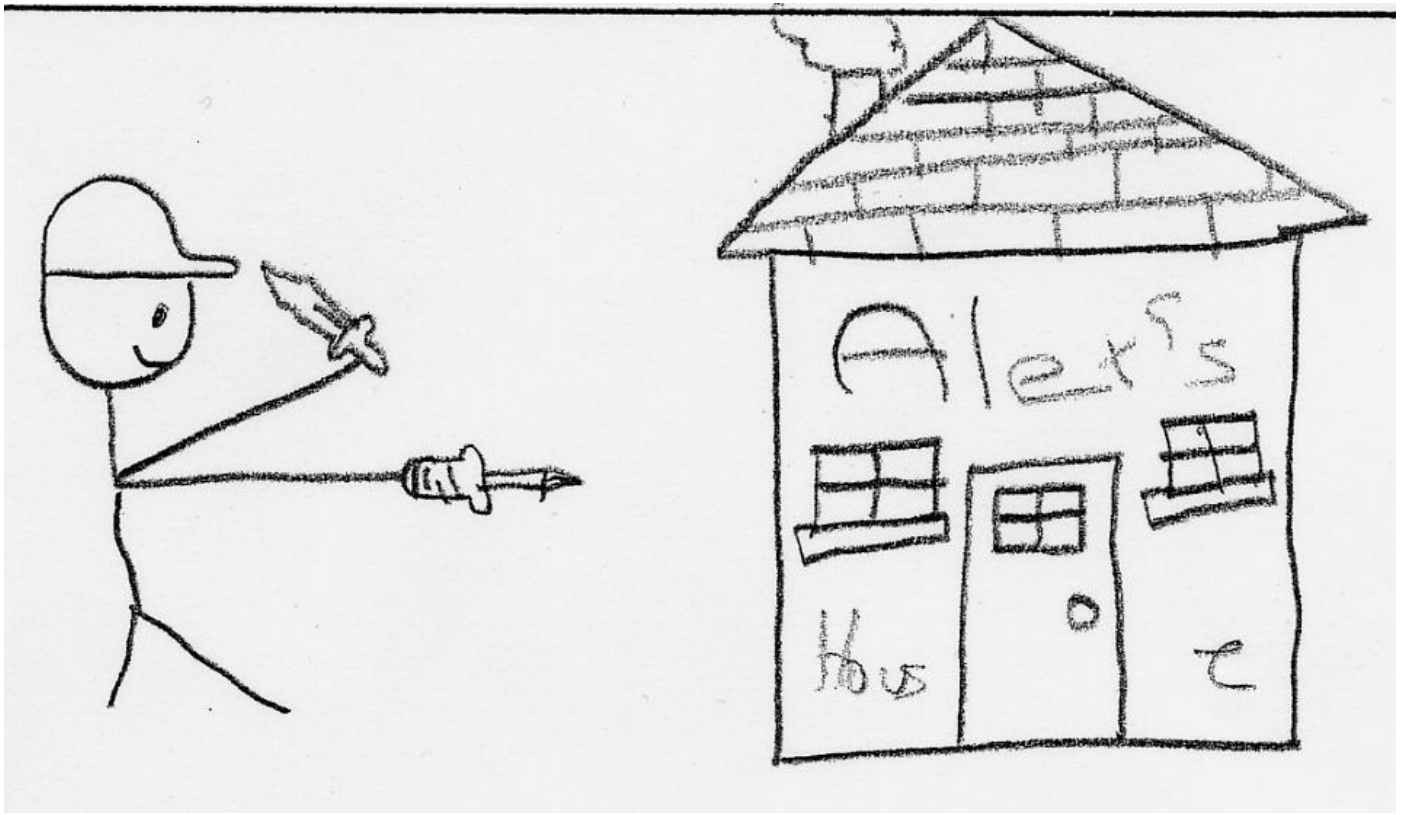
Engineering in the Michigan Science Standards

The MI Science Standards are the Performance Expectations from NGSS

APPENDIX I – Engineering Design in the NGSS

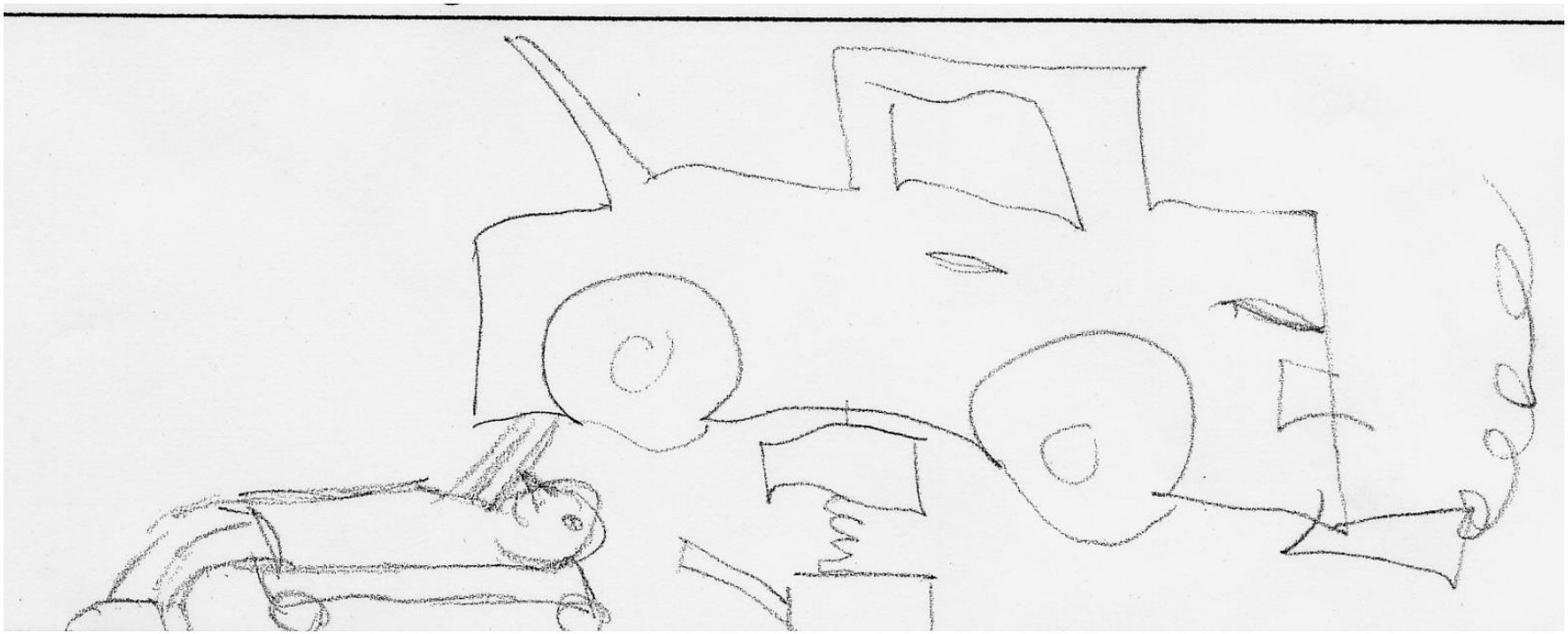
The Next Generation Science Standards (NGSS) represent a commitment to integrate engineering design into the structure of science education by ***raising engineering design to the same level as scientific inquiry*** when teaching science disciplines at all levels, ***from kindergarten to grade 12***. There are both practical and inspirational reasons for including engineering design as an essential element of science education.

