Engineering Adventures

Engineering Journal
Shake Things Up

Name:_____

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

11:11 AM

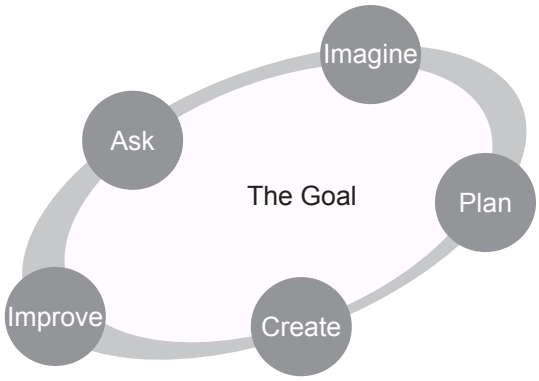
Hi everyone,

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!

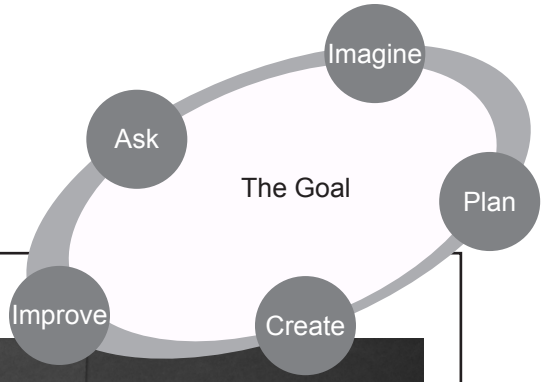
Today, we came across an engineering challenge we think you can help us solve. There are some animals living in a swamp along with lots of hungry alligators. The animals need to be at least 10 inches above the alligators to be out of their reach. India and I thought we could build a tall tower that the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

We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. Take a look at it and see if it can help you!

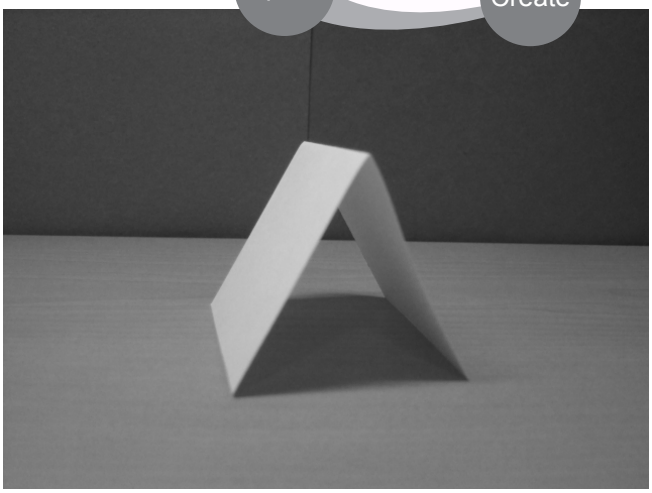


Good luck!
India and Jacob

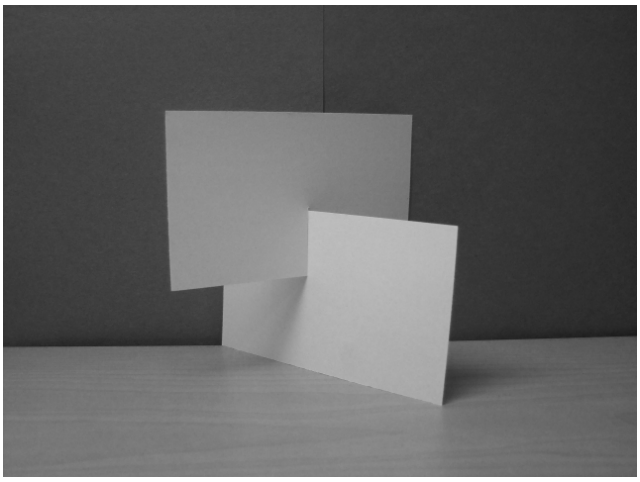
Here are three ways to build with index cards.



Roll it!



Fold it!



Cut it!

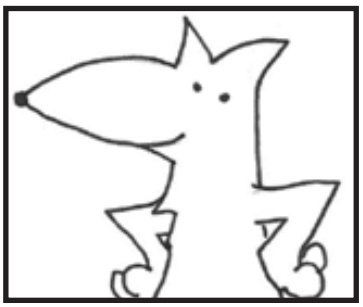
Will any of these ideas help your group build a tower? What other ideas do you have?

Talk with your group to figure it out!

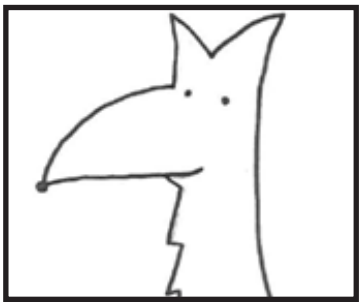
Heightened Emotions

Fearless
8 inches and up

Confident
6-8 inches

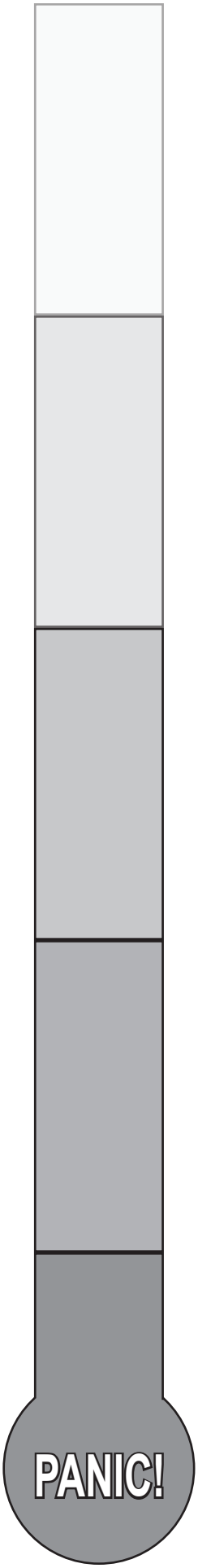


Calm
4-6 inches



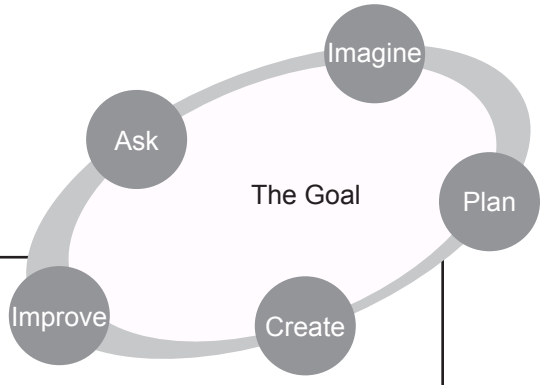
Nervous
2-4 inches

Terrified
0-2 inches



Draw Your Tower

Use the space below to draw a picture of your tower.



Which parts of your tower design would you change if you could do it again?

For the Record

I think engineering is:

- ☐ Fun
- ☐ Exciting
- ☐ Difficult
- ☐ _____

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from:	engineeringadventures@mos.org
to:	You
subject:	What is Technology?

10:36 AM

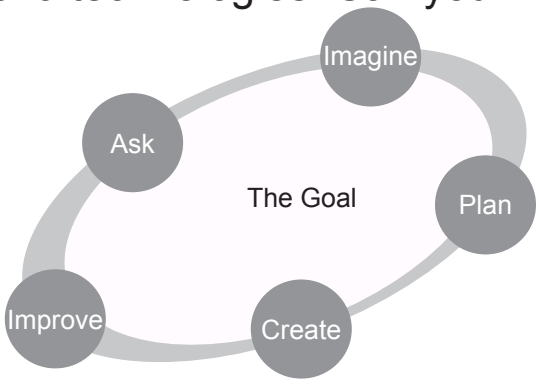
Hi engineers,

You did a great job engineering a tower to protect the animals in the swamp! Now, you can help us engineer more technologies.

Do you know that the things engineers *create* to solve problems are called technologies? Most people think technologies have to be electronic, but this isn't true. A technology is actually any thing engineered by a person that solves a problem.

