

# Engineering Adventures



## Engineering Journal Shake Things Up

Name: \_\_\_\_\_



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from engineeringadventures@mos.org  
subject Engineering a tower  
to You 10:36 AM

Hi everyone,

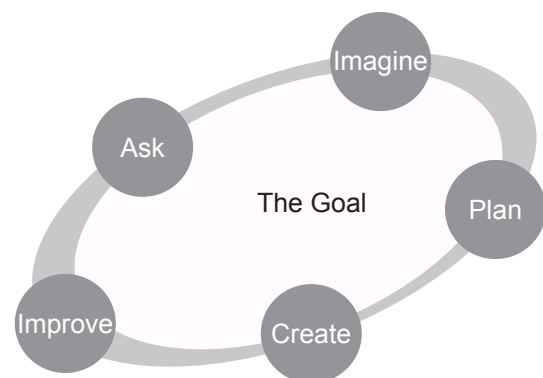
We're so excited to meet you! Our names are India and Jacob. We do a lot of traveling all over the world. We meet interesting people and see some amazing countries. Each place is unique, but we've found one thing in common. Everywhere we go in the world, we find problems that can be solved by engineers.

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?

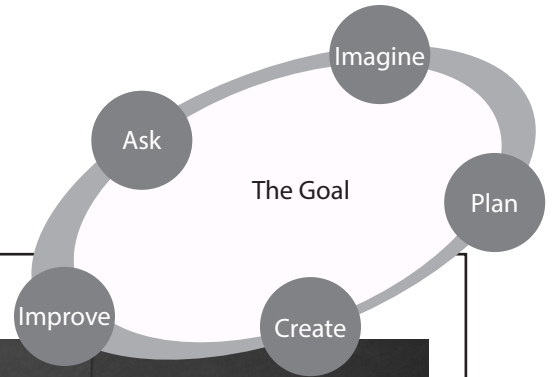
We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. Take a look at it and see if it can help you!

Good luck!  
India and Jacob

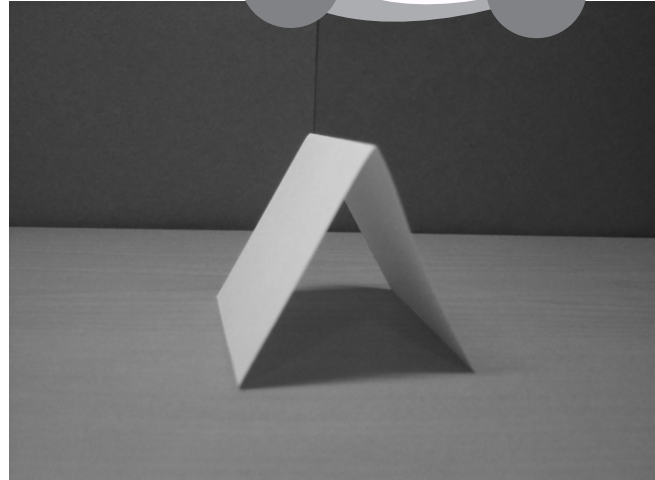




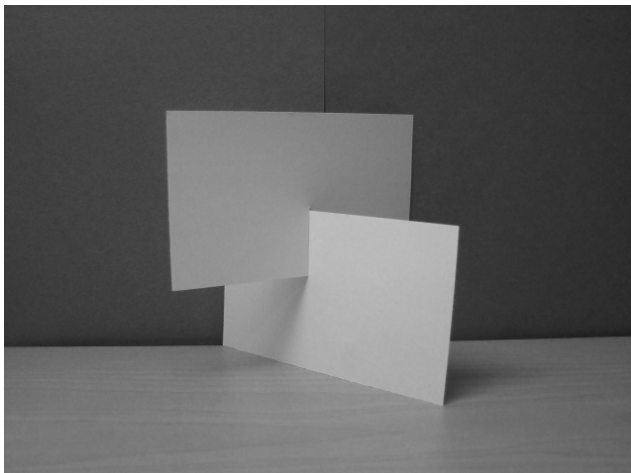
Here are three ways to build with index cards.



