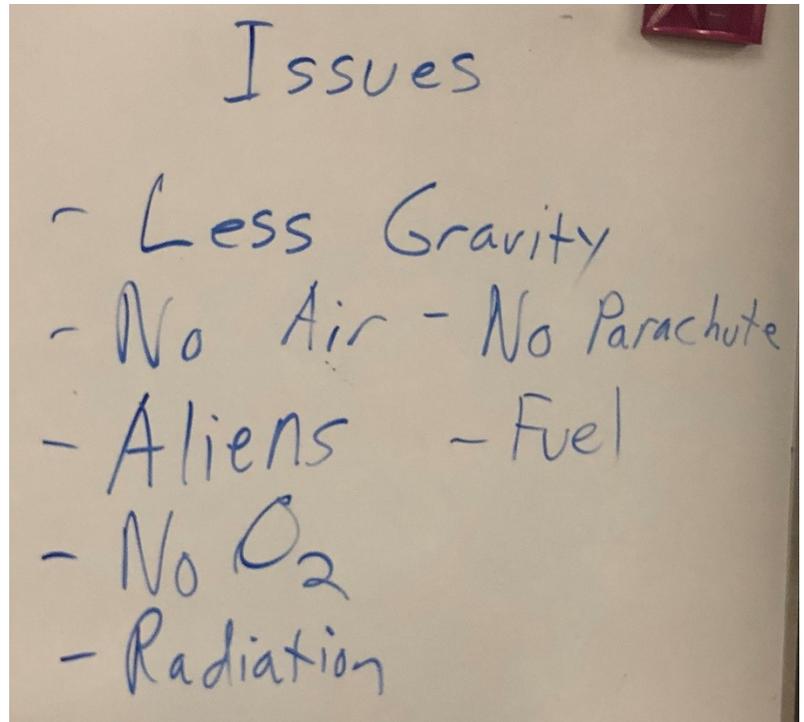


Brian Bealer

## Engineering Design Challenge

1. The engineering design process that I used with my students involved the following processes
  - a. Ask Questions
  - b. Brainstorm
  - c. Build a prototype
    - i. Test
    - ii. Redesign
    - iii. Test again
  - d. Create the final design
  - e. Share the results.
2. Students were given the following timeline
  - a. Day 1 and 2 – research and design of their prototype
  - b. Day 3 and 4 – testing and redesign to determine the best configuration for their lander
  - c. Day 5 – each group dropped their “lunar lander” from a height of 30 centimeters. Students then shared their thoughts and ideas with the rest of the class based on the comparative results of each group.
3. Engineering Design Notebook

- a. Identify the problem: In order to safely land on the moon, a system must be in place to reduce the velocity of the lunar lander to zero without harming the astronauts inside. As there is no atmosphere on the moon, this cannot be safely done using a parachute, so another solution must be



implemented. The solution will incorporate shock absorbers in the form of folded

index cards will help reduce the impact on 2 marshmallow astronauts. Success will be determined by whether the marshmallows are ejected from a cup representing the crew capsule of the lunar lander. Students will need to design a lunar lander that incorporates index cards as shock absorbers, a platform to attach them to, and a cup for the marshmallow astronauts to rest in. Another issue that was added in was which design was the most effective and has the lowest weight. This was added as it was a significant design constraint for the Apollo missions to the moon.