Think about an airplane as an example. An airplane is a technology because people engineered it, and it solves the problem of traveling long distances quickly. But something as simple as a paper cup is also a technology. A person engineered it, and it helps people hold drinks without spilling them everywhere.

We have a detective challenge for you today. We sent you some objects and we want you to figure out if they are technologies. Lots of times engineers think about ways to *improve* technologies. Can you use the Engineering Design Process to *imagine* ways to make some of these technologies even better?



Talk to you soon,
India and Jacob

What is your group's object?

Is it a technology?

Did a person engineer it?

☐ Yes ☐ No

Does it help you solve a problem?

☐ Yes ☐ No

Bonus: What problem does your object solve?

If you answered YES to both questions, it is a technology!

You are an engineer. Write or draw how you would make this technology better.

If you could engineer a brand new technology, what would it be? What would it do?

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from:	engineeringadventures@mos.org
to:	You
subject:	Welcome to Haiti!

8:18 AM

Bonjou, engineers! (That's how you say "hi" in Haitian Creole!)

Have you ever seen pictures of earthquakes on the news? When the ground starts shaking, a lot of buildings can be destroyed.

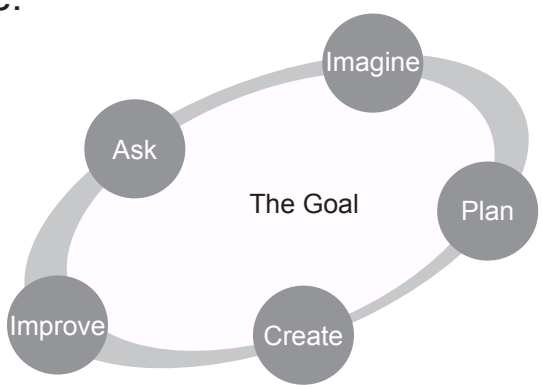
We want to learn how to engineer earthquake-resistant buildings—buildings that won't be destroyed by an earthquake. So we got in touch with our friend, Bernard, who is an earthquake engineer. Bernard works in Haiti where many buildings were damaged by a huge earthquake in 2010. A lot of the buildings in Haiti fell down because they were not engineered to be earthquake resistant.

Haiti didn't have rules about how to build earthquake-resistant buildings. These rules are called "building codes."

Bernard wants to help us engineer earthquake-resistant buildings and write our own building codes based on what we find out. Will you join our engineering team?

First, we need a way to model an earthquake. Bernard uses something called a shake table. We sent you instructions so you can build your own shake table and try it out. Let us know what you discover!

India and Jacob



Earthquake in Haiti

On January 12, 2010, Haiti was hit by a 7.0 magnitude earthquake.

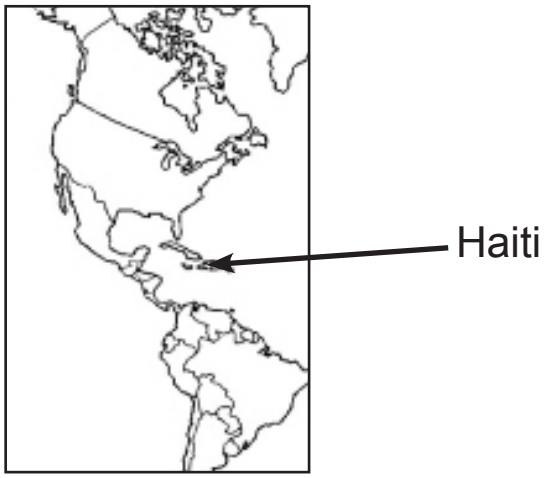
People measure how strong an earthquake is using numbers on the **Richter scale.** A 7.0 magnitude earthquake is a very strong earthquake—so strong that the shaking can destroy buildings.

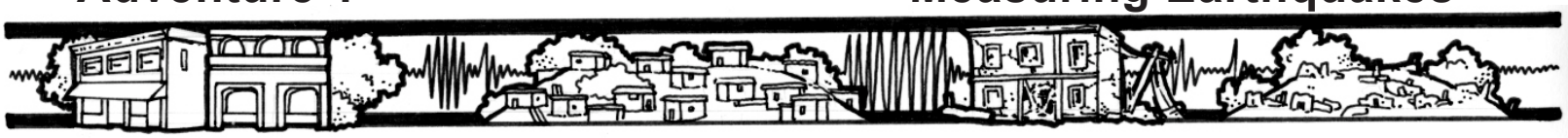
The earthquake in Haiti destroyed small buildings, like houses, and also large buildings, like the president of Haiti's home. The earthquake even destroyed hospitals, which made it hard to help people who were hurt. Many thousands of people died.

This was the worst earthquake to hit this part of the world in 200 years.

photo courtesy of: U.S. Geological Survey, Anthony Crone

photo courtesy of: United Nations, Marco Dormino





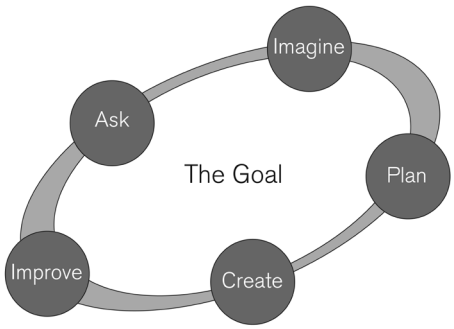
Scientists use the Richter scale to measure the size of an earthquake.

The Richter Scale

0.0 **1.0** people cannot feel shaking 2.0 **3.0** lamps swing 4.0 **5.0** windows break 6.0 **7.0** buildings heavily damaged 8.0 **9.0** most buildings destroyed

Why do you think scientists use a scale to measure earthquakes? How else could you measure the size of an earthquake?

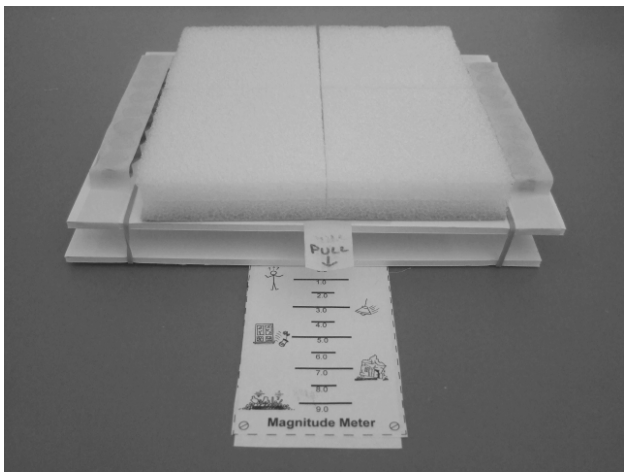
Did you know?
The Richter Scale was created in 1934 by Charles Richter.



You will need:

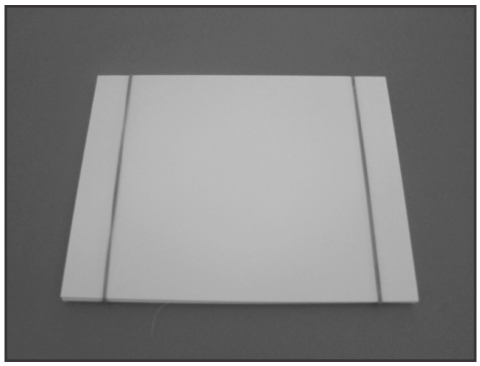
- ☐ 1 *Magnitude Meter*
- ☐ 2 foam core boards
- ☐ masking tape
- ☐ 2 rubber bands
- ☐ 4 blocks of foam
- ☐ 2 plastic tubes
- ☐ 16 hex nuts

Here is what your shake table will look like:



Step 1

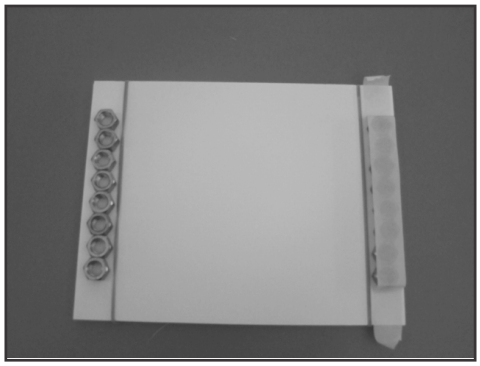
- Stretch both rubber bands around both of the foam core boards.
- Make sure the rubber bands are close to the edges, like in the picture.



