

LESSON PLAN:

Utah SEEd Standard 8.4.5

Analyze and interpret patterns of the occurrence of natural hazards to forecast future catastrophic events, and investigate how data is used to develop technologies to mitigate their effects. Emphasize how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow prediction, but others, such as earthquakes, may occur without warning. (ESS3.B)

NGSS:

MS-ETS
1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS
1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS
1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS
1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Standard 7-8.R.4:

Read grade-level text* with accuracy and fluency to support comprehension. (RL & RI)

Standard 7-8.W.1:

Write arguments to support claims with logical reasoning, relevant evidence from accurate and credible sources, and provide a conclusion that follows from and supports the argument presented.

SEP: Analyze and Interpret Data:

Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.

CCC: Patterns

Patterns can be used to identify cause and effect relationships.

DCI: Natural Hazards:

Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.

Day 1: Read "Earthquakes" by Lynda R Williams - pages 21-24

Day 2: Read 8th Grade Science for Utah SEEd Standards Textbook pages 215-216 "Preventing Natural Hazards from Becoming Natural Disasters", and 223-224 "Analyzing Data about Earthquakes"

Day 3: Analyzing Data from Maps Worksheet

Research the Wasatch Fault using the United States Geological Society webpage

<https://www.usgs.gov/programs/earthquake-hazards/science/how-big-and-how-frequent-are-earthquakes-wasatch-fault>

Sanpete Specific:

https://earthquake.usgs.gov/cfusion/qfault/show_report_AB.cfm?fault_id=2351§ion_id=i

University of Utah Seismograph Stations: <https://quake.utah.edu/earthquake-center/quake-map>

Earthquakes in Utah: <https://earthquakes.utah.gov/>

Day 4: Objective: Students will work together in a group to design and build a three story structure out of some of the provided materials. Students will be able to use hot glue, popsicle sticks, toothpicks, marshmallows, cardstock, tape, glue, gumdrops, or cardboard to create their design.

As a class, students will determine what makes a successful earthquake resistance building. The teacher will prompt students to hopefully create a rubric similar to the one created by the National Science Teachers Association.

<https://static.nsta.org/connections/middleschool/201411DesignProjectRubric.pdf>

Teachers First says this about including students in the creation of a rubric: "students feel more empowered and their learning becomes more focused and self-directed. Intrinsic motivation occurs when students design their own assessment tools... The development of a rubric is a reflective process. It extends beyond just turning in a project. ("TeachersFirst - Rubrics to the Rescue: Involving Students in Creating Rubrics")

They will test their structure to see how well it withstood the earthquake simulation.

Day 5: Students will build their first design without specific discussion questions other than creating the rubric together. Each group will be able to test their building. After all groups have tested, we will conduct a class discussion with the following questions (along with any additional questions posed by the students).

- What makes a structure strong?
- What would make a structure more resistant to earthquakes?
- What do you think engineers need to think about when they design a structure in an earthquake prone area?
- How do you think height and width of the base of the building affect the stability of the building?

Watch the video "Can We Make Buildings Truly Earthquake-Proof"

<https://www.youtube.com/watch?v=yJXjcCUpzeY>

Day 6: Students will redesign their structure and test their new structure to see if their new structure was able to better mitigate the effects of the earthquake.

1. Draw a representation of your design:
2. Record your observations as you watched your first building go through the simulation.
3. Draw a representation of your second design here. Emphasize any changes that you and your group made. Explain why you chose the material that you chose for your second design.
4. Record your observations as you watched your second building go through the simulation.
5. Were you successful in mitigating the damage caused by the earthquake simulation?

Day 7: The student reflections varied from class to class - as determined by the rubric that they created.

"TeachersFirst - Rubrics to the Rescue: Involving Students in Creating Rubrics." *TeachersFirst: The Web Resource by Teachers, for Teachers*,
<https://teachersfirst.com/lessons/rubrics/involving-students.cfm#:~:text=By%20involving%20students%20in%20the,hold%20them%20to%20its%20standards>. Accessed 2 Jan. 2024.

