FINAL PROJECT: ENGINEERING DESIGN CHALLENGE- TOUCHDOWN

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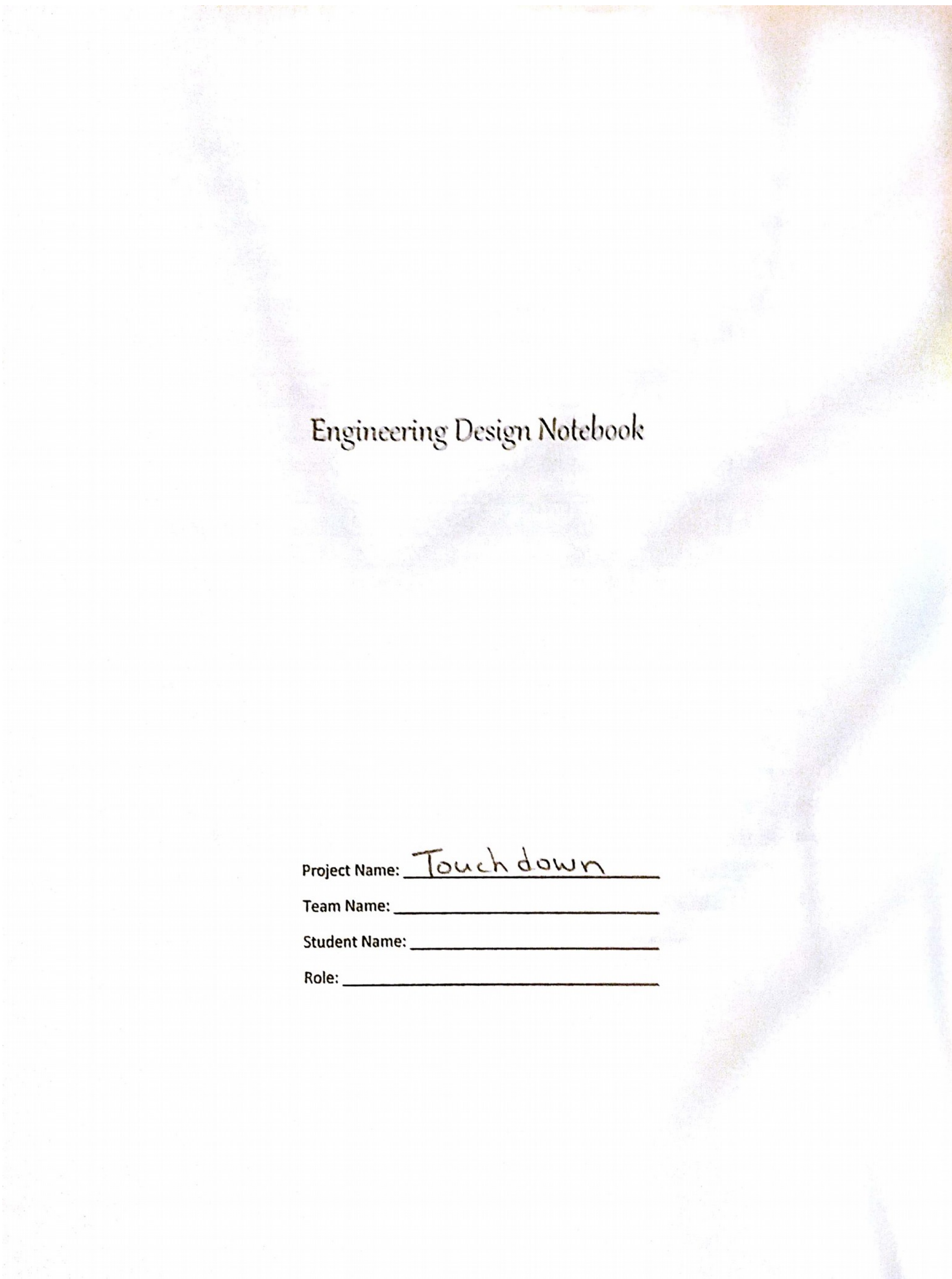
THE “E” IN STEM: MEANINGFUL CONTENT FOR ENGINEERING

Part 2-Final

<u>Reflection:</u>

Overall, the engineering design challenge went well. The students were engaged in conversations relating to gravity, force, balance, and acceleration. By completing the engineering design challenge, the students were able to relate the science concepts to real world events. The students were able to apply measurement in the project in determining where the parts of the lander should go to remain balanced. I did find, however, that dropping the landers at 12 inches from the floor made it difficult to measure the time it took to drop, so they were not able to compute the rate. I think if we used a higher drop point this would be more effective, but the students would have to modify their landers more to account for the added distance. The design process that was used with the notebook template was very effective for all levels of students. Some of the problems with this challenge was that one of the students was having trouble with visualizing the materials. I should have shown him the materials again before having them draw their initial design. Also, I should have been more clear about the fact that they did not have to use all of the materials provided. In the future, I will show students the materials before beginning the project and remind them that they do not have to use all of the materials. I also found that they were better able to explain their brainstorming ideas to the group when they had the materials in their hands. Initially, I was not going to let them touch the materials until they came up with their group design. In doing this project again, I will allow the groups to use the materials in explaining their ideas after they complete their initial individual design.