Step 2

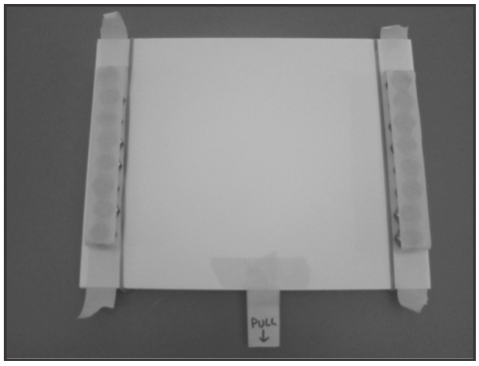
- Put 8 hex nuts in a line on each side of the top foam core board.
- Tape the hex nuts down with a long piece of tape.

The hex nuts are heavy and help the shake table shake at a good speed.



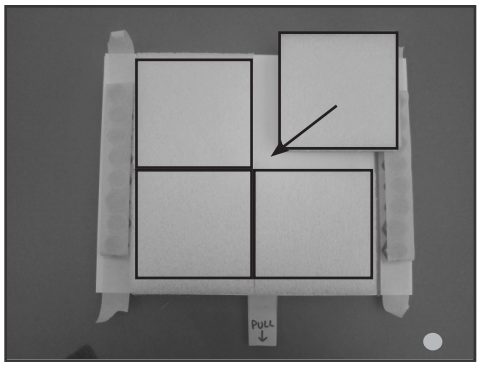
Step 3

- Make a pull tab by folding a piece of masking tape and taping it onto the center of the top board.
- Make sure you can pull on the tab without ripping it off. Draw an arrow on the tab or write “pull.”



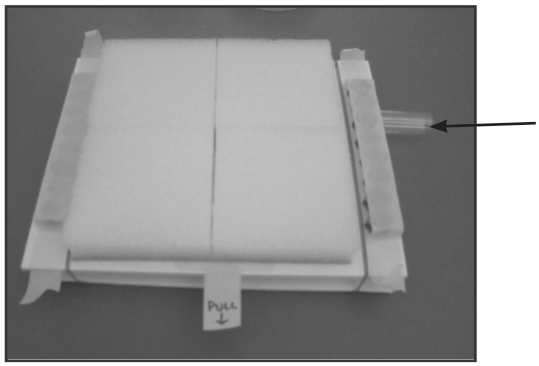
Step 4

- Peel the paper off the back of the foam blocks. Stick them to the board like in the picture.
- Make sure you do not cover the rubber bands!



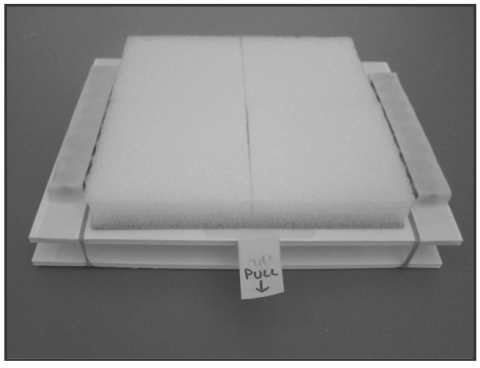
Step 5

- Lift up one of the boards and push one of the plastic tubes into the gap.
- Put the other tube in between the board facing the same direction as the other tube!



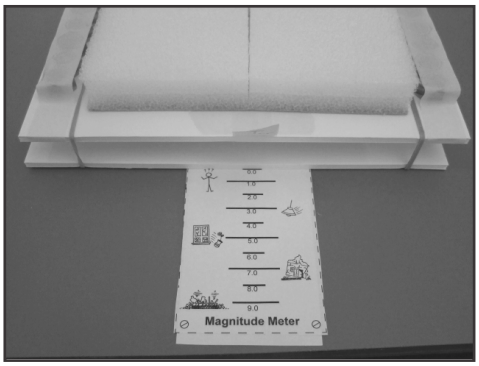
Step 6

- The shake table should look like the picture at the right.
- Pull the tab and the top board should shake back and forth on the tubes.



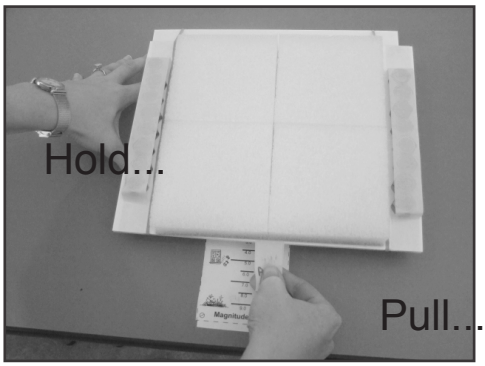
Step 7

- Line up the 0.0 line of the *Magnitude Meter* with the edge of the bottom board.
- Tape the *Magnitude Meter* to the bottom board underneath the pull tab.



Step 8

- Have one or two group members hold the bottom board down on the table.
- Pull the pull tab until the edge of the top board is over the magnitude of earthquake you want to create.



Step 9

- Let go of the tab! Watch as your shake table shakes back and forth!

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from:	engineeringadventures@mos.org
to:	You
subject:	What's Inside Building Walls?

9:01 AM

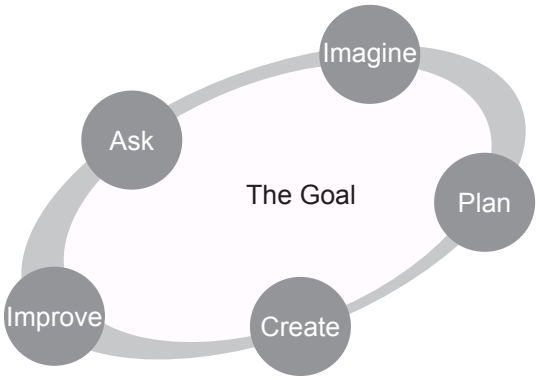
Hi engineers!

Fantastic job constructing your shake tables! We can use the shake tables to test the model buildings we engineer.

Bernard says we should start by making a building skeleton for our model buildings. He says lots of buildings have metal or wooden skeletons inside the walls where we can't see them. The building skeletons do the same job our own skeletons do. They hold everything up.

A building skeleton is made of lots of little pieces. We're calling them 'building units.' Jacob and I sent you directions on how to make one. If everyone makes a unit, we can stack them up and then use the shake table to figure out what shape and size skeleton is the strongest during an earthquake.