Engineers….build buildings.



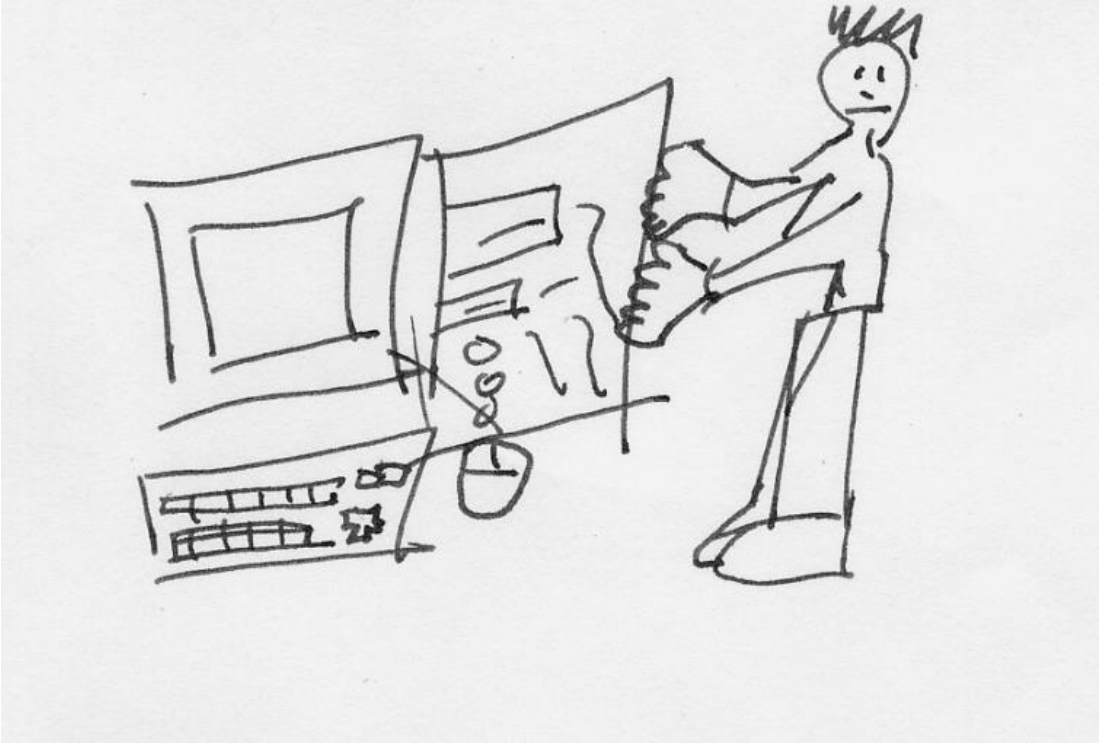
Engineers….

fix cars, engines, and machines.

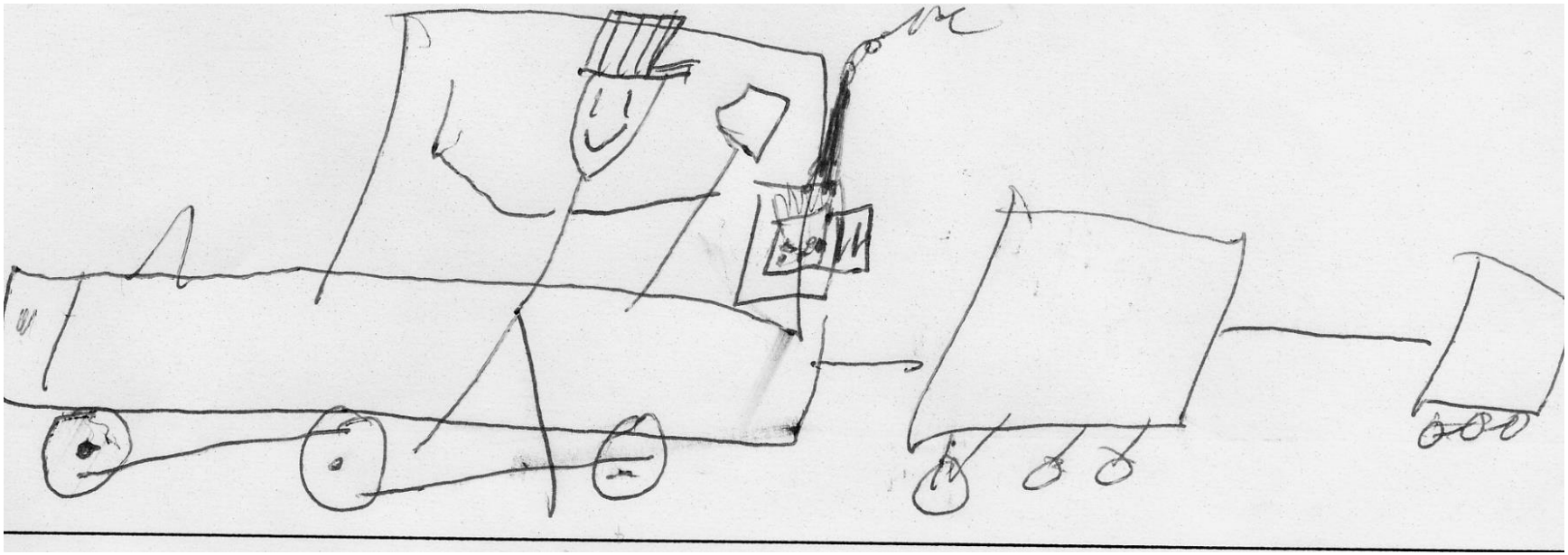


Engineers….