<u>Engineering Design Notebook-Teacher:</u>


Engineering Design Notebook

Project Name: Touchdown

Team Name: ____________________

Student Name: ____________________

Role: ____________________

Identify the Problem: Design and build a shock-absorbing system to protect 2 astronauts when they land

What I Know: (information and constraints)

1. needs to absorb shock & keep astronauts inside - springs and cushins
2. Keep lander steady so it doesn't tip - balanced
3. No cover on cup for astronauts
4. drop is 30 cm (12 in)
5. should land gently - use folds in index cards to make "springs"

What I Need to Know: (questions to research/test)

1. How can I soften landing?
2. Does adding folds make index card "springs" absorb more shock?
3. How do I balance the weight of the lander?
4. Will longer or shorter legs absorb more shock?
5. Will more legs absorb more shock?

Available Materials:

cardboard "platform", 1 cup, 3 index cards, 10 mini-marshmallows, 3 rubber bands, 8 plastic straws, scissors, tape, 2 marshmallow "astronauts"

Research:

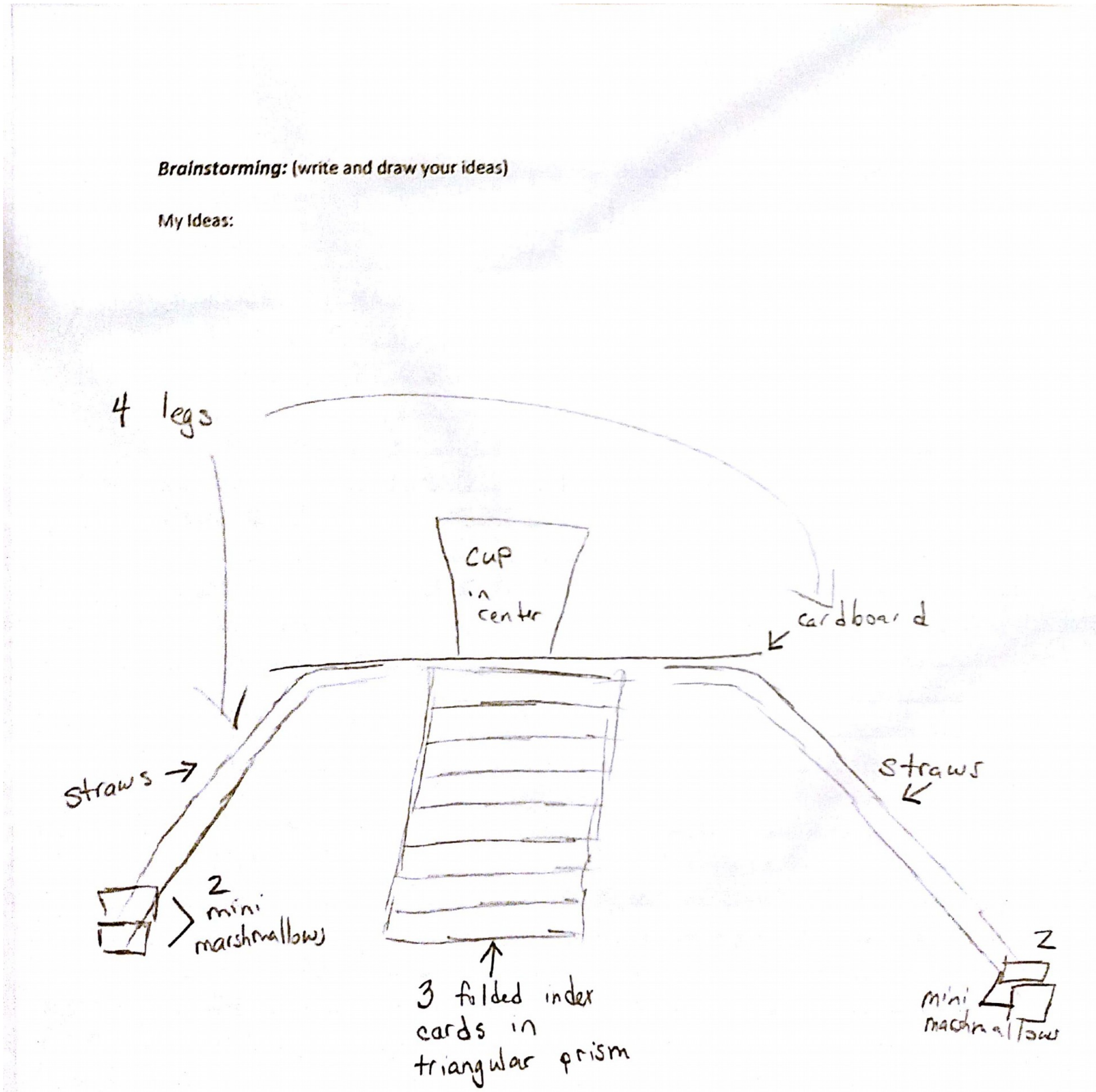
(1) legs - Apollo Lunar Module had 4 legs - part of each leg was collapsible - 3 legs not robust enough, 5 legs not reliable - 4 legs were splayed far apart