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!

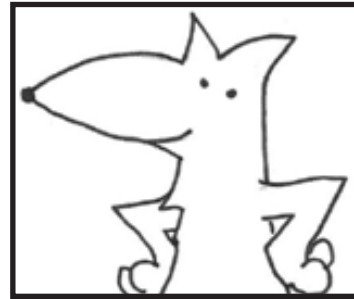
# Prep Adventure 1

# Heightened Emotions

**Fearless**  
8 inches and up



**Confident**  
6-8 inches



**Calm**  
4-6 inches



**Nervous**  
2-4 inches



**Terrified**  
0-2 inches

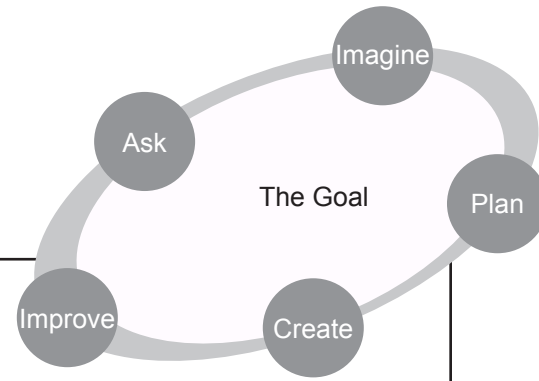


**PANIC!**



**Draw Your Tower**

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



What 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  
subject What is technology?  
to You 11:11 AM

Hi engineers,

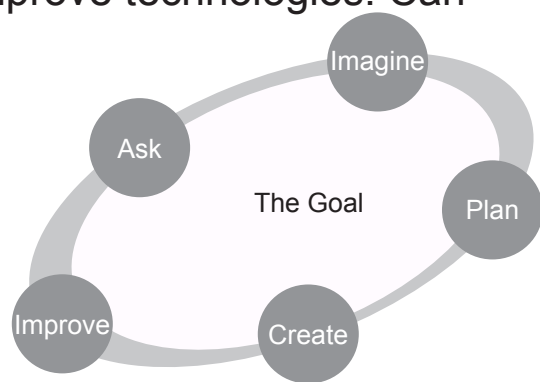
You did a great job engineering a tower to protect the animals in the swamp! Now you can help us engineer more technologies.

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 anything 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 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're 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  
**Subject** Welcome to Haiti!  
**To** You 8:18 AM

*Bonjou*, engineers! (That’s how you say “Hi!” in French Creole!)

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

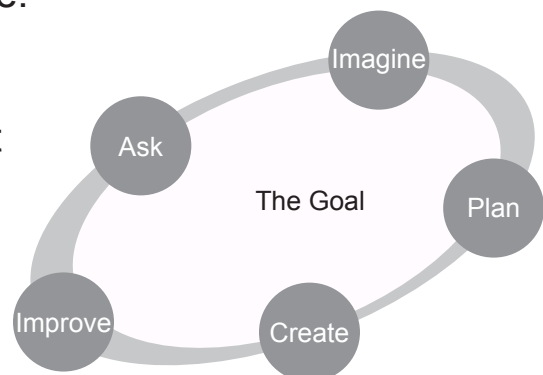
We want to learn how to engineer earthquake resistant buildings—buildings that won’t be destroyed by an earthquake. We searched the web to find an earthquake engineering expert and became pen-pals with our new friend Bernard. Bernard works in Haiti where many buildings were damaged by a huge earthquake in 2010. A lot of the buildings in Haiti fell down because they were not engineered to be earthquake resistant.

Haiti didn’t have any 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, the Duo





# Earthquake in Haiti

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

People measure how strong an earthquake is using numbers on the **Richter scale**. A 7.0 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.