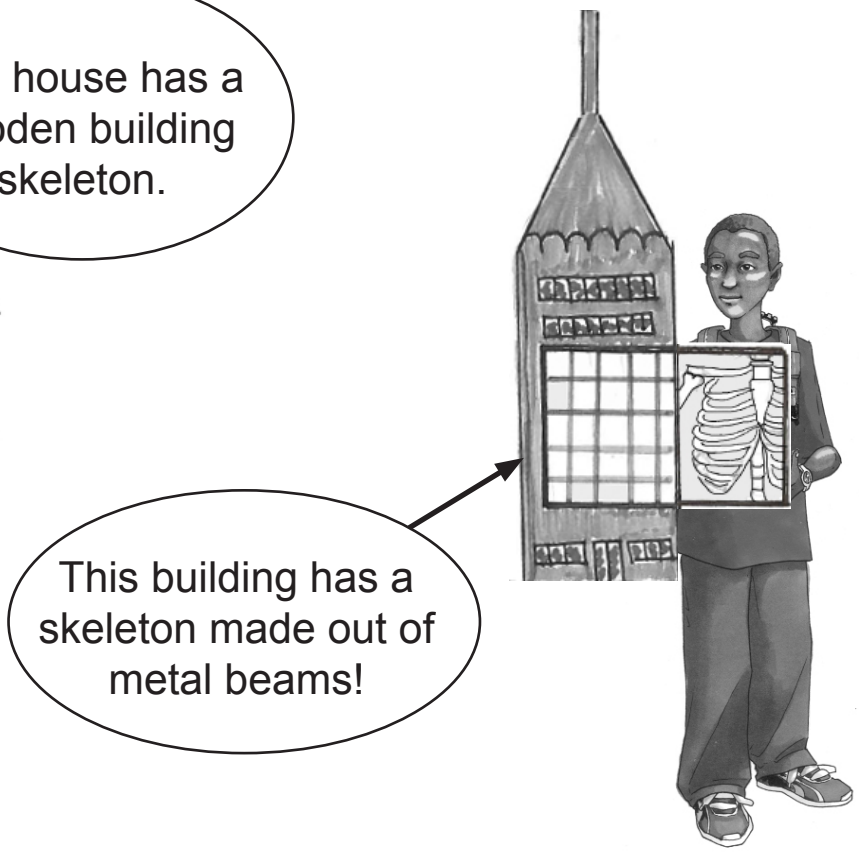
Let's use the *ask* step of the Engineering Design Process to *ask* questions about what shape and size skeleton is the strongest. When we're done, we will write a building code about it so people know what shapes and sizes are good choices.



Let me know how it goes!

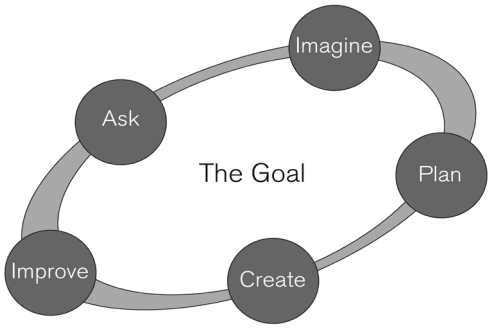
India

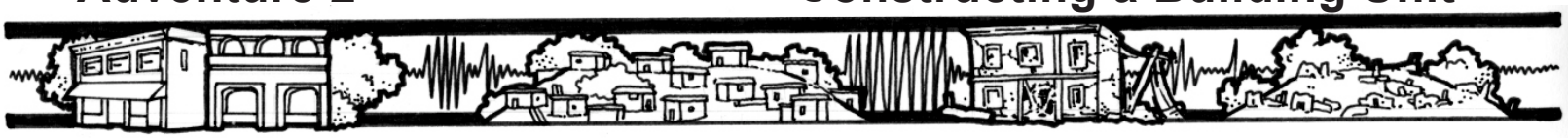
Check out the X-rays of these buildings! See the skeletons behind the walls?



Your Turn to Ask

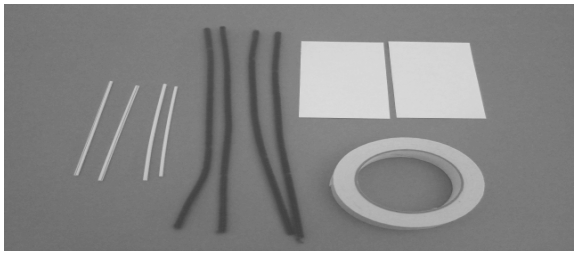
How do you think you could make building skeletons stay strong during an earthquake?





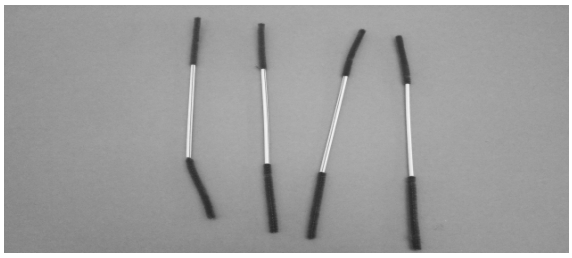
You will need:

- ☐ masking tape
- ☐ 2 index cards
- ☐ 4 coffee stirrers
- ☐ 4 pipe cleaners



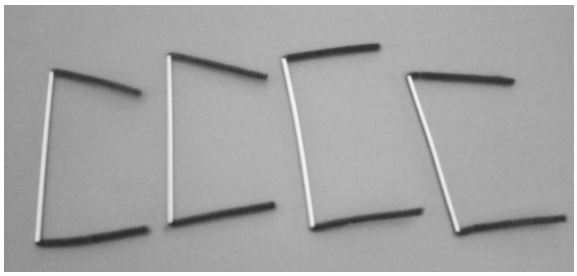
Step 1

- Push one pipe cleaner into each coffee stirrer.



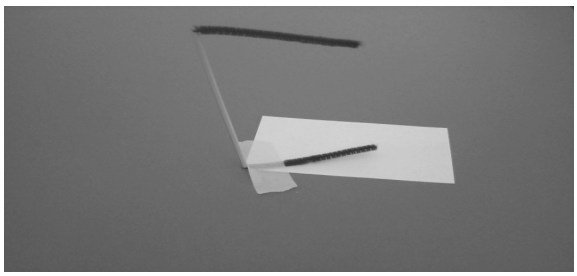
Step 2

- Fold over the ends of the pipe cleaner.



Step 3

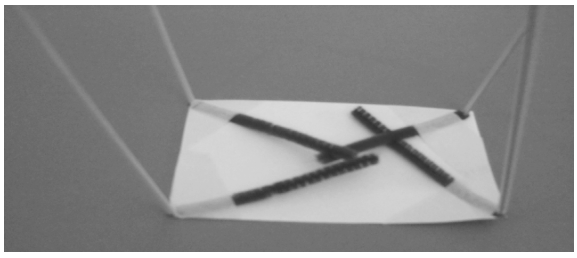
- Tape the pipe cleaner to the corner of an index card. Tape as close to the corner as you can.



Step 4

- Tape the other pipe cleaners to the other corners of the index card.

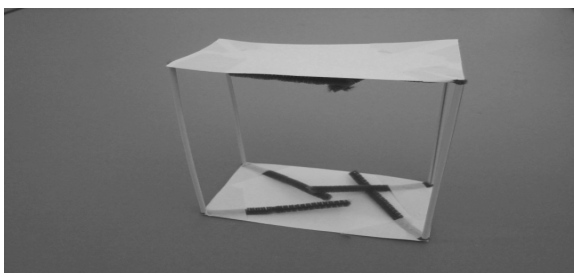
To the right is a close-up image of what it should look like.

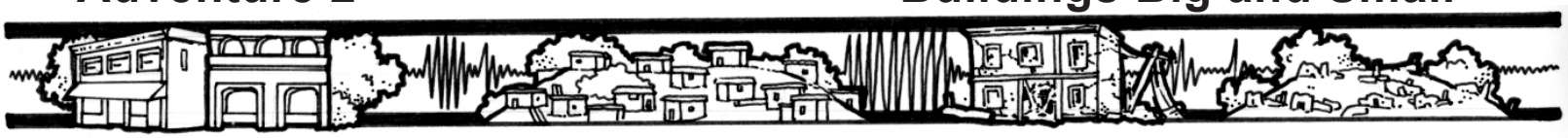


Step 5

- Tape the other index card to the top.

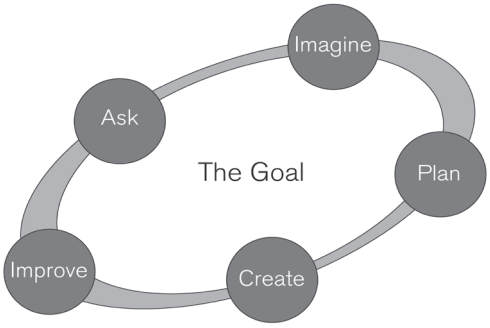
You should ask someone to help you with this!



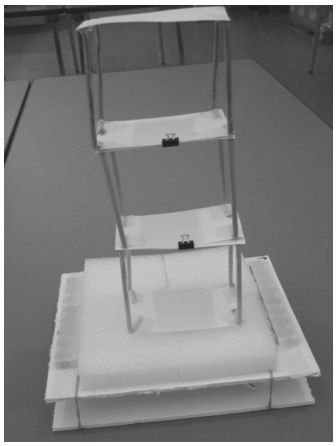


Stack your units up to make building skeletons.