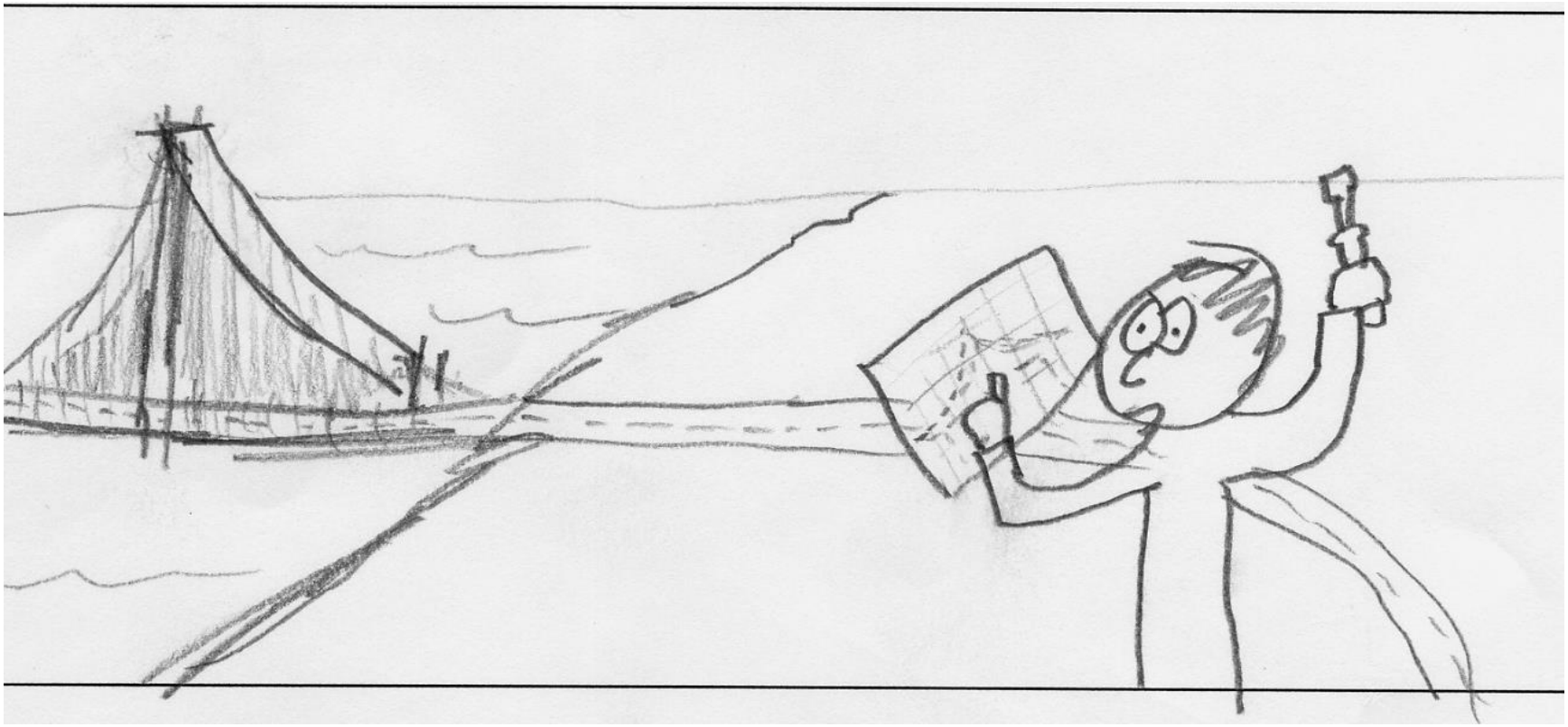
use or fix computers.



Engineers….drive trains.



Engineers….
build bridges and roads.



An engineer is someone (men and women) who uses his or her creativity and knowledge of math and science to design things that solve problems.

APPENDIX I – Engineering Design in the NGSS

Pg. 1 We use the term "engineering" in a very broad sense to mean any engagement in a systematic practice of ***design to achieve solutions to particular human problems***. Likewise, we broadly use the term ***"technology" to include all types of human-made systems and processes***—not in the limited sense often used in schools that equates technology with modern computational and communications devices. Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants. (NRC 2012, p. 11-12)

Technology in a Bag

- What is the technology?
- What does your technology do? What problem does it solve?
- How else could you use it?
- What material(s) is it made of?
- What other materials could it be made of?

EiE defines technology as:

Anything human-made that is used to solve a problem or fulfill a desire.

Technology can be an object, a system, or a process.

APPENDIX I – Engineering Design in the NGSS

Pg. 2 According to the Framework: "From a teaching and learning point of view, it is the ***iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices***" (NRC 2012, pp. 201-2). The Framework recommends that students explicitly learn how to engage in engineering design practices to solve problems.

http://marshmallowchallenge.com/TED_Talk.html

APPENDIX I – Engineering Design in the NGSS

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What is Engineering?
Tower Power

Engineering Terminology

- **Criteria:** The qualities designated within a design to solve a problem or fulfill a need.

- **Constraints:** Components like time, money, or materials that may limit the design.

Tower Power

Criteria (requirements)	Constraints (limitations)
You must work in small groups.	You will have 20 minutes to engineer.
Your tower should stand at least 10 inches tall.	Each group can only use 1.100 index cards and 2. 1 foot of tape The ruler and scissors cannot be used in the tower.
Your tower should support the stuffed animal for 10 seconds.	Groups can hold the stuffed animal briefly, but cannot test with it until the 20 minutes are up.

reply forward archive delete

from:	engineeringadventures@mos.org
to:	You
subject:	Engineering a Tower

11:11 AM

Hi everyone,

We're so excited to meet you! Our names are India and Jacob. We do a lot of traveling all over the world. We meet interesting people and see some amazing countries. Each place is unique, but we've found one thing in common. Everywhere we go in the world, we find problems that can be solved by engineers.

Engineers are problem solvers. They're people who design things that make our lives better, easier, and more fun! We heard you might be able to help us engineer solutions to some of the problems we find. That means you'll be engineers, too!

Today, we came across an engineering challenge we think you can help us solve. There are some animals living in a swamp along with lots of hungry alligators. The animals need to be at least 10 inches above the alligators to be out of their reach. India and I thought we could build a tall tower that the animals could stand on. Do you think you can engineer a tower to help?