(2) landing gear on Lunar Module - 4 legs connected to outriggers - primary strut with foot pad - strut had crushable aluminum honeycomb material to soften impact

Sources:

(1) www.space.stackexchange.com

(2) history.nasa.gov

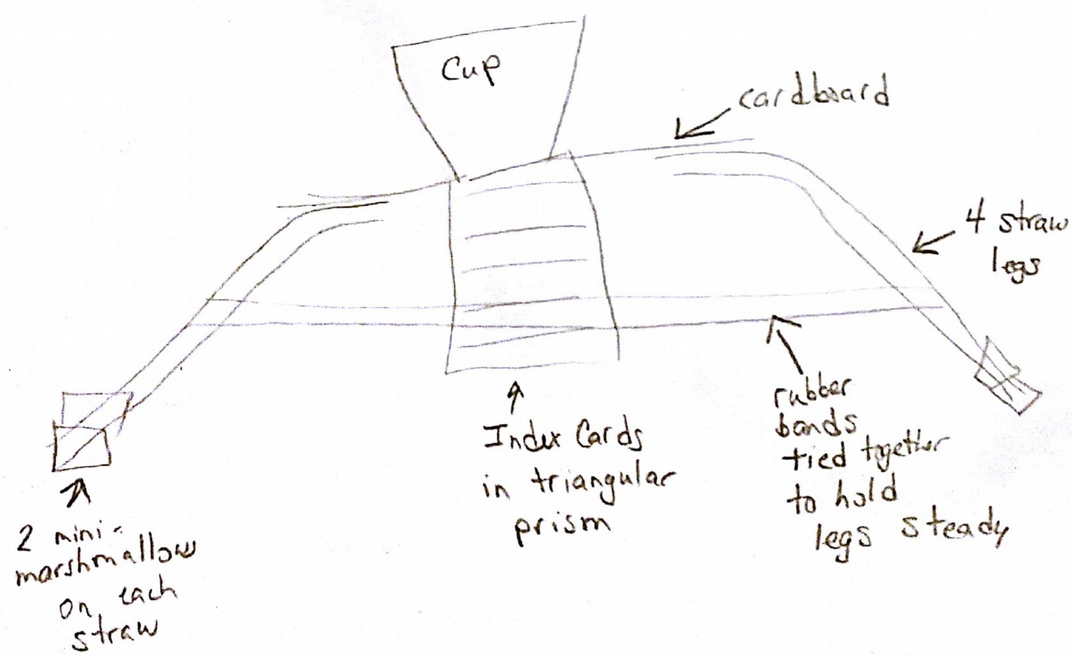

Brainstorming: (write and draw your ideas)
My Ideas:
4 legs
cup in center
cardboard
straws
straws
2 mini marshmallows
3 folded index cards in triangular prism
2 mini marshmallows
3

Evaluate and Refine:

1. What problems did you have with this design?
Design worked well from 12 in, but not from 24 in

2. What improvements or changes can you make to your design?
Attach rubber bands around legs to make them more stable

Revised Design:



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Engineering Design Notebook-Student 1:

Identify the Problem: Design and build a shock absorbing system to protect the landing astronaughts.

What I Know: (information and constraints)

1. landers absorbs landing shocks
2. must stay balanced while landing
3. marshmellos can't fall out
4. Intext cards can be springs and marshmellos (small) cusions
5. springs redirect force

What I Need to Know: (questions to research/test)

1. How many legs did the actual lander have?
2. What cusions were used in the real landing?
3. what balances work best?
4. can to many legs destabalize the lander?
5. can to much cusioning be a problem?

Available Materials:

1 cardboard peace, 1 plastic cup, 3 index cards, 2 long marshmellows, 1 small marshmellows, 3 rubber bands, 8 straws, tape, scissors

Research:

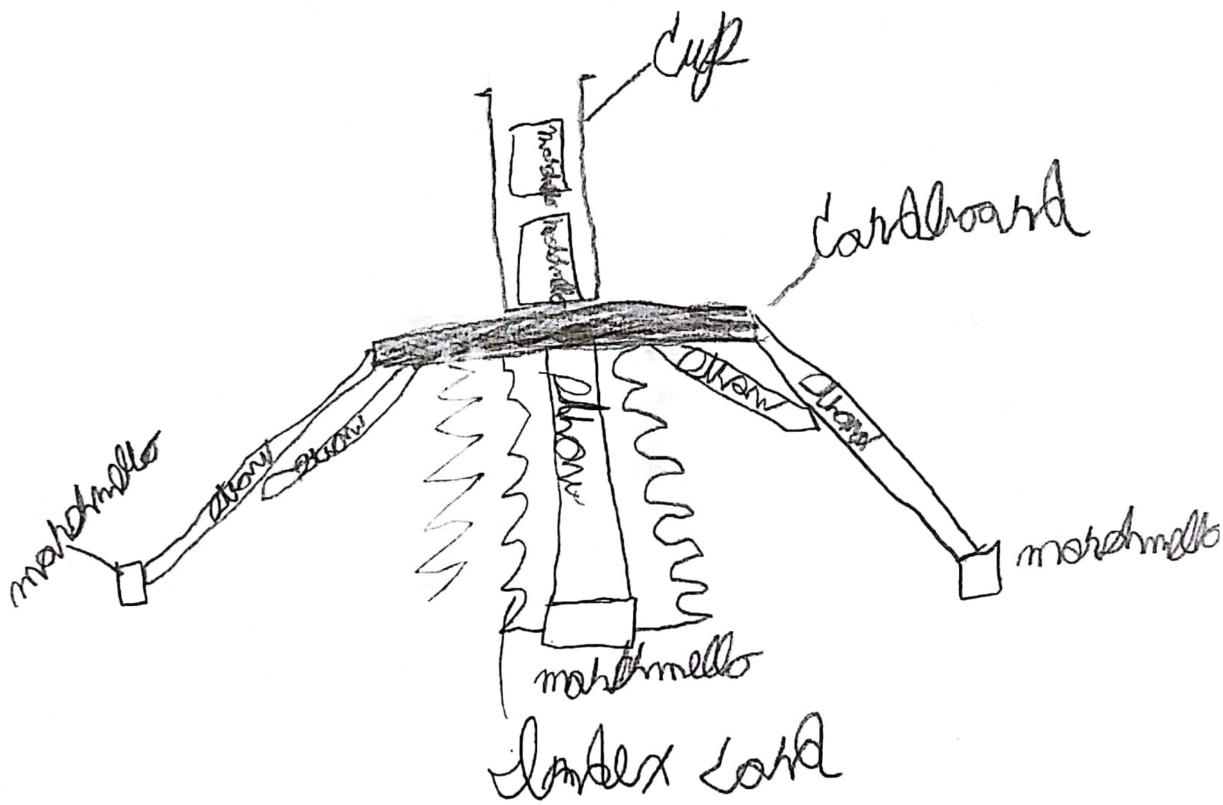
The lunar lander generaly has 4 legs for balance. The legs have a chushonfule honeycomb to absorb the shock of landing. These shapes were light and distribut balance.

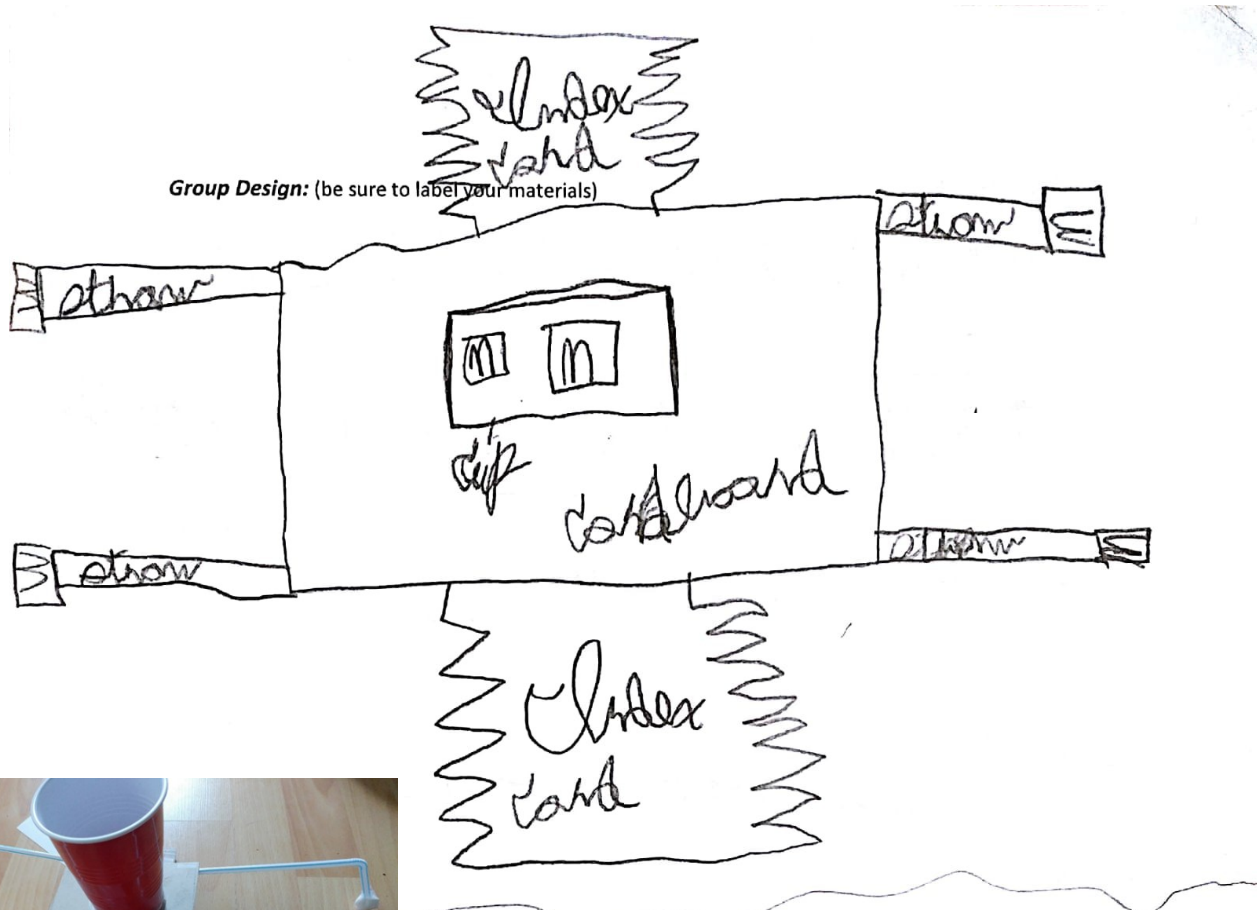
Sources:

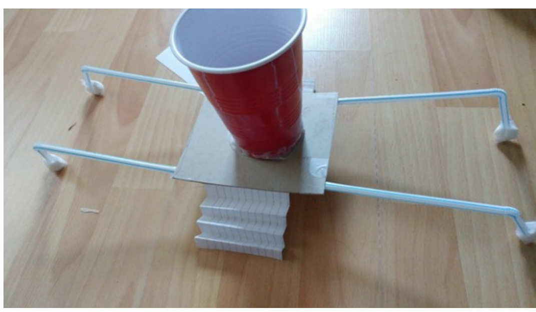
www.seradata.com, www.heroicrelics.org

Brainstorming: (write and draw your ideas)

My Ideas:




Group Design: (be sure to label your materials)
Index card
straw
cup
cardboard
straw
straw
Index card
cup
cardboard
straw
straw

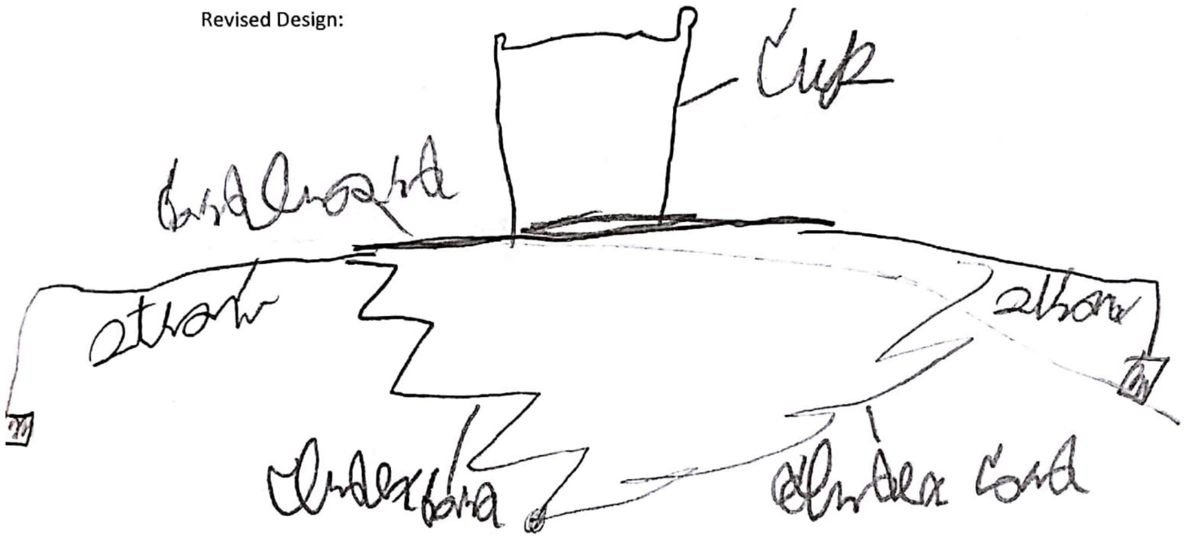


Evaluate and Refine:

1. What problems did you have with this design?
   We were unable to attach supports

2. What improvements or changes can you make to your design?
   cut straws at angle to use supports.

Revised Design:



1. What parts of the changes you made worked?
No parts worked. The cup came off

2. What (if any) other changes could you make?
To reshape the cup.

Engineering Design Notebook-Student 2:

Identify the Problem: design and build a shock absorbing system that will protect two astronauts when they land.

What I Know: (information and constraints)

1. Has to absorb the shock of the landing.
2. I have to make a cardboard spaceship with a cup.
3. The cup can't have a lid.
4. The spaceship has to land flat.
5. The astronauts are marsh mallows.