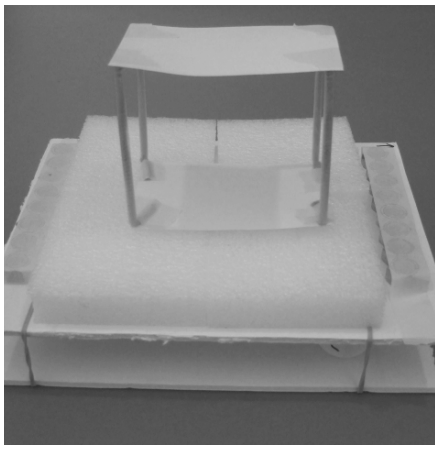
Test them at different magnitudes to find out what sizes and shapes are strongest.



Tall



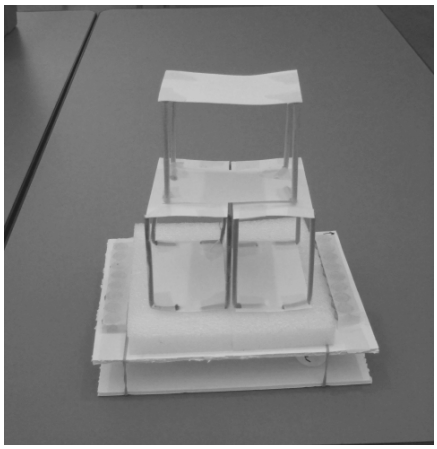
Short



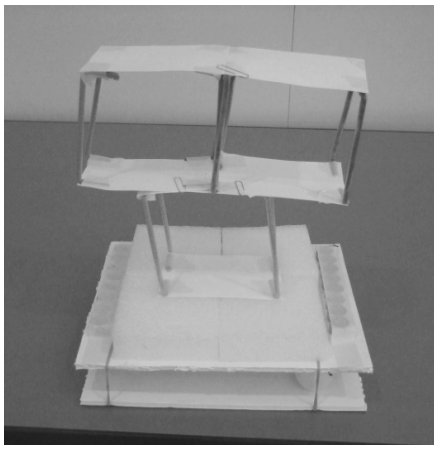
Circle the **size** you think was strongest during an earthquake.

Circle the **base shape** you think was strongest during an earthquake.

Wide-base



Narrow-base



What other shapes and sizes do you want to test? Try them out with your group!

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from:	engineeringadventures@mos.org
to:	You
subject:	Building from the Bottom Up

9:57 AM

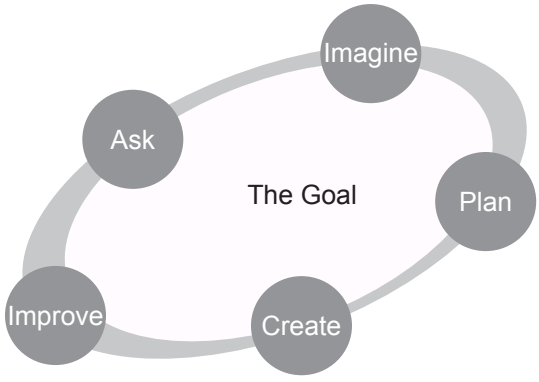
Hey engineers,

Did you notice that the building units slide right off the shake tables when you shake them? We have to figure out a way to attach them so they don't slide around during an earthquake. Bernard tells us that earthquake engineers have to think about this problem all of the time.

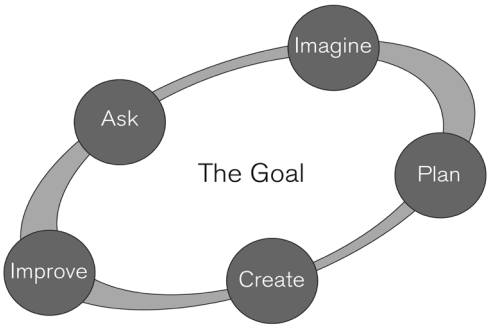
You can use the *ask* and *imagine* steps of the Engineering Design Process to help you. *Ask* about how buildings you've seen in real life are attached to the ground and *imagine* ways to attach your building unit to the shake table using some materials we sent along. *Create* and test some different ideas. For an extra challenge, try to use as few materials as possible and see if you can still stop the slide.

Once you figure out an idea that works well, write a building code about it and send it to us, so we can see what you're working on!

Jacob



How did you stop your building unit from sliding?
Draw your design here:

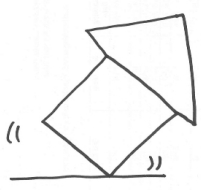


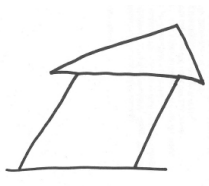
What materials did you use?

Test your building unit on the shake table at a 7.0 magnitude.

Watch your building unit carefully. Circle what happens when you test it.