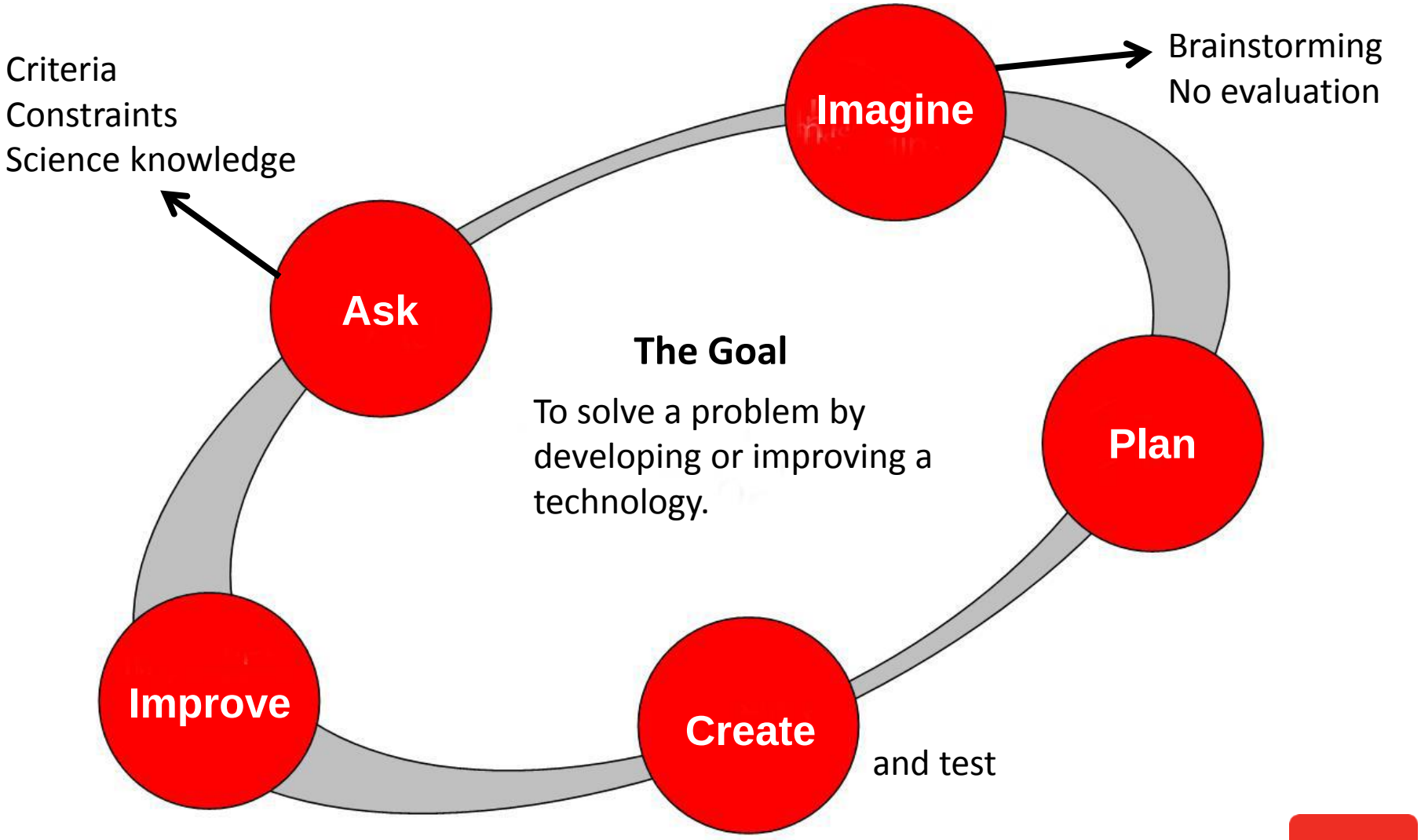
Good luck!
India and Jacob

Reflect on Your Process

Reflect on the activity you just went through with your group.

- On sticky notes, write down 1 action word or phrase to describe each step you went through during the activity.
- Each sticky note should only have 1 action word or phrase

The Engineering Design Process




Imagine
Ask
THE GOAL
Plan
Improve
Create


IDENTIFY
INVESTIGATE
IMAGINE
PLAN
CREATE
TEST
IMPROVE
COMMUNICATE

APPENDIX I – Engineering Design in the NGSS

Pg. 2 By the time these students leave ***high school, they can "undertake more complex engineering design projects related to major global, national, or local issues***"

APPENDIX I – Engineering Design in the NGSS

Pg. 2

A. Defining and delimiting engineering problems involves ***stating the problem to be solved as clearly as possible in terms of criteria for success***, and ***constraints or limits***.

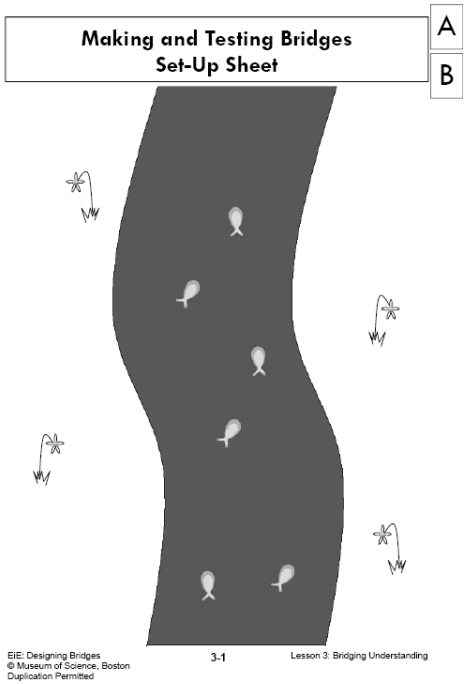
B. Designing solutions to engineering problems begins with generating a number of different possible solutions, then ***evaluating potential solutions to see which ones best meet the criteria and constraints*** of the problem.

C. Optimizing the design solution involves a process in which ***solutions are systematically tested and refined and the final design is improved*** by trading off less important features for those that are more important.

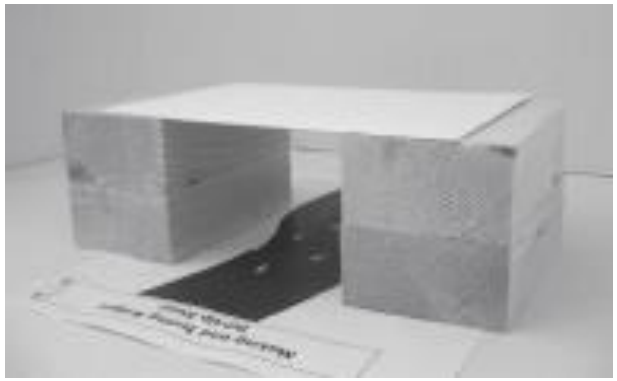
Tower Power

Criteria (requirements)	Constraints (limitations)
You must work in small groups.	You will have 20 minutes to engineer.
Your tower should stand at least 10 inches tall. Build your tower in a tray. If your tower stands, you will use it in a later activity.	Each group can only use 1.100 index cards and 2. 1 foot of tape The ruler and scissors cannot be used in the tower.
Your tower should support the stuffed animal for 10 seconds.	Groups can hold the stuffed animal briefly, but cannot test with it until the 20 minutes are up.