U.S. Geological Survey photo by Anthony Crone



United Nations photo by Marco Dormino





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

# The Richter Scale



0.0

1.0

people  
can't feel  
shaking

2.0



3.0

lamps  
swing

4.0



5.0

windows  
break

6.0



7.0

buildings  
very  
damaged

8.0



9.0

most  
buildings  
destroyed

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

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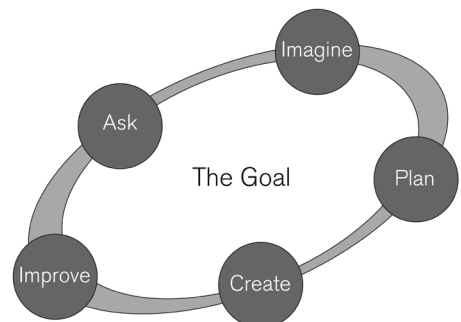
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## Did you know?

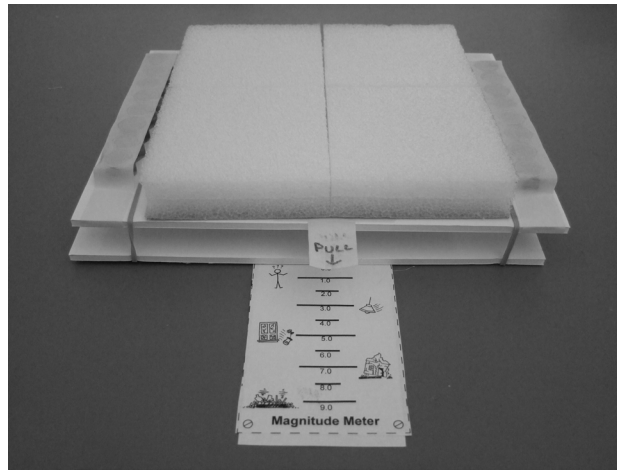
The Richter Scale was created in 1934 by Charles Richter.



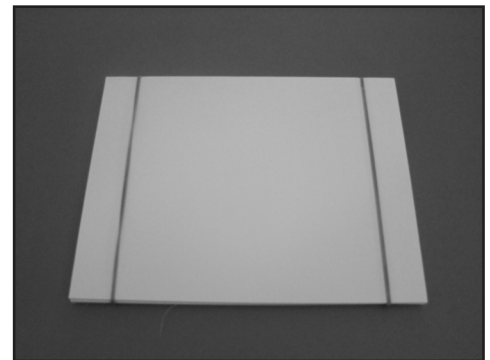
**You will need:**

- |   |   |  |
|---|---|--|
| <input type="checkbox"/> 1 <i>Magnitude Meter</i> | <input type="checkbox"/> 2 rubber bands   | <input type="checkbox"/> 2 plastic tubes |
| <input type="checkbox"/> 2 foam core boards       | <input type="checkbox"/> 4 blocks of foam | <input type="checkbox"/> 16 hex nuts     |
| <input type="checkbox"/> masking tape             |   |  |

**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. Tape them down with a long piece of tape. The hex nuts are heavy and help the shake table shake at a good speed.



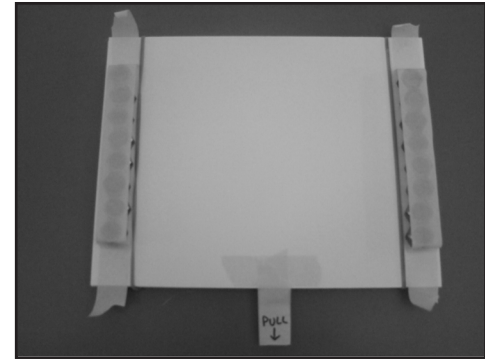




### Step 3

Make a pull tab by folding a piece of masking tape and taping it onto the top board.