What I Need to Know: (questions to research/test)

1. Wouldn't the spaceship have thrusters to make it land flat?
2. Wouldn't these thrusters make it land slowly?
3. Wouldn't the astronaut compartment be closed.
4. How many legs did the lunar lander have?
5. Did one of these legs break off?

Available Materials:

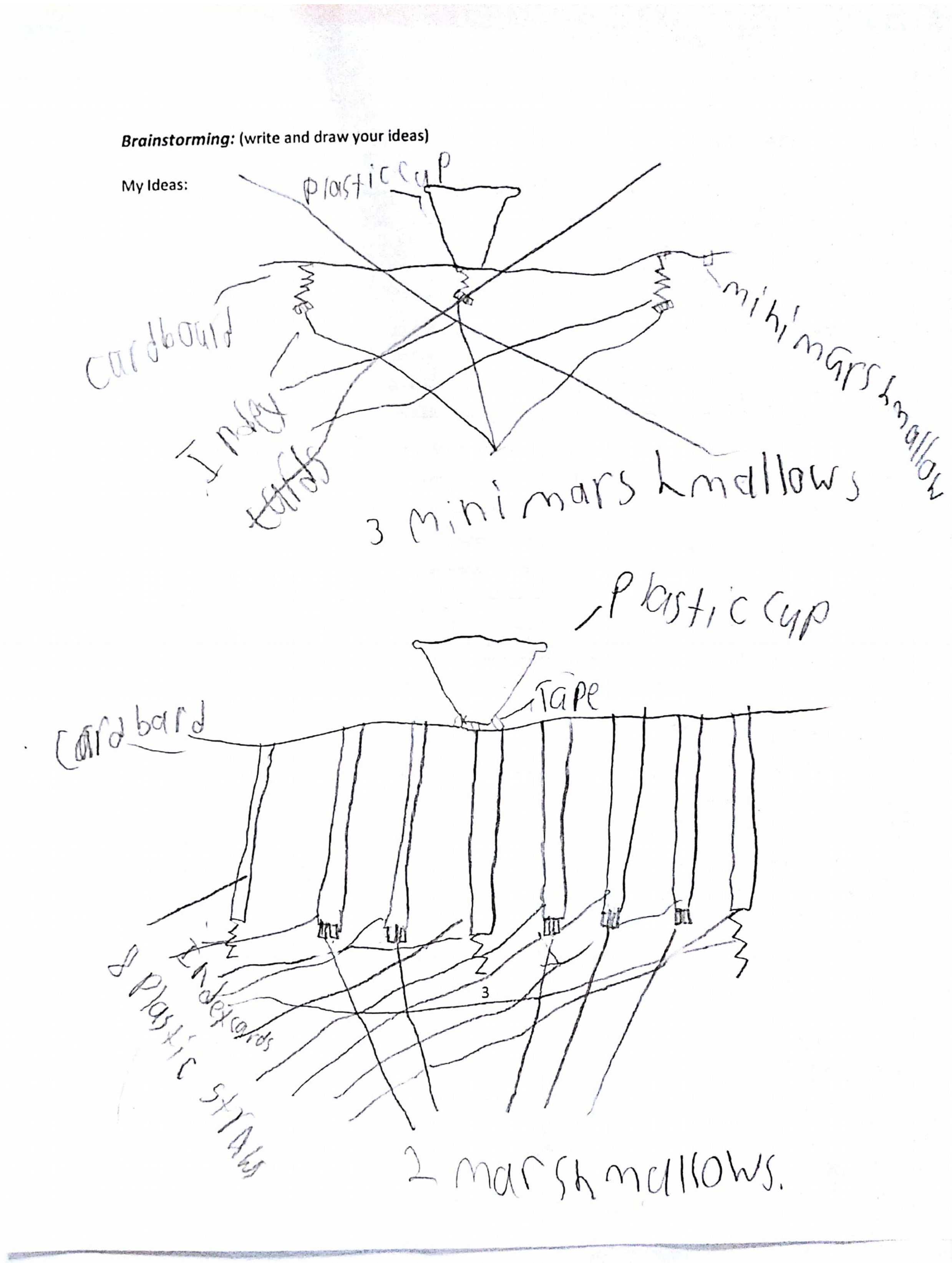
1piece of cardboard, 1plastic cup, 3 index cards, 2regular marsh mallows, 10 mini marsh mallows, 3 rubber bands, 8 plastic straws, scissors, tape.

