the process of building our machine, the Pioneer Engineers have had many things go wrong. Probably the biggest problem was having to redo our whole design many times! One example is that in our original design one of the bottles that represents the esophagus was supposed to have a chemical reaction and blow up a bread bag. Every time that we would test it it would not blow up because the gas was somehow escaping and eventually we started running out of our homemade “food cubes” which were really bath bombs. Luckily, our team did not give up. Instead we kept on looking for the solution. We made more “food cubes” and, after buying plenty of different balloons, we finally found one that worked. Eventually, we decided not to use food cubes and just use the active ingredients in our food cubes, which are baking soda and citric acid. We combined the citric acid with the water and placed that in the bottle. In the balloon we put the baking soda and a little red cabbage powder for a color change effect. This helps highlight the chemical reaction. No matter how hard things are, you can always figure it out if you work as a team.

Another challenge we faced was how to drop the waste bottle into the toilet. We wanted to use dominoes to push it in. They were too light and did not have enough force to move the bottle. We ended up creating a mouse trap connected to a pencil that held the bottle up until the mousetrap was triggered. It works extremely well. Another problem was the waste bottle itself. We painted it. That did not work. The paint came off in the bucket of water. And it did not sink. So we painted the inside and packed it with clay. That still did not work because the clay removed the paint and it still did not sink enough. We solved the problem by filling a bottle with brown colored water. Challenge solved!

Looking back, we are extremely grateful that we got the opportunity to deal with all the issues that we did during this process. It has taught us things that you can use for school, your career, extra curricular activities, and in general, everyday life. It has taught us how to deal with problems in life and not give up. This was an amazing experience for everyone that got to participate. We made tons of fun memories that we will never forget. And we are now closer and better classmates. We learned so many life lessons that will be helpful for the rest of our lives. We learned perseverance, hard work, patience, communication, and teamwork.

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