USING TECHNOLOGY TO MITIGATE THE EFFECTS OF NATURAL HAZARDS

THERE ARE PATTERNS IN THE OCCURRENCES OF NATURAL HAZARDS AND THESE PATTERNS CAN BE USED TO PREDICT FUTURE CATASTROPHIC EVENTS.

12.13

How can we use technology to mitigate the effects of natural hazards?

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Unit Goal: BY THE END OF UNIT 2, I WILL BE ABLE TO EXPLAIN THE SCIENTIFIC REASON FOR UNEVEN DISTRIBUTION TO RESOURCES, DETERMINE NONRENEWABLE ENERGY SOURCES, FIND A SOLUTION TO DIMINISHING NATURAL RESOURCES, AND INTERPRET DATA FROM GLOBAL ENERGY CHANGES AND NATURAL DISASTERS TO DETERMINE WAYS TO MITIGATE THEIR EFFECTS.

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I can analyze and interpret changes in global temperatures.

Agenda: Investigate It! - Earthquakes Design It! - Earthquake Engineering Lab Rubric

Earthquakes

By Lynda R. Williams

An **earthquake** is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the **fault** or **fault line**. The location below the earth's surface where the earthquake starts is called the **focus** and the location directly above it on the surface of the earth is called the **epicenter**.

The surface of the earth is the layer called a crust. The crust is not all in one piece – it is made up of many pieces like a puzzle covering the surface of the Earth. We call these puzzle pieces the tectonic plates. These plates keep slowly moving around, sliding past one another and bumping into each other. The edges of the plates are the plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults.

Sometimes the edges of the plates can get stuck as they are moving because they are rough and not smooth. Pressure slowly starts to build up to where the edges are stuck and, once the pressure gets strong enough, the plates will suddenly move to cause an earthquake. The energy radiates outward from the fault in all directions in the form of **seismic waves** like ripples on a pond. The seismic waves shake the earth as they move through it. This is the shaking we feel standing on the crust of the Earth.

The shaking that the seismic waves create is what we think of as an Earthquake. They are the Earth's natural means of releasing stress. More than a million earthquakes rattle the world each year. Many are small and we do not feel them. Occasionally an earthquake is so large it can be felt miles away!



Earthquakes can be felt over large areas, although they usually last less than one minute. Earthquakes can cause considerable damage to structures on the surface of the Earth. Earthquakes cannot be predicted.

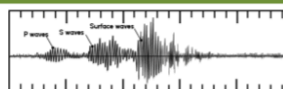


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Page One

Earthquakes

By Lynda R. Williams



Scientists measure how big an earthquake is by looking at seismic waves. A seismograph is a tool that measures seismic waves. It shows both the intensity of the waves and for how long they were sent out. The longer and taller their signal is, the stronger the earthquake.

After scientists have recorded the intensity of an earthquake, they need a way to talk about it. So, they have developed scales for the intensity of earthquakes. There are many kinds of intensity scales. The most well-known is the Richter Scale.

There are three main types of waves:

- **Primary Waves (P Waves)** – These waves are recorded by the seismograph first. They are longitudinal, which means that they move from side to side. They shake the Earth in the direction that they move. This type of wave can travel through liquid.
- **Secondary Waves (S Waves)** – These waves are the second waves recorded by the seismograph. These waves shake the Earth perpendicular to the direction that they move in. They move up and down. Secondary waves cannot travel through liquid.
- **Surface Waves** – These waves are recorded by the seismograph last. These waves can only move through the surface of the Earth.



Crust-Solid
Mantle-Molten State
Outer Core-Liquid
Inner core-Solid

Because P Waves can move through liquid and S Waves cannot, scientists have been able to make inferences about which parts of the Earth's layers are solid and which are liquid by observing how seismic waves move through them. The mantle is mostly solid, but it is molten, so it moves more like a very thick fluid.