Research:

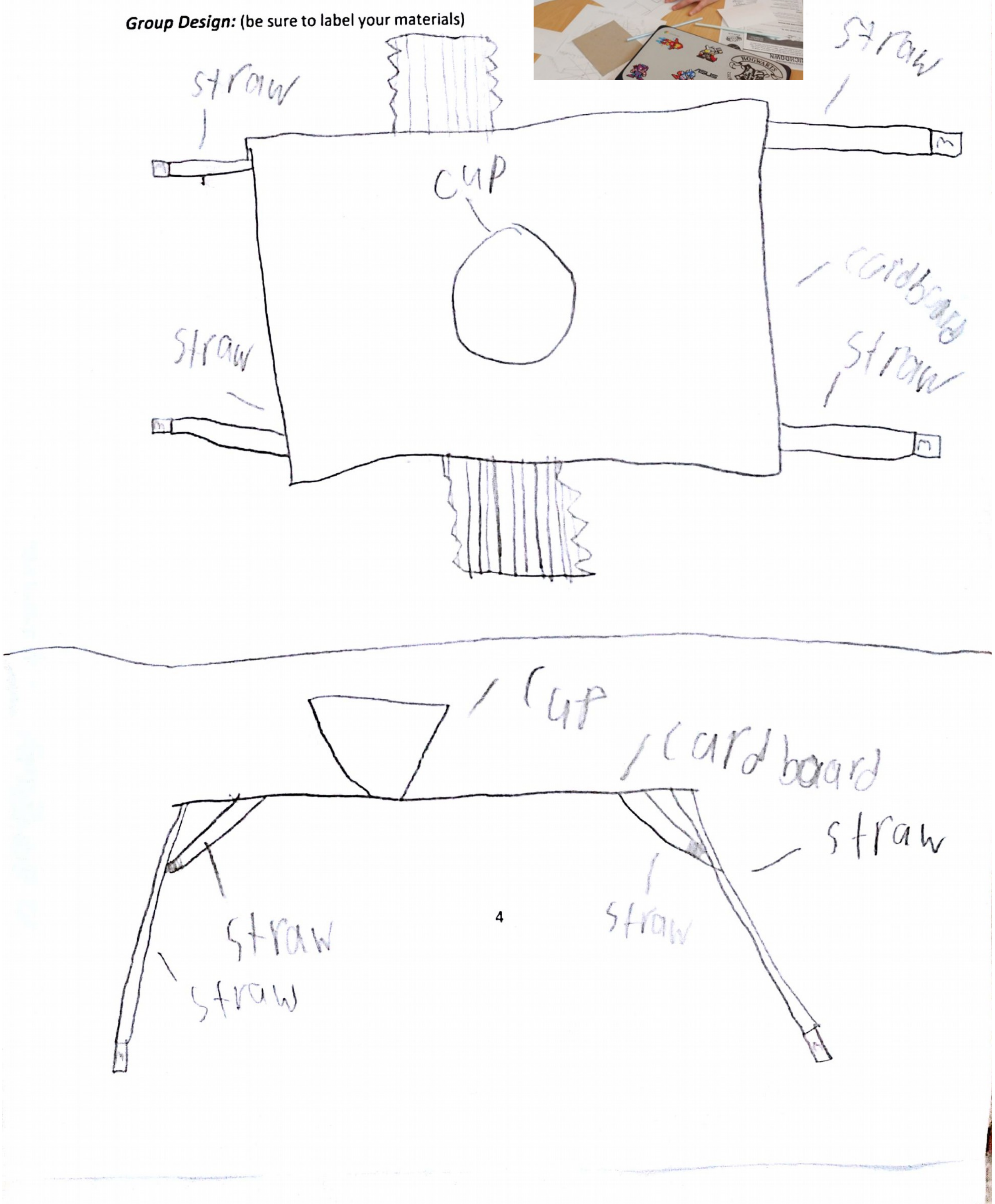
The lunar landing module had four landing legs, but three or five would be better balance.

Sources:

Space.Stackexchange.Com


Brainstorming: (write and draw your ideas)

My Ideas:

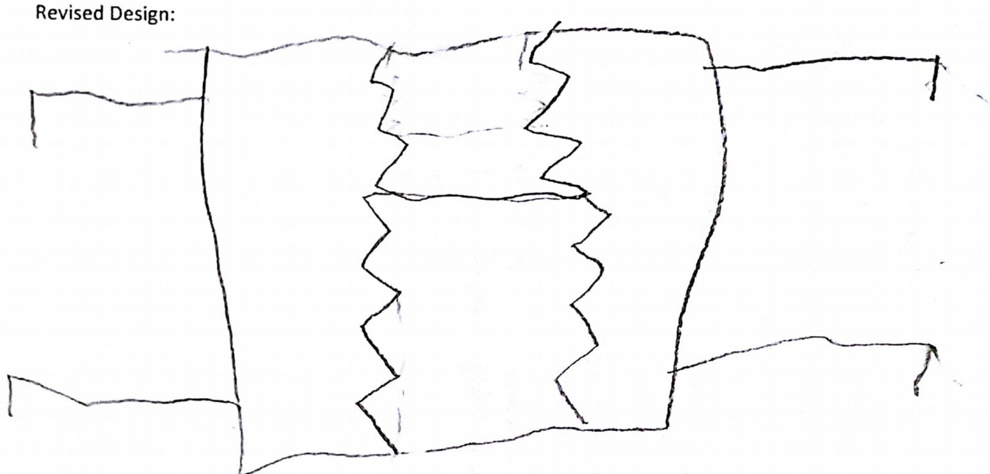

Group Design: (be sure to label your materials)
straw
straw
cup
cardboard
straw
straw
cup
cardboard
straw
straw
straw
straw
4