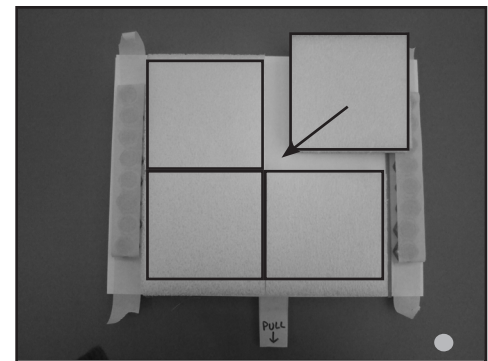
Make sure you can pull on the tab without ripping it off. Draw an arrow on the tab or write “pull.”



### Step 4

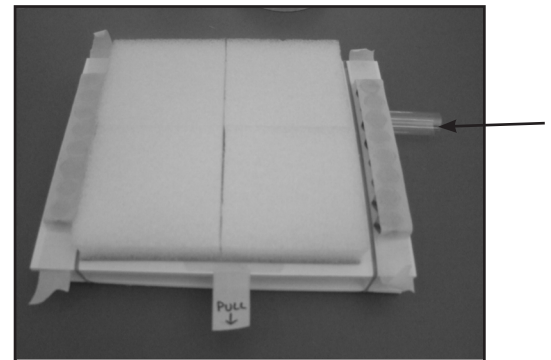
Peel the paper off the back of the foam blocks. Stick them to the board like in the picture.

Make sure you don't cover the rubber bands!



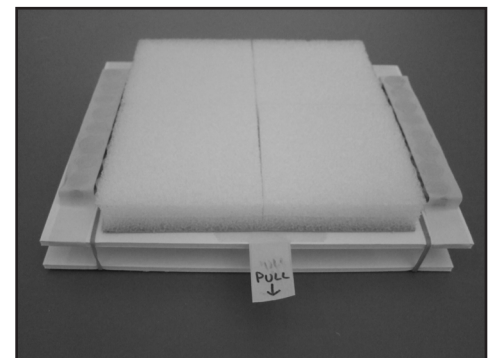
### Step 5

Lift up one of the boards and push the plastic tubes into the gap. The tubes should both be facing the same direction.



### Step 6

The shake table should look like this. Pull the tab and the top board should shake back and forth on the tubes.

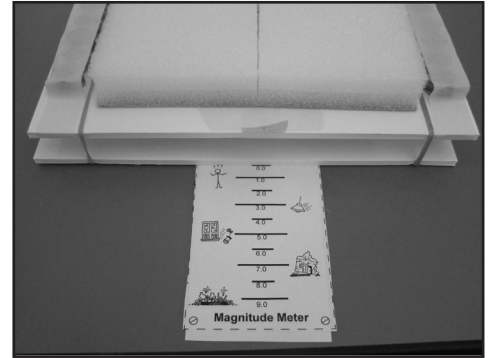




## Step 7

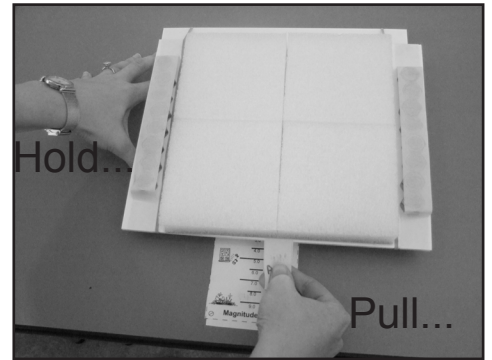
Line up the 0.0 line of the *Magnitude Meter* with the edge of the bottom board.

Tape the *Magnitude Meter* to the bottom board underneath the pull tab.



## Step 8

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  
**Subject** What's Inside Building Walls?  
**To** You 9:01 AM

Hi engineers!