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Page Two

Read
"Earthquakes"
on Canvas



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BUILDING A STRUCTURE

- 30 beams—toothpicks or pieces of spaghetti
- 30 connectors—miniature marshmallows or gumdrops

Using no more than 30 connectors and 30 beams design a structure that will hold up to an earthquake.

Plan your structure—draw a sketch

Build it

Test it. You can use two small pieces of tape to secure it to the lid.

- Start with a gentle earthquake. Use your finger to gently shake the lid. Observe how your structure moves.
- Gradually increase the strength. How hard do you need to shake the building to make it fail?
- Note weak points in your structure and think about how you can improve them..
- Make modifications and test again!

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Requirements:

- 40 points on the rubric.
- Materials list.
- Group points AND individual points.
- Graded on improvement of second design.

USING TECHNOLOGY TO MITIGATE THE EFFECTS OF NATURAL HAZARDS

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12.14

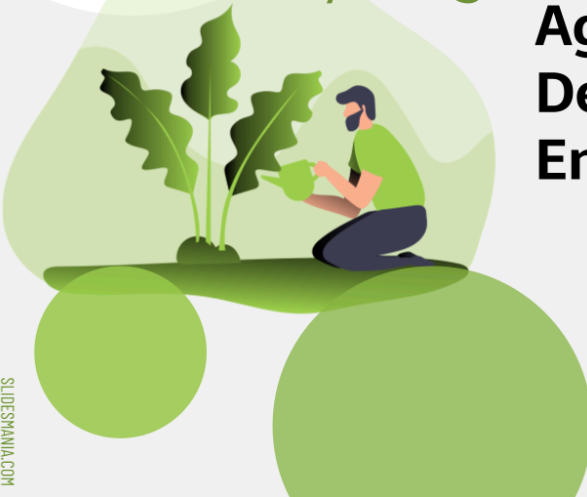
How can we use technology to mitigate the effects of natural hazards?

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UNIT GOAL: BY THE END OF UNIT 2, I WILL BE ABLE TO EXPLAIN THE SCIENTIFIC REASON FOR UNEVEN DISTRIBUTION TO RESOURCES, DETERMINE NONRENEWABLE ENERGY SOURCES, FIND A SOLUTION TO DIMINISHING NATURAL RESOURCES, AND INTERPRET DATA FROM GLOBAL ENERGY CHANGES AND NATURAL DISASTERS TO DETERMINE WAYS TO MITIGATE THEIR EFFECTS.

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6th/7th Periods SKIP CER - we need to build everything today for MONDAY.



Agenda: **Design It! - Earthquake Engineering Lab**

HOW many per group? DO the math.

Actual amount of materials per class (total number divided by six classes, two buildings each group)

1. Popsicle sticks: 34 divided by 6 ~6
2. Marshmallows: One Bag ~ $\frac{1}{6}$ of a bag
3. Gumdrops: 36 ~6
4. Round Toothpicks: 150 ~25
5. Flat Toothpicks: 300 ~ 50
6. Glue sticks: 13 ~2
7. Tongue depressors: 11 ~2
8. Cardstock: 30 ~5

Remember that things can be cut or broken in pieces also

LAB DAY ONE & TWO:

- Draw a representation of your design
- Build today/tomorrow and plan to test in class on Monday
- If you finish early, work on missing work or have free time

Sixth Period Rubric

	5	4	2	0
Height Requirement	6 or more inches	5 inches	4 inches	Below 4 inches
Blueprint	All straight lines are ruler-drawn and measurements are given. Design is properly labeled. Blueprint and model match.	All straight lines are ruler-drawn and measurements are given, but there are minor errors in the features compared to the actual model.	Most straight lines are ruler-drawn. Many errors in the features compared to the actual model.	Drawing does not resemble the actual model.
Earthquake-Resistant Features	Incorporated three or more earthquake-resistant features.	Incorporated two earthquake-resistant features.	Incorporated one earthquake-resistant feature.	Did not incorporate any earthquake-resistant features.
Structural Survival	Structure survived the simulated earthquake with no damage.	Structure survived the simulated earthquake with little damage.	Structure survived the simulated earthquake with major damage, such as a partial collapse.	Structure did not survive the simulated earthquake.