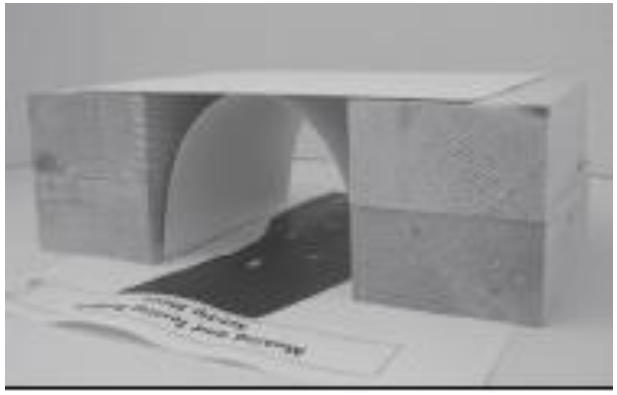
Bridge Type Models



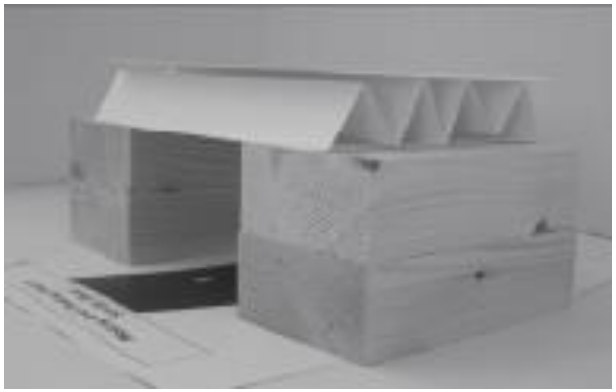
Beam Bridge



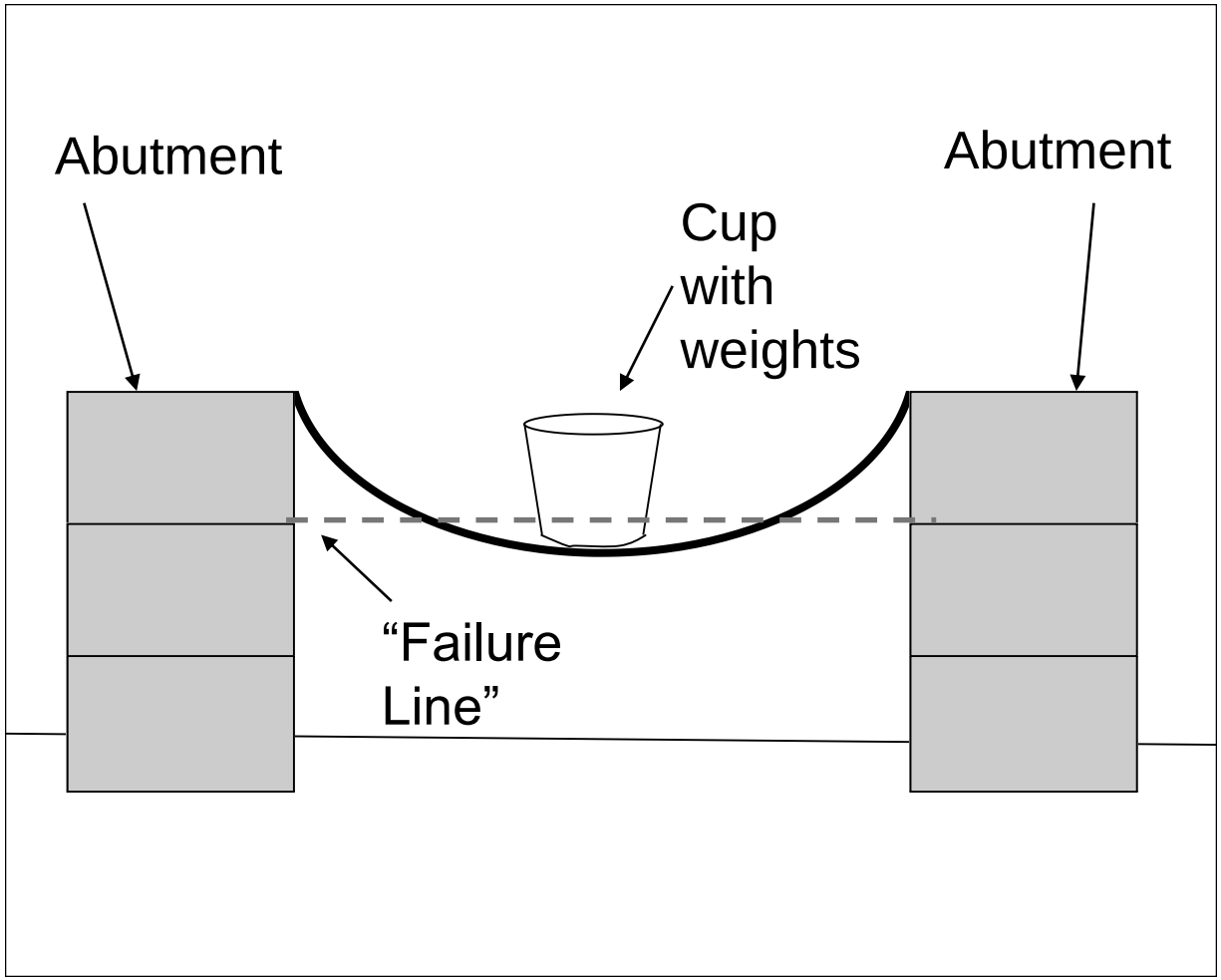
Arch Bridge



Deep Beam Bridge



How to Tell When a Bridge Design has Failed



Bridge Testing and Scoring

Name: _____ Date: _____

Bridge Design Scoring Sheet

B

Stability Score

Stability Score	How many times did a car successfully roll across your bridge?
1	1 time
2	2 times
3	3 times
4	4 times

Strength Score

Strength Score	How many weights did your bridge hold before it failed?
1	fewer than 15 weights
2	15-29 weights
3	30-44 weights
4	45-59 weights
5	more than 60 weights

Directions: Record your Stability Score and Strength Score in the table below. Add your scores together to get your Total Score.

	Design #___	Design #___	Design #___
Stability Score			
Strength Score			
Total Score			

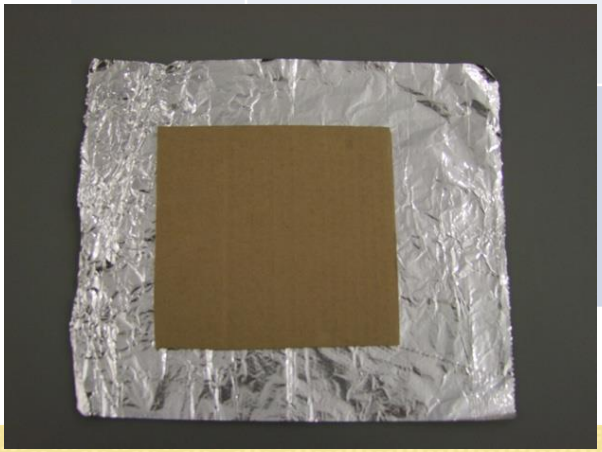
	How can we keep polluted runoff out of our river?
1.	What do you predict will happen? Why?
2.	Spray a steady rain for 30 seconds • What do you notice? • How do you think this runoff might affect the environment? • What steps of the Engineering Design Process did we use?