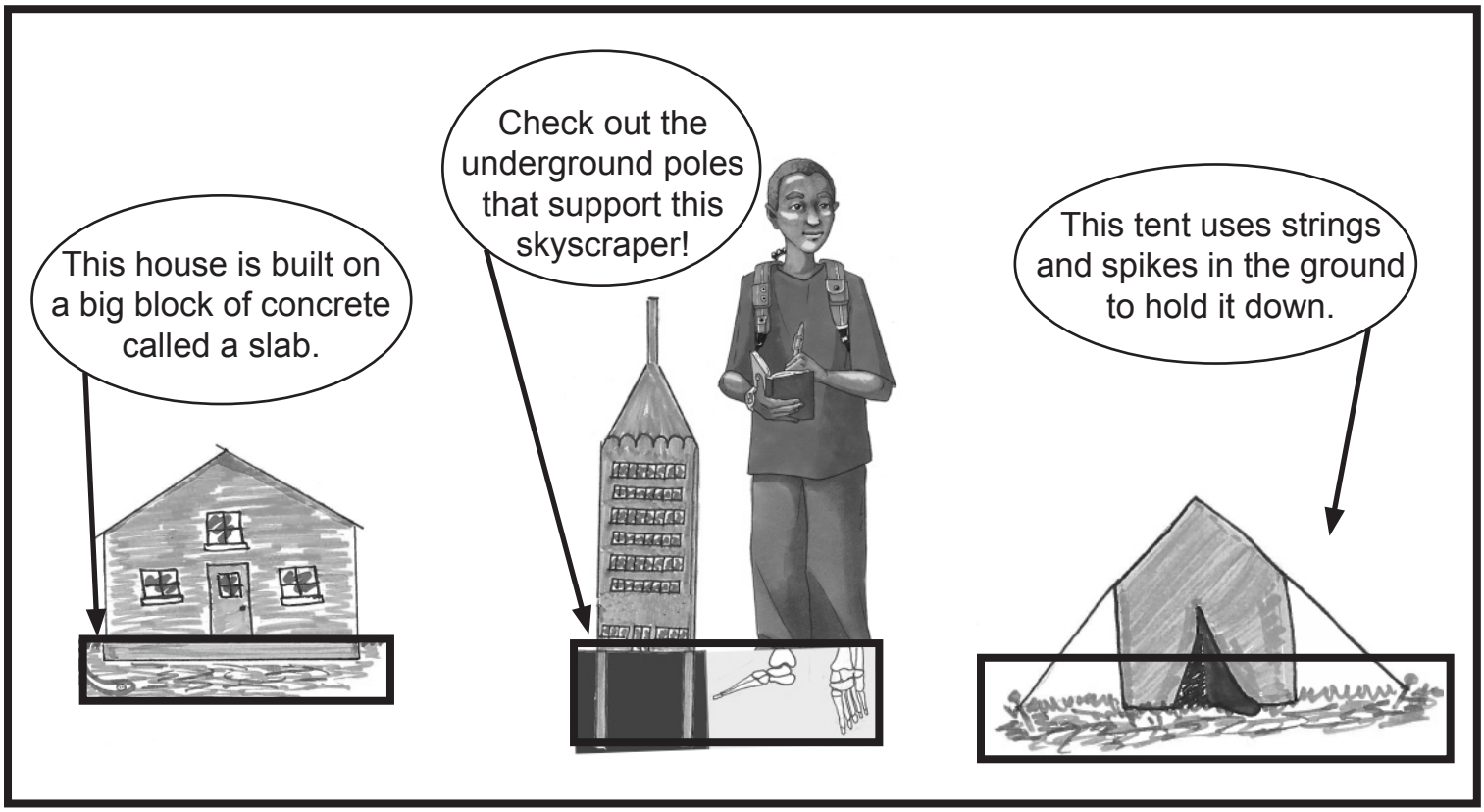

slides


tips or falls


shears

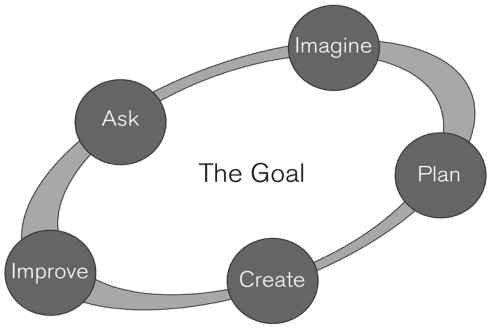

nothing

Would you feel safe inside this building? ☐ Yes ☐ No



Think About It

Circle the step of the Engineering Design Process that you used most today. Do you like using this step? Why or why not?



reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Let's Make Our Building Stronger!

10:15 AM

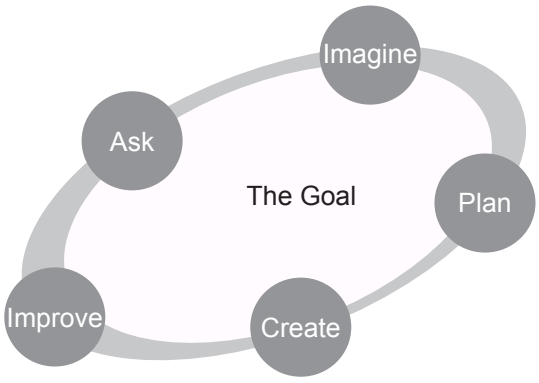
Greetings engineers!

We have another problem with our building units. They flop over and change shape when we test them on the shake table. Has this happened to you, too?

Bernard told us that the building units are floppy because the bottom moves fast and the top can't keep up. That makes the unit flop over and change shape. This is called 'shear.' We need to engineer a way to make sure our building units don't shear during an earthquake!

How can we engineer a way to stop the shear during an earthquake? Jacob and I are going to use the Engineering Design Process to help us *imagine, plan, create,* and test some technologies that we think will stop the shear. Then, we'll write a building code about what we find out.

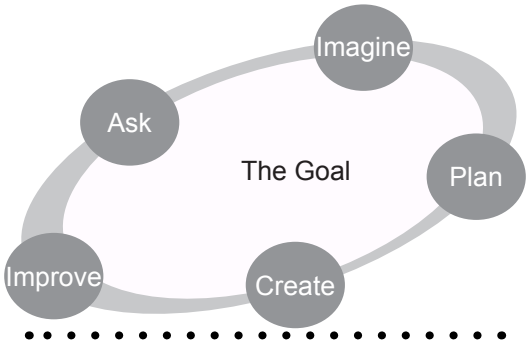
Bernard said that earthquake engineers usually choose their materials based on a budget. Do you think you can engineer a technology to stop the shear using a budget of 10 materials or less? It's a challenge, but I think you're up to it.



Good luck!

India

How did you stop your building unit from shearing? Draw your design here:

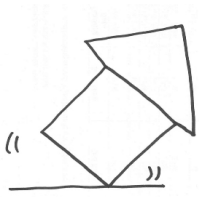


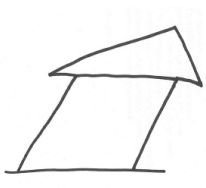
What materials did you use?

Test your building unit on the shake table at a 7.0 magnitude.

Watch your building unit carefully. Circle what happens when you test it.

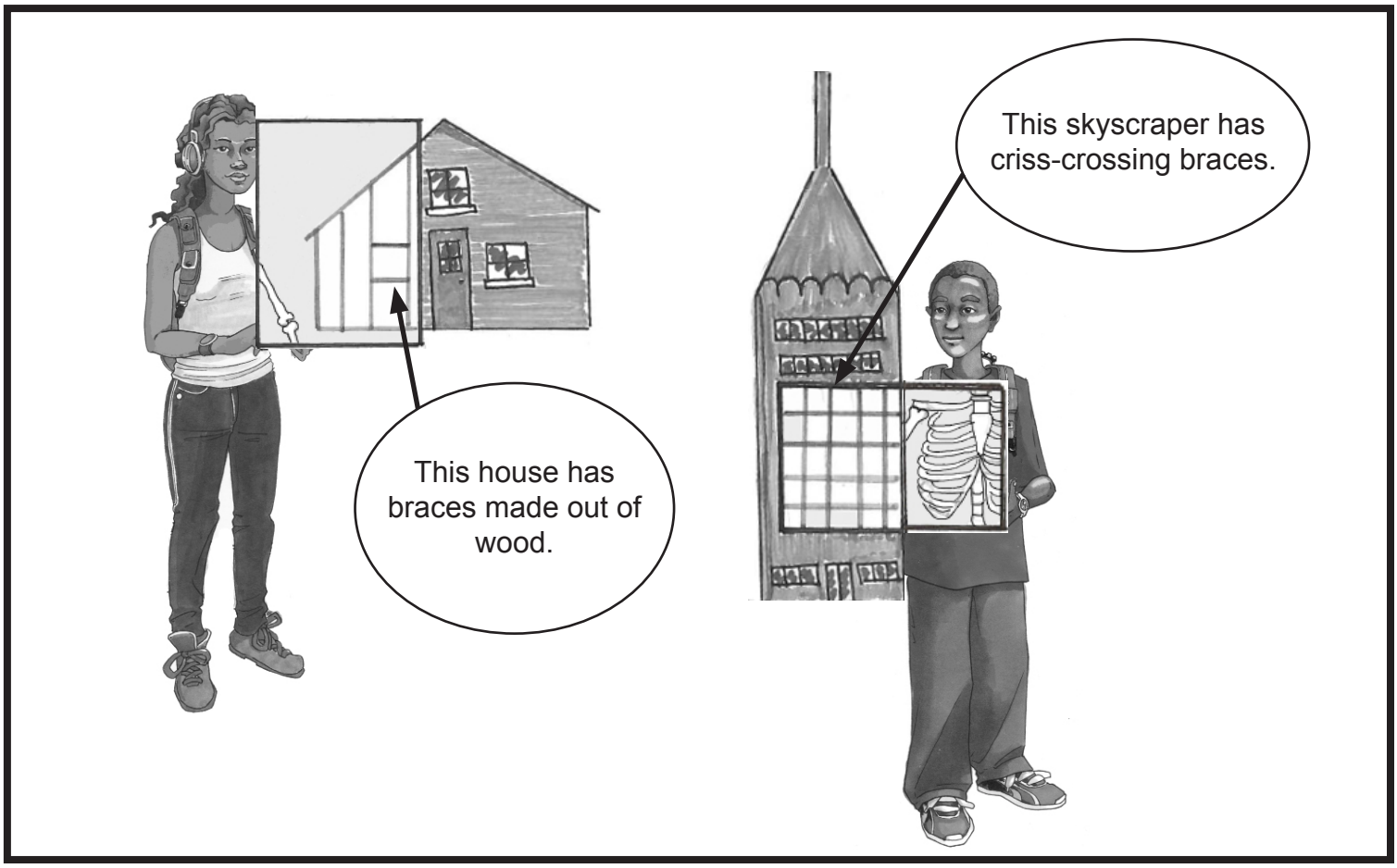

slides

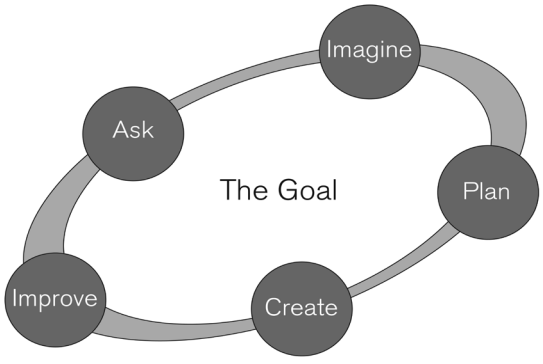

tips or falls


shears


nothing

Would you feel safe inside this building? ☐ Yes ☐ No





Think About It

Would you like to be an earthquake engineer? Explain your answer.