	10	7	5	0
Participation points	Everyone in the group says you helped	One person said that you didn't help	Two people said that you didn't	Everyone said you didn't help
One thing you did wrong and one thing you did right.	Two complete sentences (one for wrong and one for right). Talks about the materials used.	One sentence or incomplete sentences. Talks about the materials used.	Does not mention the materials used	One word answers.

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Seventh Period Rubric

	4	3	2	1
Participation	All group members said you participated.	One group member said you didn't participate.	Two group members said you didn't participate.	No one said you participated.
Changes Question: What happened to the first model and why did you change it?	Three complete sentences that answer the prompt. Everything is spelled correctly.	Two sentences that answer the prompt.	One sentence that answered the prompt.	Does not answer the prompt
What materials and why.	Two sentences that answer the prompt. Everything is spelled correctly.	One sentence that answered the prompt. Everything is spelled correctly.	One sentence that answered the prompt. Spelling mistakes.	Does not answer the prompt
Proper Writing Conventions	All writing conventions and spelling are correct. The report is error-free.	There are a few conventions and spelling errors, but they do not interfere with correct content and readability.	There are some convention and spelling errors that interfere with correct content and readability.	There are many convention and spelling errors that make the report incomprehensible.

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	4	3	2	1
Weight Requirement	Can hold 5 pennies	Can hold 4 pennies	Can hold 3 pennies	Can hold less than 3 pennies
Height Requirement	8 inches	6 inches	4 inches	Less than 4 inches
Blueprint	Design is properly labeled. Blueprint and model match.	There are minor errors in the features compared to the actual model.	Many errors in the features compared to the actual model.	Drawing does not resemble the actual model.
Diversity of Material	Used all eight provided materials	Used 6 of the 8 provided materials	Used 4 of the 8 provided materials	Used less than 4 of the provided materials.
Earthquake-Resistant Features	Incorporated three or more earthquake-resistant features.	Incorporated two earthquake-resistant features.	Incorporated one earthquake-resistant feature.	Did not incorporate any earthquake-resistant features.
Structural Survival	Structure survived the simulated earthquake with no damage.	Structure survived the simulated earthquake with little damage.	Structure survived the simulated earthquake with major damage, such as a partial collapse.	Structure did not survive the simulated earthquake.

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Agenda:

- Design Test
- Revised Design

TEST THE DESIGNS



LAB DAY THREE

- Test Second Structure. Record your observations on your rubric.
- Grade your rubric according to the rubric you created. Make sure all names are on the rubric and that you include your blueprint.
- Answer the two “individual” questions on Canvas
- Earthquake Quiz on Canvas
- Participation/Collaboration Survey on Canvas

INDIVIDUAL COMPONENT OF THE ASSIGNMENT:

1st and 5th Period

- CER Paragraph:

What mitigation techniques do engineers use to make earthquake resistant buildings?

2nd Period

You need to take a survey to decide how well each member of your group participated on the project.

4th Period

- Participation survey.
- Two questions:

What material did you use, and why?

If you could change anything about your project, what would it be? Why?