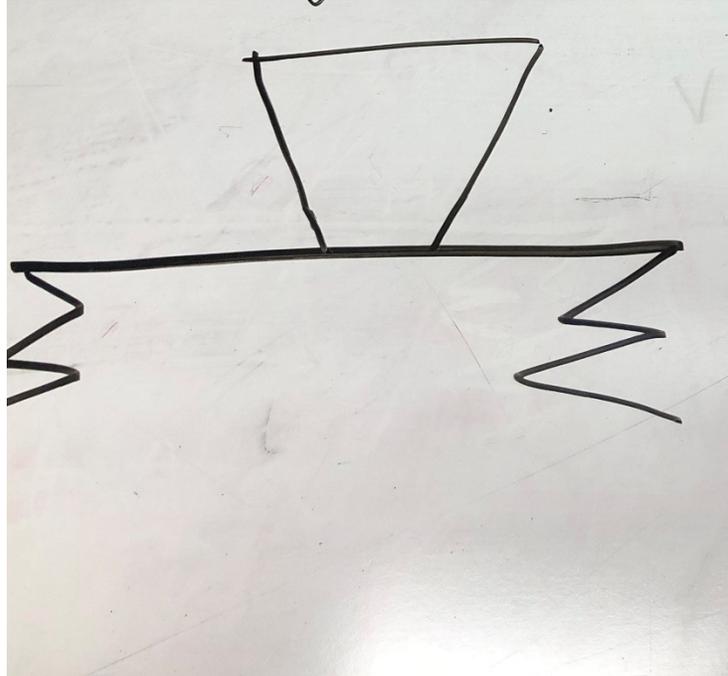
- b. Brainstorming: Students had to decide how to attach their shock absorbers to their platform, how many folds to have in their index card, what is the best type of platform to use (cardstock paper, cardboard, foam), where to attach their cup to the platform, and



whether or not a stabilizing bar should be attached to the shock absorbers for additional support.

- c. Design: Students had a choice between cardboard or packing foam as their platform to attach their index cards and Styrofoam cup to. Folded index cards will act as the shock absorbers while the cup will serve as the capsule that will hold the marshmallow astronauts. Each group was able to decide the number of times they folded the index card, how to attach it to the base (3-inch side vs the 5-

inch side), where to  
put the cup on the  
base (on the side or  
closer to the  
middle), as well as  
whether or not to  
connect with cards  
together with  
supports (straws  
attaching both cards  
together).