Activity 2: Green Possibilities

	Can green roof technology help reduce runoff?
1.	Watch video http://tinyurl.com/7famxtv
2.	• Engineer a model building at least 9 inches high (you can use 40 index cards and 1 roll of tape) • Engineer a roof for the building that reduces runoff by absorbing water. Materials available: gravel, potting soil, sand, and sphagnum moss
3.	• Review engineering notebook, p.2 • Build your tower in a foil tray • To test add 1 cup of water to your rooftop

Activity 3: Passing Through

	Can permeable pavement technology help reduce runoff?
1.	Check out the plan for Philadelphia http://tinyurl.com/2fxjqeo
2.	• Your pavement will be created in a foil tray, 5” x 1.25” x 7.5” • The directions to create the foil tray are on pg. 15 of the student notebook.

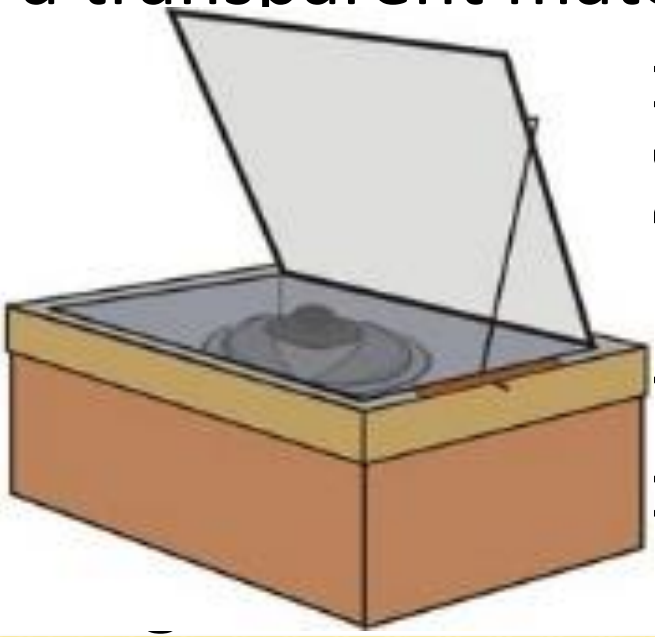


Activity 3: Passing Through

Criteria (requirements)	Constraints (limitations)
You must work in small groups.	You will have 25 minutes to engineer.
The pavement must be smooth enough for people to use for walking and driving. The wind-up toy must walk across your pavement in a straight line.	Each group can only use the materials listed in the Materials Price List on page 12 of the student notebook. Your pavement will be created in a foil tray, 5” x 1.25” x 7.5” (pg. 15)
The pavement must absorb water Spray your pavement with 20 squirts of water.	You have a budget of $200. See pg. 12 in the student workbook for the price list

Solar Cookers - High School Sample Classroom Task

People all over the world cook using electricity, gas, coal, and wood as a heating source…The most basic design of the solar oven is one of a box with a hole in the top covered by a transparent material. The sunlight enters the bo dow and hits the surface of the painted black), which transfor y to thermal energy, increasing the ne inside of the box. How well the box depends on the materials and

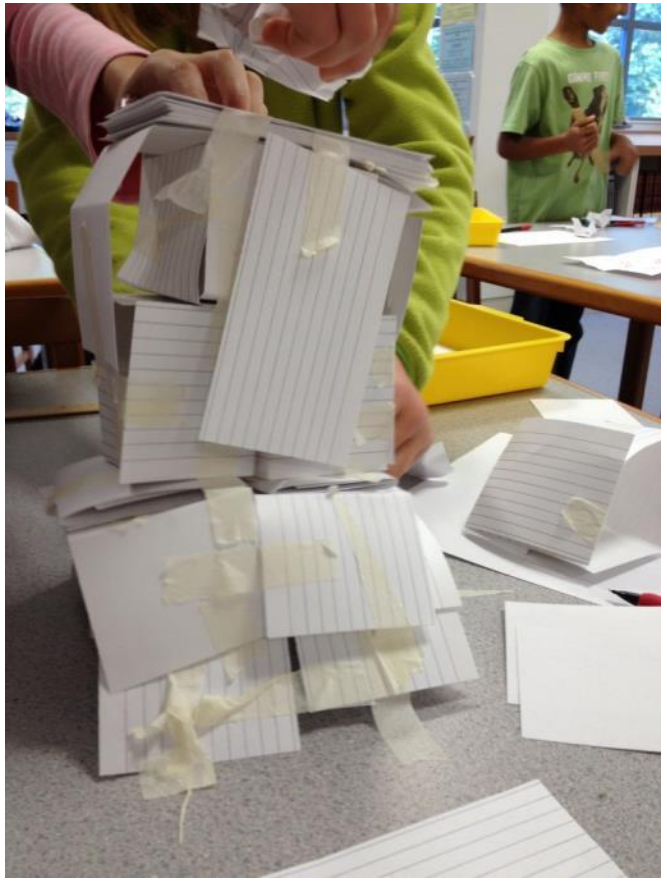


Performance Expectations That Incorporate Engineering Practices

	Physical	Life	Earth and Space	Engineer
9-12	HS-PS1-6 HS-PS2-3 HS-PS2-6 HS-PS3-3 HS-PS4-5	HS-LS2-7 HS-LS4-6	HS-ESS3-2 HS-ESS3-4	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4

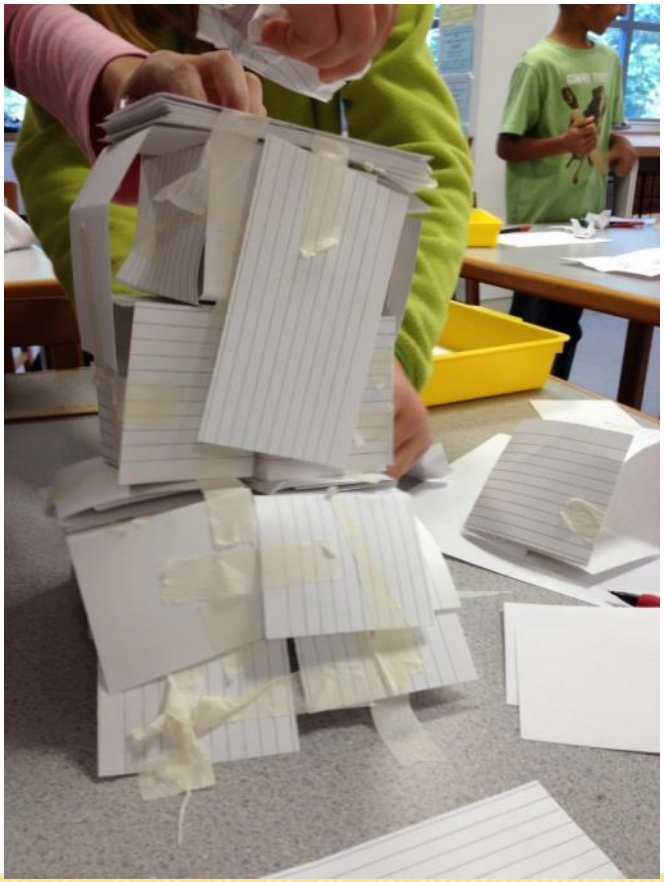
Questioning Strategies

What do you do when…it's not working?