6th Period

- Participation survey.
- One question:

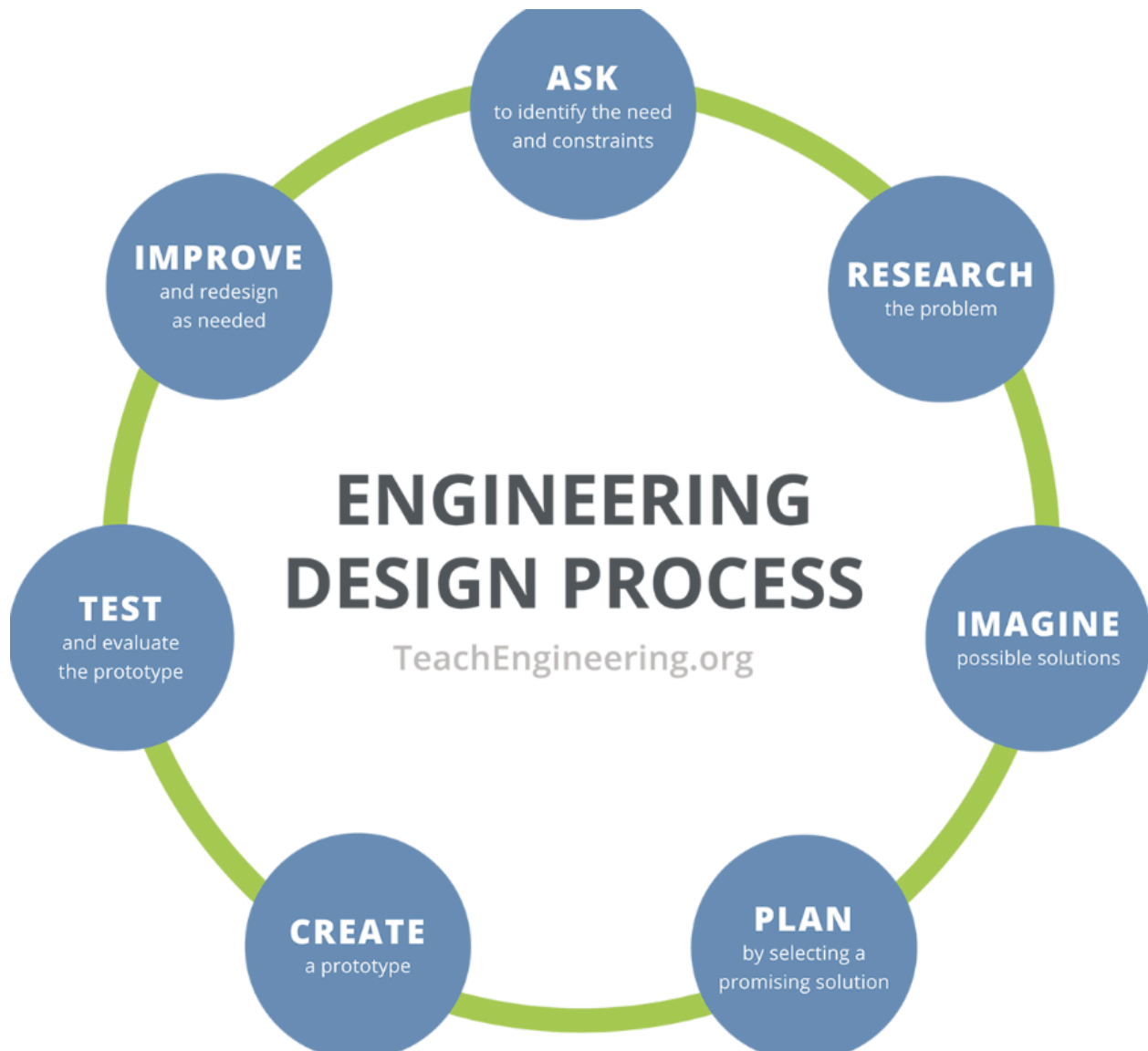
One thing you did wrong and one thing you did right.

7th Period

- Participation survey.
- Two Questions:

What happened to the first model and why did you change it?