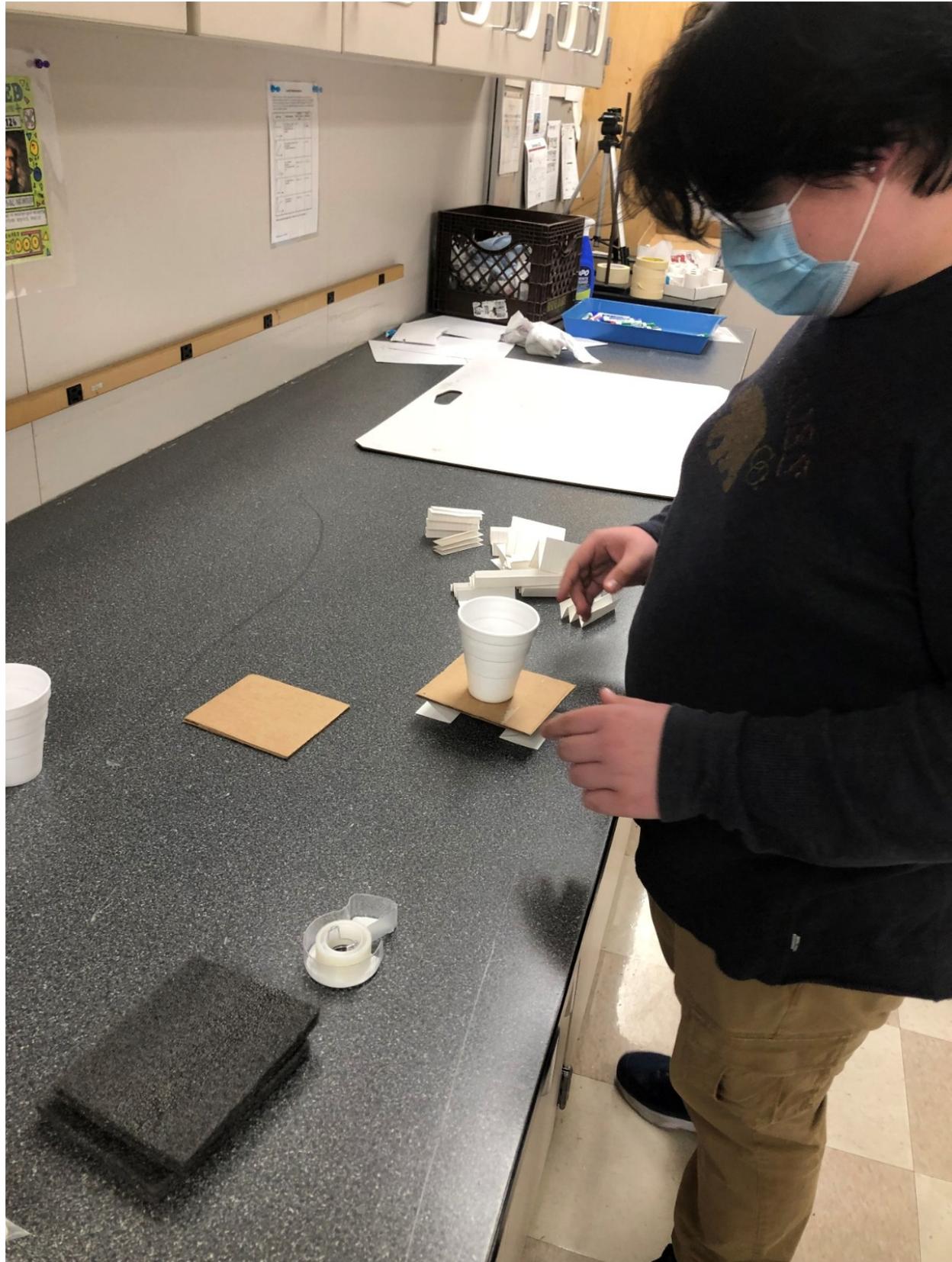


- d. Build – Students assembled their landers. They used scotch tape to hold everything together so they can add/remove materials to improve their design.















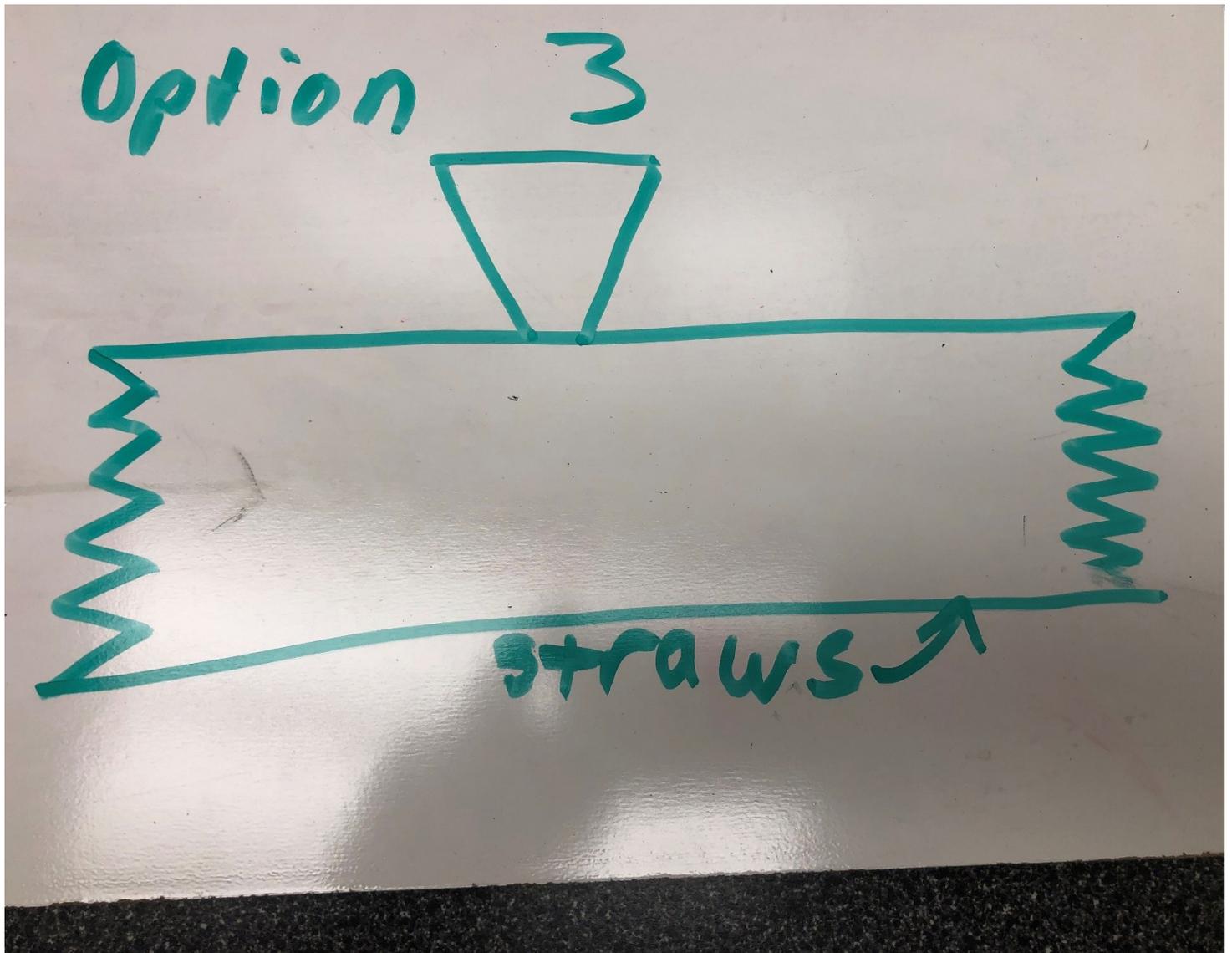
- e. Test and evaluate – The landers were dropped from a height of 30 centimeters and the marshmallow astronauts inside were observed to see how much they bounced within the Styrofoam cup.