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Ready, Set, Engineer!

12:12 PM

Hey engineers!

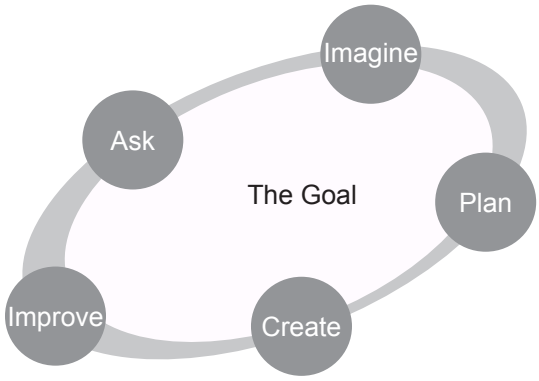
Now that we've practiced making our building units earthquake resistant, Bernard has challenged us to engineer a model of an entire earthquake-resistant building! Our model buildings need to survive at least a 7.0 magnitude earthquake, like the one that hit Haiti in 2010.

India and I walked around the city to choose what type of building we want to engineer. India saw a large apartment building that was four stories high. That is what she wants to try! I am going to engineer an earthquake-resistant hospital.

We wanted to start creating right away, but Bernard reminded us that we need to make sure we're following our building codes. We will use the *plan* step of the Engineering Design Process to help us design our technology according to our building codes. Then, we will be ready to *create* and test!

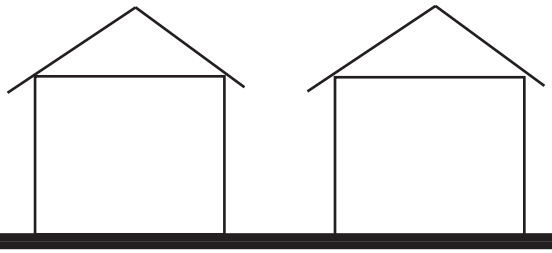
Let us know how it goes!

Jacob



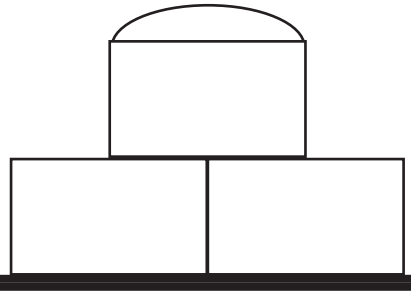
Choose your building! Pay attention to the budget. The budget tells you how many items you can buy from the Materials Store. If you make your own, decide on the budget and materials, and have it approved before beginning!

Note: For string and tape, 1 foot counts as one item.



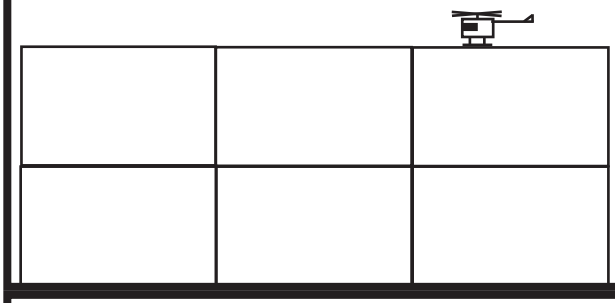
Houses
- 2 houses on the shake table
- both houses need a sloped roof

Budget for Materials
- 15 items or less



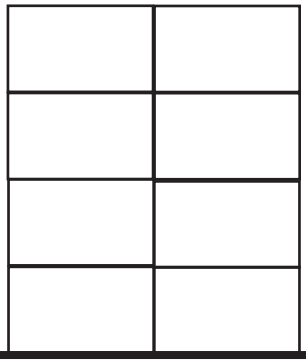
Library
- 2 units on the bottom, 1 on top
- needs a domed roof

Budget for Materials
- 30 items or less



Hospital
- 2 units high, 3 units wide
- needs a helicopter landing pad

Budget for Materials
- 40 items or less

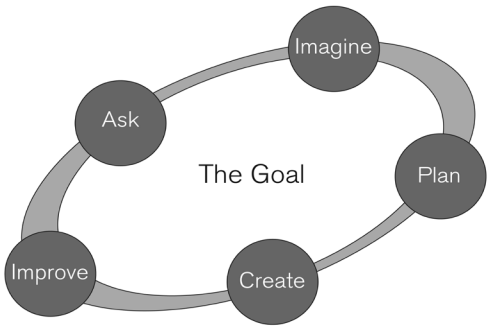


Apartment Building
- 4 units high, 2 units wide

Budget for Materials
- 50 items or less

What building are you engineering? _____

What is your budget? _____ materials.



Draw a plan for your model building here:

How many of each material will you use?

_____

_____

_____

_____

_____

_____

_____

_____

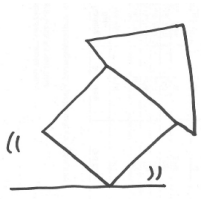
_____

_____

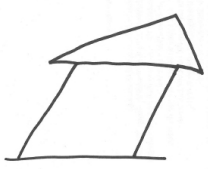
Test your building on the shake table at a 7.0 magnitude.

Watch your model building carefully. Circle what happens when you test it.

slides



tips or falls



shears

nothing

Would you feel safe inside this building? ☐ Yes ☐ No

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Tried and Tested

1:41 PM

Hello!

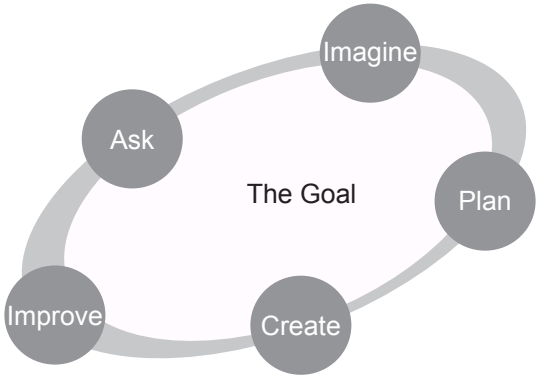
It is almost time for us to leave Haiti, and we want to make sure we have time to show Bernard our earthquake-resistant designs. First, let's use the *improve* step of the Engineering Design Process to make sure our buildings are really earthquake resistant.

We also have one more surprise for Bernard. We want to give him the building codes we've been working on! Our building codes will help people know the types of things to think about when engineering a full-size earthquake-resistant building.

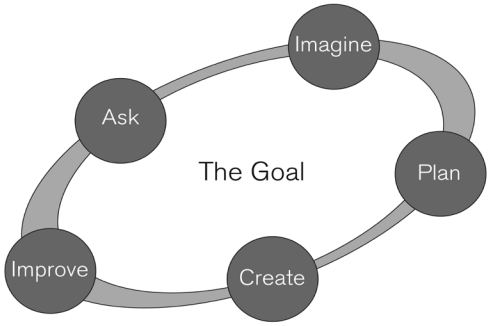
Take a look at your building codes today and *improve* them if you want to, then send them along to us. Jacob and I are looking forward to seeing your ideas!

Let us know how it goes,

India



Look back at your first design on *Plan and Test,* p. 25. What do you want to *improve*?



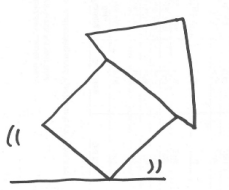
Draw your plan for *improving* your model building here:

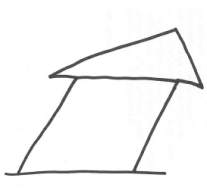
What materials will you use?