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

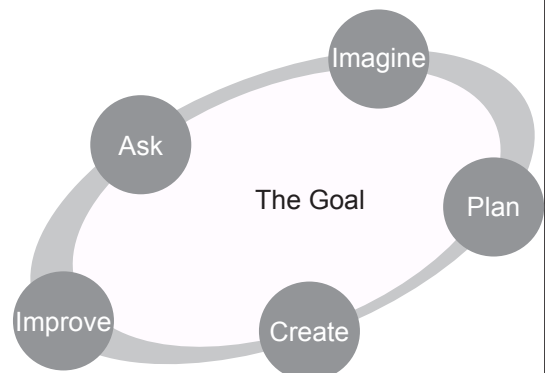
Bernard says we should start by making a building skeleton for our model buildings. He says lots of buildings have metal or wooden skeletons inside the walls where we can't see them. The building skeletons do the same job our own skeletons do. They hold everything up.

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?



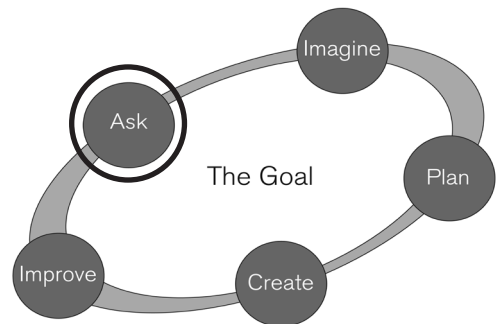
This house has a wooden building skeleton.

This building has a skeleton made out of metal beams!



### Your Turn to Ask

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



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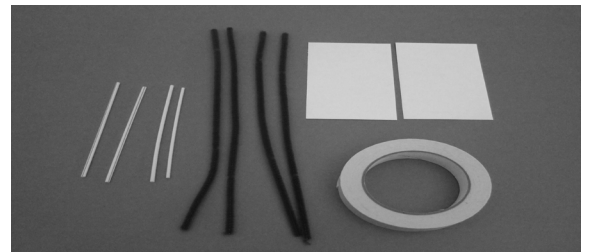
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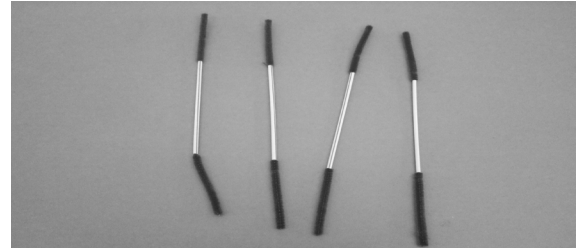
**You will need:**

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



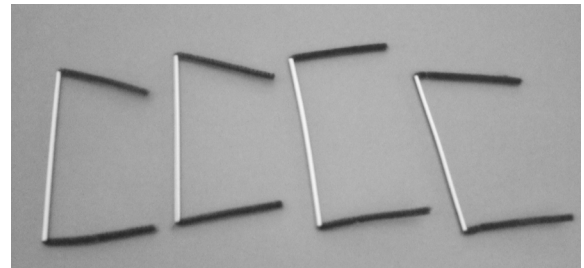
**Step 1**

Push each pipe cleaner into one coffee stirrer.



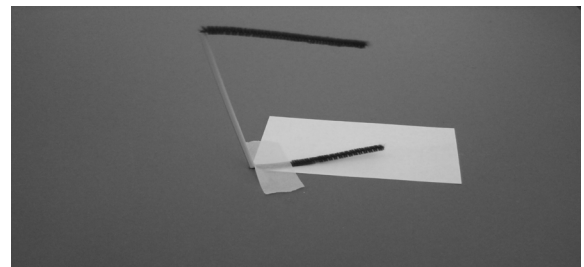
**Step 2**

Fold over the ends of the pipe cleaner.