Goal: Build the highest tower that will support the stuffed animal

Come up with several questions you could ask your kids to help guide them to improve their design.



Questioning Strategies

Question Category	Description
Design Choices	Justifying material and construction choices
Reflection of Design	Analysis of how the final product works
Improvement	Changes that could be made with more time or materials
EDP & Teamwork	Reflection of the Engineering Design Process steps, how group members collaborate

There are questions included in the Engineering Everywhere unit that can be used to help students reflect.

Key Points

- Asking questions about design choices instead of fixing the problem yourself encourages kids to think through their own problems.
- Questions focusing on the design process can help all kids talk about their successes, even if their design isn't yet meeting its goals.
- Asking every group how they might improve emphasizes that there is always room for improvement.
- Calling out the Improve step for kids helps them recognize "failure" as a natural and valuable part of engineering.

Questioning Strategies

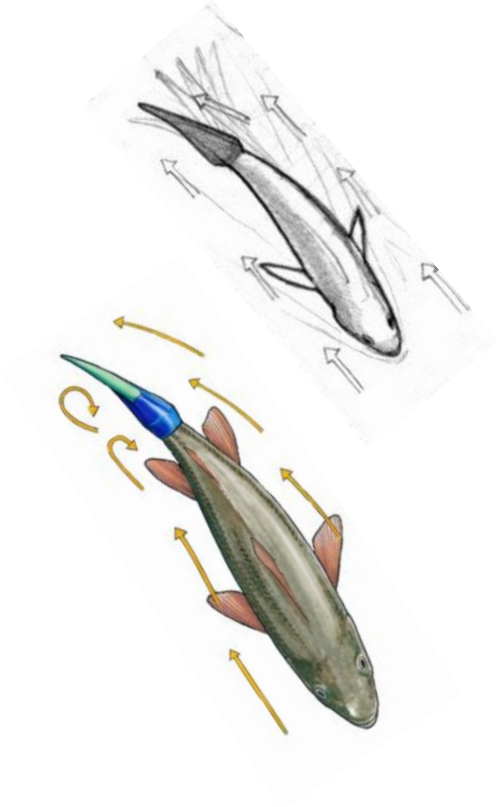
What Questions would you ask if there was no more time for your students to improve their technology?

- **How would you *improve* your design with more time?**
- **Which step of the Engineering Design Process was most difficult for you? Most useful? Why?**
- **In what area do you feel like you made the most improvement?**
- **What technology will you engineer next?**

Unit Evaluation

- What is the goal of the final design challenge?
- What scaffolding activities prepare kids for the final design challenge?
- How did the activities you just completed fit into the unit?

Curriculum Development Process



- Initial Unit Development
- National Pilot Testing
- Unit Revisions
- National Pilot Testing
- Unit Revisions
- Final Unit Released

Each (Free) Engineering Adventures Unit:

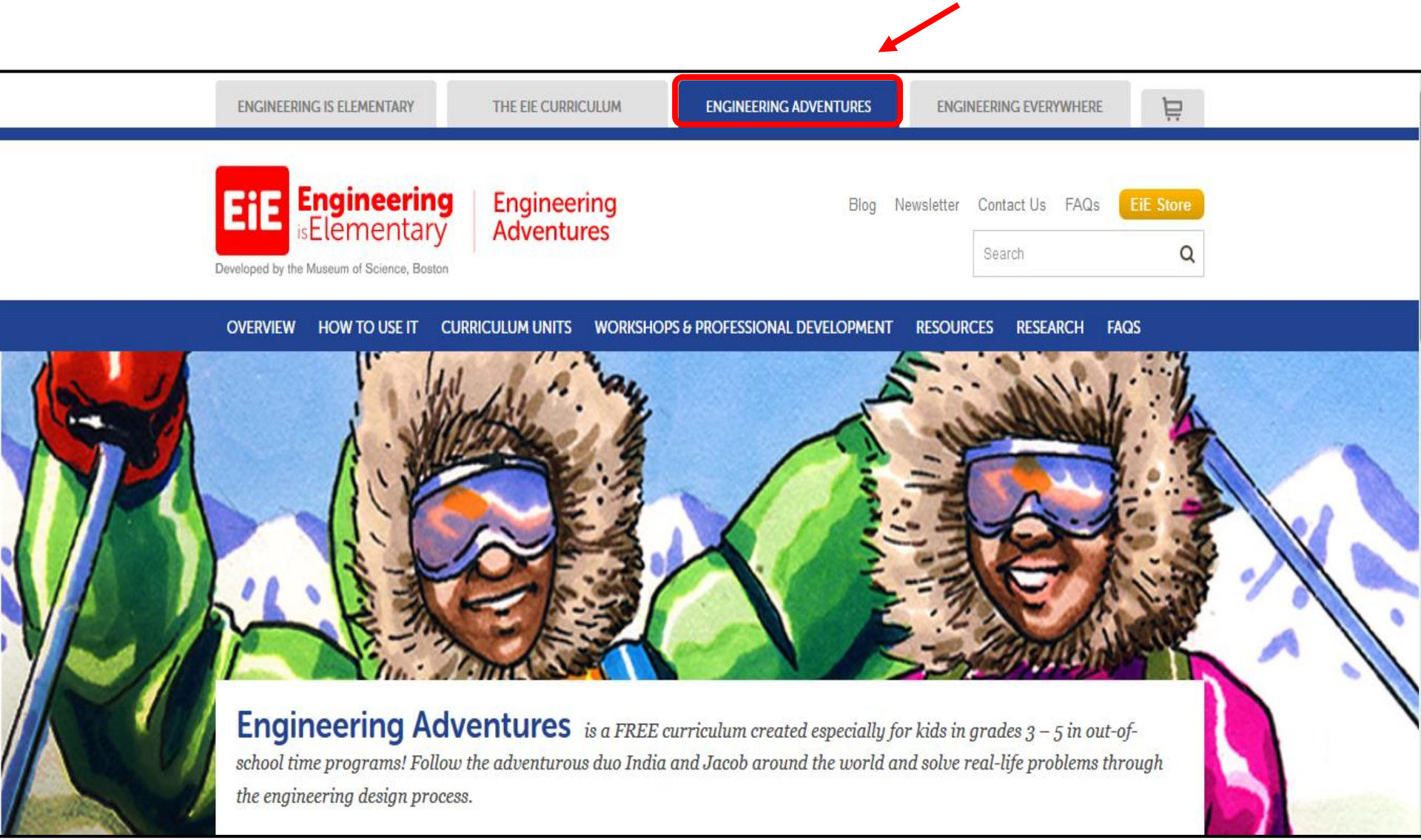
- engages kids in grades 3-5 in the Engineering Design Process
- sets a multicultural and real-life context for the challenge
- gives kids the chance to work in groups and share their work
- contains 6-10 activities, each about 45 minutes long, with flexible scheduling options