- f. Redesign – students looked at whether changing the number of folds, orientation of the paper, material used for the platform (cardboard vs. foam).



- g. Share the Solution: The results showed that the material that worked best for the base was cardboard and having 2 folds in the index card worked best. The orientation of the cards and using straws had no affect on how well the lander performed. Also, it was found that having the cup centered on the platform was necessary to prevent the lunar lander from falling over after it hit the ground.

#### 4. Reflection

- a. I thought the design and implementation process worked very well for this activity. Students were very engaged and could easily explain how bringing the lander to a stop was due to a change in momentum by applying an impulse. They really enjoyed being able to find an application for the content they are learning.
- b. The part that I felt did not go well was how little there was for students to experiment with. Using a limited number of materials made it easy to get all the materials together, but with only a couple of factors to change, there really wasn't enough to challenge students and by the end their designs were basically the same. I was hoping to see more variety in their final solutions to the problem.
- c. The concepts and standards are as follows:  
New York State Science Learning Standards  
HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.  
HS-PS2-3: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.  
ETS1.A: Defining and Delimiting Engineering Problems  
ETS1.C: Optimizing the Design Solution
- d. The ED process gave students a chance to delve deeper into the concept. As they were designing and redesigning their lander, they were having great discussions about the content and could be heard using the vocabulary. It led to a deeper understanding of how an impulse changes the momentum of the passengers. Students were also able to make connection with how this can be applied to safety devices such as airbags in cars work. Students were able to apply the momentum ( $p=mv$ ) and the impulse equation ( $J=Ft$ ).

- e. I felt that the engineering design process that I used with my students was appropriate for the grade level. Students had no issues following the process and were able to follow the steps without any issues.
- f. To improve this activity with students I would use mini marshmallows so they don't get crammed into the cup. I would also cut the cup down so it was smaller. With the high walls of the cup, the marshmallows didn't have enough energy to pop out of the cup, which would have made it easier to determine students level of success. I was also like to add a way to get more empirical data to show how must the marshmallows moved inside the cup by attaching or drawing a ruler inside the cup and using video to measure the movement of the marshmallows. I think it could also be improved by using a greater variety of materials like rubber bands as shock absorbers and straws for legs. Only using 3X5 cards to construct the legs led to most of the designs being essentially the same after the redesign and testing phase of the process.