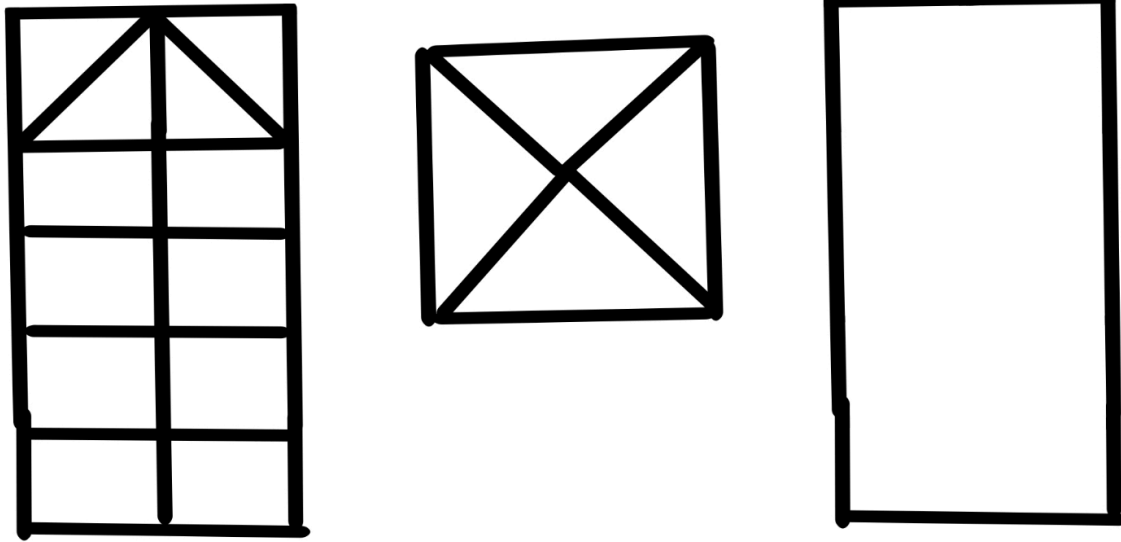
What materials and why.



("Engineering Design Process - TeachEngineering")

EXAMPLES OF STUDENT DRAWING AND REFLECTIONS

STUDENT ONE: FIFTH PERIOD RUBRIC



engineers have a couple methods to help with earth quakes. The ones we used are called braces, shear wall, and we streanghtened are hitches. these help make earthquake resistaint buildings by making the buildings stronger.