Each Engineering Everywhere Unit:

- engages youths in grades 6-8 in the Engineering Design Process.
- has a real world context, where youths are solving engineering problems relevant to today's world.
- Empower and challenge youths to think critically and creatively.
- Contains 8-9 activities, each about an hour long

www.engineeringadventures.org
www.engineeringeverywhere.org

- Engineering unit materials
- Introductory activities
- iOS Apps
- Professional Development Guide
- Videos
- Pilot opportunities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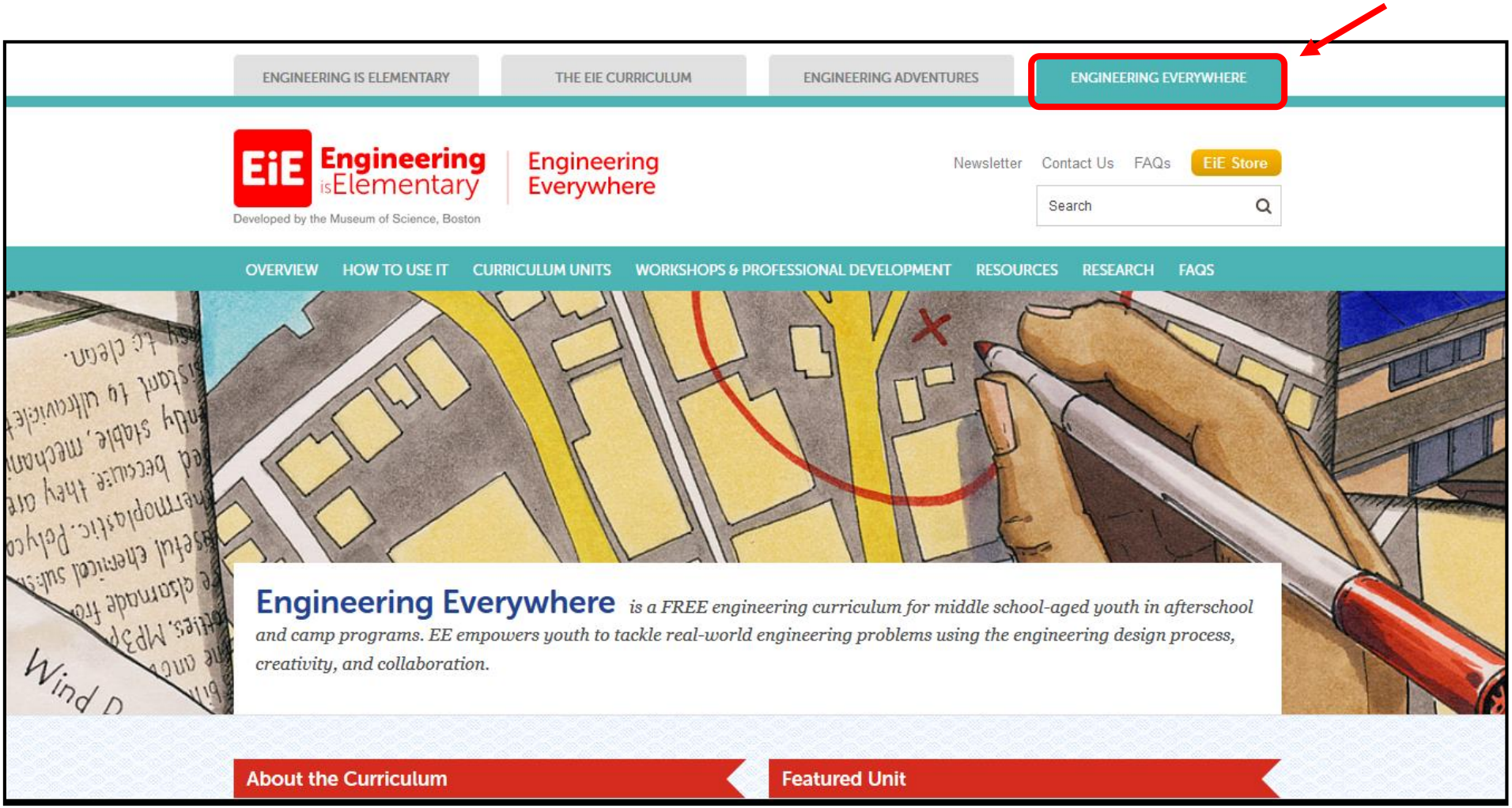
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Engineering Everywhere is a FREE engineering curriculum for middle school-aged youth in afterschool and camp programs. EE empowers youth to tackle real-world engineering problems using the engineering design process, creativity, and collaboration.
About the Curriculum
Featured Unit

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Sky's the Limit

3-5 Grades

Afterschool

Aeronautical Engineering

Rockets and Rovers

Liftoff

3-5 Grades

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Aerospace Engineering

Bubble Wands

Bubble Bonanza

3-5 Grades

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Materials Engineering

Aid Drop Packages

To the Rescue

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Package Engineering

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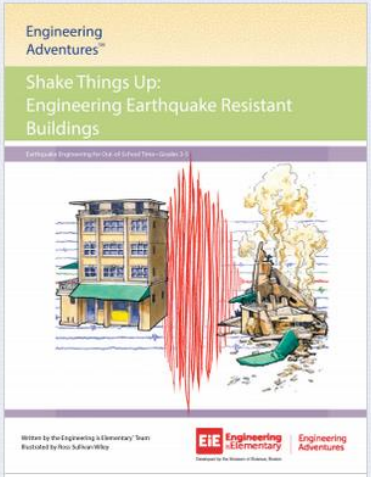
EARTHQUAKES

Shake Things Up



What's Included?

- Educator Guide
- Engineering Journal
- Online Resources

BUY THE UNIT

DOWNLOAD FOR FREE

Unit at a Glance

3-5 Grades

Afterschool

Engineering Field: Earthquake Engineering

- 9 lessons
- 45 minutes per lesson

Unit Overview

A huge and very destructive earthquake hit Haiti in 2010. Now Jacob and India are there, learning how to support and protect buildings during earthquakes. Your kids will engineer model buildings that are earthquake resistant. They'll also develop building codes that help others build earthquake resistant structures.

Questions?

Contact Us!

engineeringadventures@mos.org
engineeringeverywhere@mos.org

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