Evaluate and Refine:

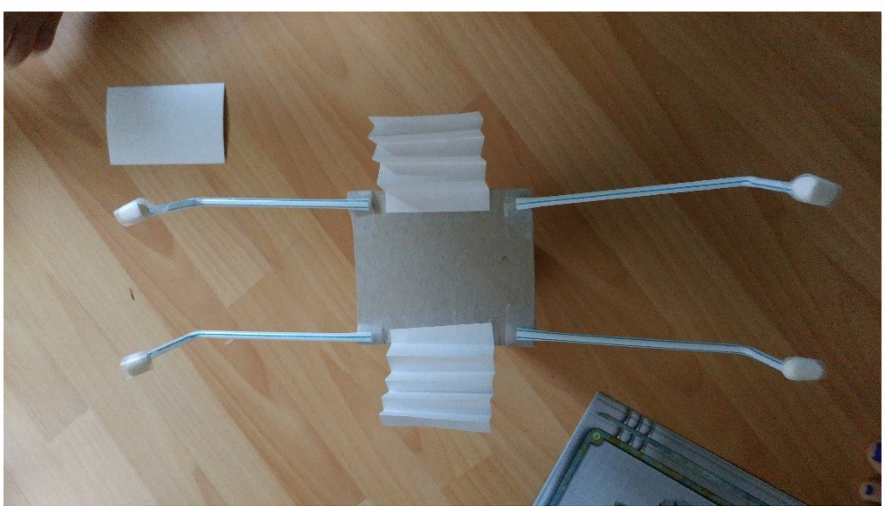
1. What problems did you have with this design?
We hav problems fitting the legs on.

2. What improvements or changes can you make to your design?
We can have better index cards.

Revised Design:



under veiw

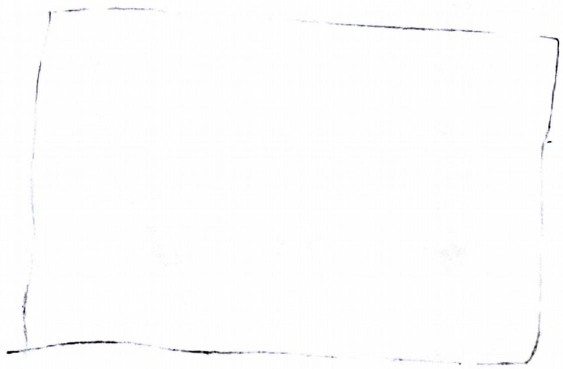


1. What parts of the changes you made worked?

None of the parts worked.

2. What (if any) other changes could you make?

I can not make any more changes



Part 1-Midterm

Lesson-**Touchdown**-How can you design and build a shock-absorbing system that will protect two "astronauts" when they land?

Standards:

SC.6.P.11.1 Explore the Law of Conservation of Energy by differentiating between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.

SC.5.P.13.1 Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects.

SC.6.P.13.2 Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

LAFS.68.RST.1.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

MAFS.5.MD.1.1 Convert among different-sized standard measurement units (i.e., km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec) within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

MAFS.6.RP.1.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.

b. Solve unit rate problems including those involving unit pricing and constant speed.*For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?*

c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

e. Understand the concept of Pi as the ratio of the circumference of a circle to its diameter.

MAFS.6.SP.2.5 Summarize numerical data sets in relation to their context, such as by:

a. Reporting the number of observations.

b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

Types of Problem Solving:

This is a trouble-shooting problem because students are generating and testing hypotheses. It is also a strategic performance problem as the students use their knowledge and results to explore possible solutions and refine their designs.

Declarative Knowledge:

Students must be familiar with:

- Law of Conservation of Energy
- Law of Gravity
- Balanced and Unbalanced Forces
- Acceleration
- Measurement tools, uses, and conversions
- Ratios and Rates

Procedural Knowledge:

Students must be familiar with the NASA engineering design process:

- Identify the problem
- Identify criteria and constraints
- Brainstorm possible solutions
- Generate ideas
- Explore possibilities
- Select an approach

- Build a model or prototype
- Refine the design

Objective:

- Students will be able to use an understanding of forces, gravity and energy to design and build a shock-absorbing lander for space missions.

Ancillary Concepts:

- Students will gain practical application to the use of measurement, ratios, and rates.
- Students will gain experience through the problem solving and engineering design models.

Activity:

Students will follow the design process as presented in the NASA/Design Squad Challenge, “Touchdown”. They will work in small groups of 2-4 students of mixed age groups, ranging from 10-12 years old. Students will work on the project approximately 30-45 minutes per day for 3 days.

References:

Home . DESIGN SQUAD GLOBAL | PBS KIDS. (n.d.). Retrieved from http://pbskids.org/designsquad/

Jonassen, D. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development 48 No4 2000,48*(4), 63-85.

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