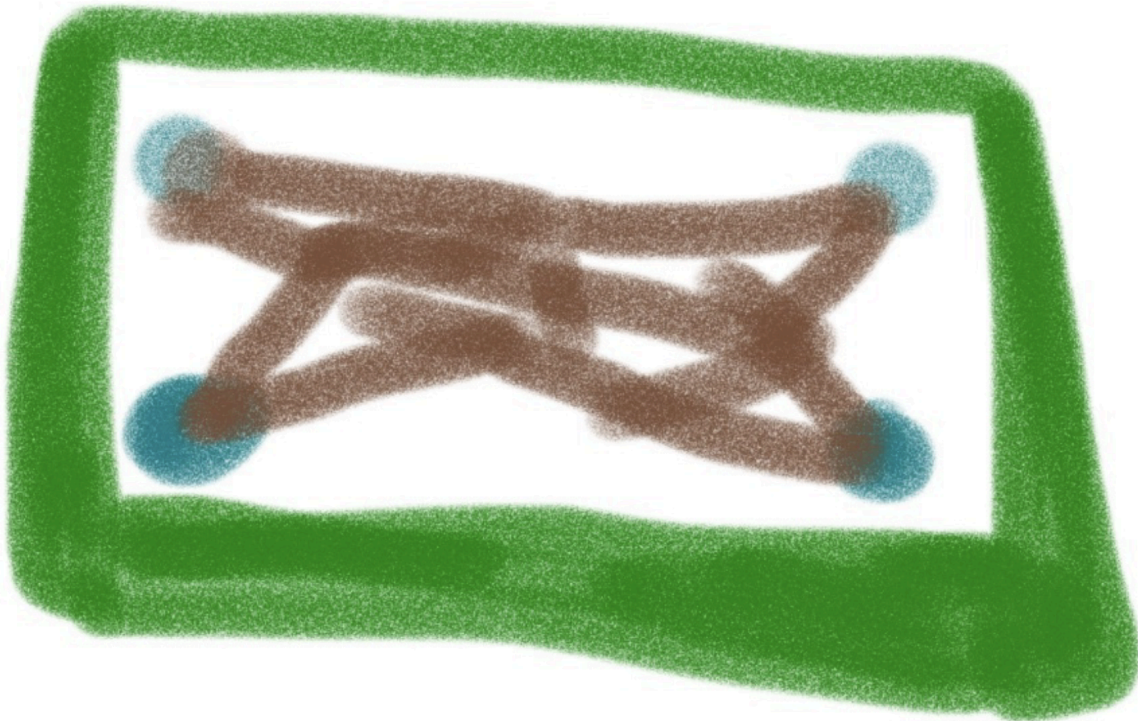
STUDENT TWO: FOURTH PERIOD RUBRIC

We used big popsicle sticks, small popsicle sticks, paper, marshmallows, gum drops, and hot glue. We used these materials because we thought if we put the popsicle sticks on a diagonal they would be stronger. We used the paper so we could meet the 6 inch requirement.

If i could change anything about it I'd change the way it looks. We made it look really bad, it was covered in glue, we didn't really take our time. It would've had the same outcome even if it looked better.

STUDENT THREE: SECOND PERIOD RUBRIC

1. We used popsicle sticks, gumdrops, marshmallows, construction paper, and skinny stick thinggies. We used the popsicle sticks for the walls and the building because they are strong resources. The gumdrops for the rollers, the marshmallows for wall closers and a person, construction paper for the base and the tiny sticks for the things to roll on.
2. I would make the walls taller so the building doesn't try to fall off the base.



STUDENT FOUR: FIRST PERIOD RUBRIC

1. For our group structure, we used six small popsicle sticks, two large popsicle sticks, five marshmallows, five gumdrops, and twenty-five toothpicks. Four popsicle sticks, two small and two large, were positioned in a square on their sides, and were then glued together. In each gap was also positioned a marshmallow. The inside was filled with all but five toothpicks, which were later used. The initial structure had four gumdrop bottoms connected by toothpicks reinforced by glue. Four small popsicle sticks were stabbed into the gumdrops, creating a pyramid shape, connected at the top by a gumdrop. One last toothpick was placed in the topmost gumdrop with a marshmallow on top, which was also reinforced with glue.
2. If I were to change anything about the structure, I would add more glue as reinforcements. I would make sure each pillar of framing was connected, and make sure it was all properly glued. Other than that, I don't think there is much I would change. Of

course, there are always things that could be improved, but as this is a class assignment, rather than real architecture, I think I will leave it at that.

STUDENT FIVE: SEVENTH PERIOD RUBRIC

The material we used were gumdrops, card stock, a whiteboard, marshmallows, toothpicks, and popsicle sticks. We hot glued the card stock to the whiteboard we were given for extra support. We cut the gumdrops in half and stuck the popsicle sticks into them for the base of the project. We put the toothpicks into the gumdrops, and put another gumdrop on top of each toothpick. We hot glued popsicle sticks to each gumdrop in the middle, making triangles. We stuck another toothpick on each gumdrop and stacked marshmallows on top. We glued 2 on each other for extra support. We put one more toothpick on top and connected them with one more marshmallow.

STUDENT SIX: SIXTH PERIOD RUBRIC

If I could change anything about my project, I'd try to put more triangles in the structure. I'd probably put a little more on both the bottom for more support, and to make it more bottom heavy so the chances of falling are less. I'd also probably use more toothpicks, less hot glue and less marshmallows.

"Engineering Design Process - TeachEngineering." TeachEngineering.Org,
<https://www.teachengineering.org/populartopics/designprocess>. Accessed 2 Jan. 2024.

"TeachersFirst - Rubrics to the Rescue: Involving Students in Creating Rubrics." TeachersFirst:
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