Test your building on the shake table at a 7.0 magnitude.

Watch your model building carefully. Circle what happens when you test it.


slides


tips or falls


shears


nothing

Would you feel safe inside this building? ☐ Yes ☐ No

India and Jacob, the Duo
c/o Museum of Science, EiE
1 Science Park
Boston, MA 02114

Dear India and Jacob:

We finished engineering our earthquake-resistant buildings. We also created lots of building codes. The building code I think is the most important is _____

_____ because _____

_____.

Here is a picture of my group's final design:

Sincerely,

_____

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	On Solid Ground

1:41 PM

Hey engineers!

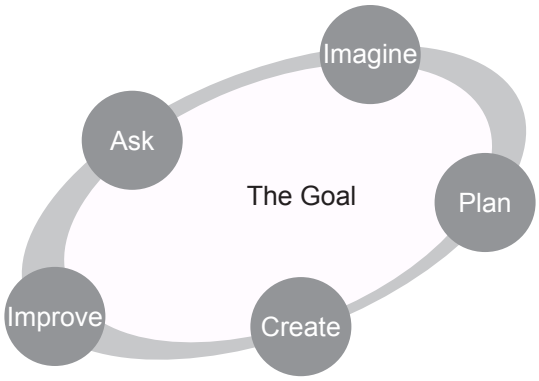
We have had such a great time in Haiti. We've learned so much from Bernard and from each other about how to engineer an earthquake-resistant building. We are ready to show Bernard how earthquake resistant our model buildings are during a 7.0 magnitude earthquake. We're also going to show him the building codes that we all came up with. As a final surprise, we're going to combine our shake tables and buildings into a model city, and see if the city is earthquake resistant!

Who else do you want to share your work with? We think you should share with lots of people. Make sure to tell everyone how you used the Engineering Design Process to engineer your earthquake-resistant building and building codes. We can't wait to hear how it goes!

Orevwa! (That's how you say goodbye in Haitian Creole!)

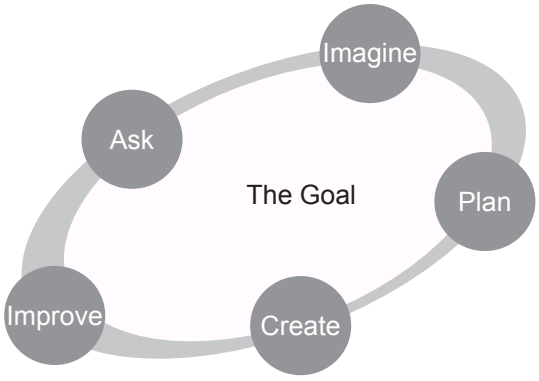
Until next time,

India and Jacob



What do you want to engineer next?

_____



Draw your technology here:

What materials do you want to use?

_____

_____

_____

_____

_____

_____

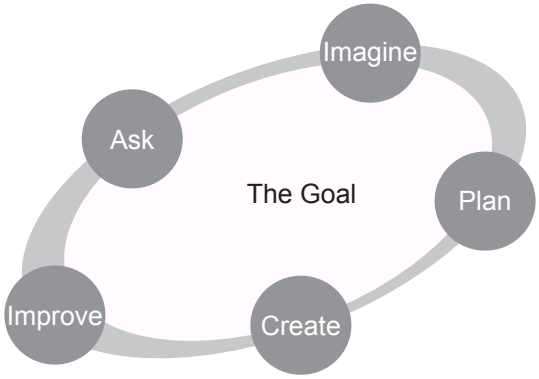
_____

My engineering checklist:

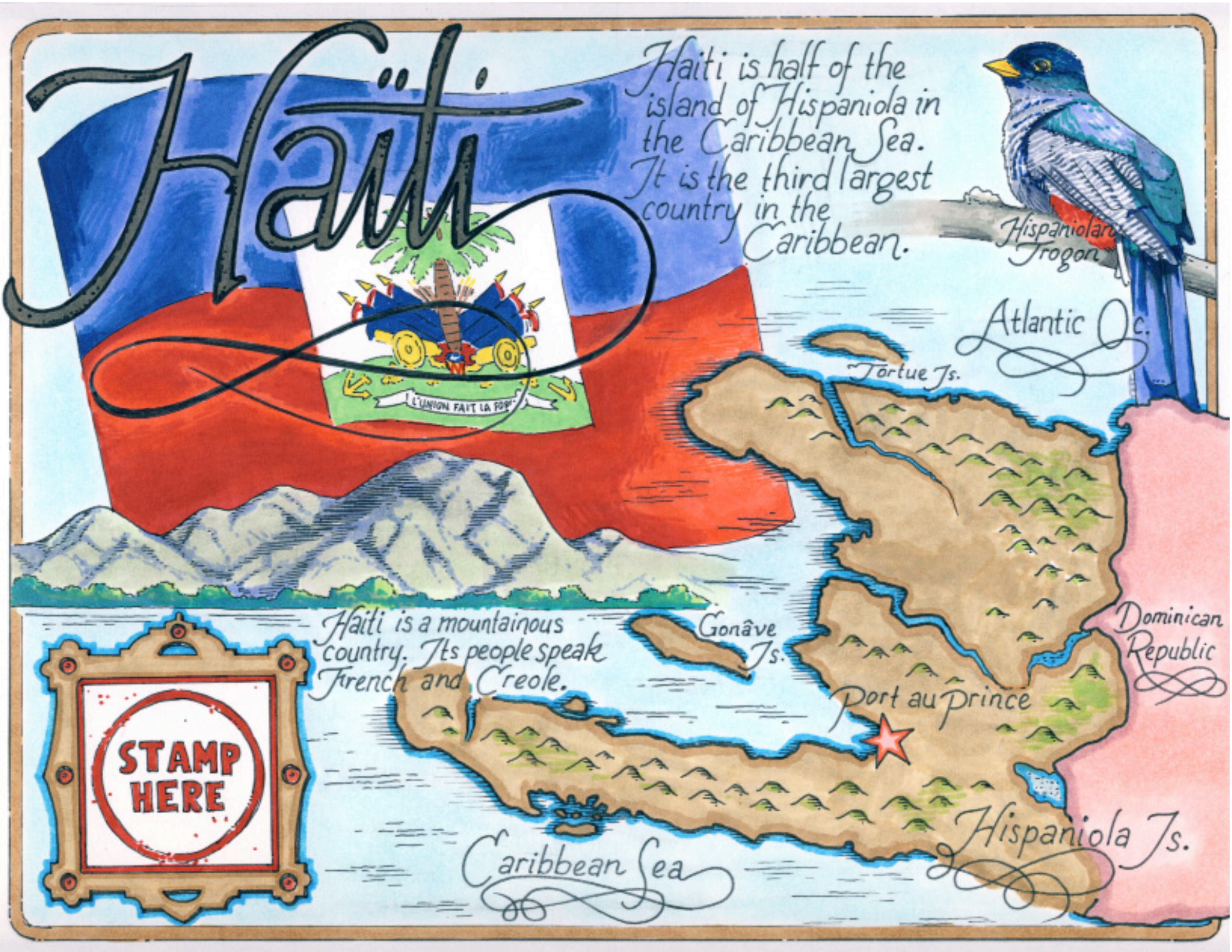
- ☐ Find friends to work with.
- ☐ ***Ask*** questions about how to start.
- ☐ ***Imagine*** lots of ideas.
- ☐ Make a ***Plan***.
- ☐ ***Create*** and test the plan.
- ☐ ***Improve*** until you think it is ready.

Use the next page to keep track of your work!

How is your engineering project going? Keep track of what you do on this page.



Haïti


Haiti is half of the island of Hispaniola in the Caribbean Sea. It is the third largest country in the Caribbean.
Hispaniolan Trogon
Atlantic Oc.
Tortue Js.
Gonâve Js.
Haiti is a mountainous country. Its people speak French and Creole.
Dominican Republic
Port au Prince
STAMP HERE
Caribbean Sea
Hispaniola Js.