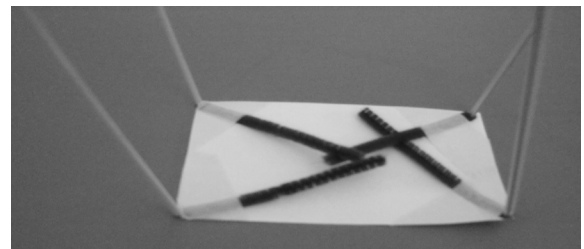
**Step 3**

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



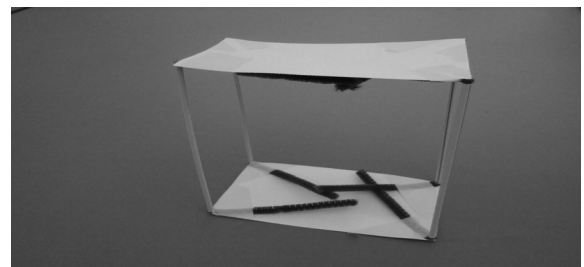
**Step 4**

Tape the other pipe cleaners to the other corners. Here's a close up of what it should look like.



**Step 5**

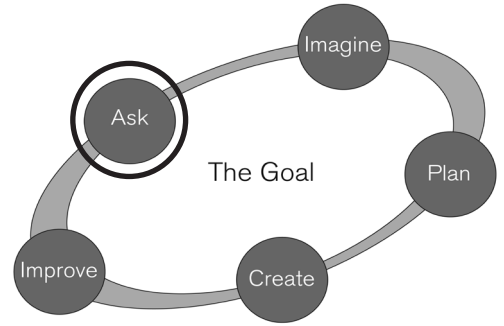
Tape the other index card to the top. You should ask someone to help you with this!



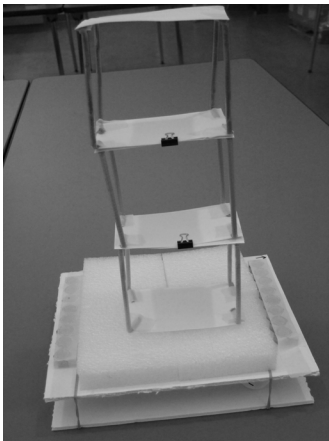


Stack your units up to make building skeletons.

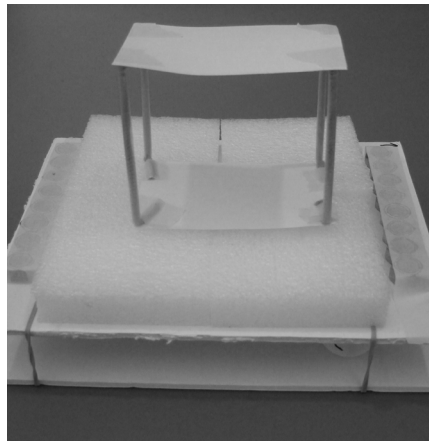
Test them at different magnitudes to find out what sizes and shapes are strongest.



Tall

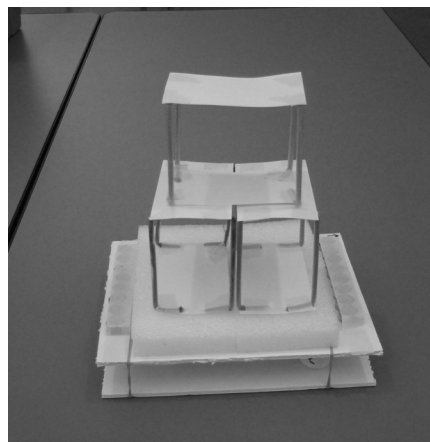


Short

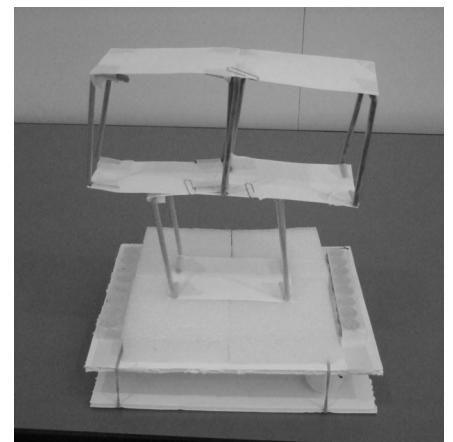


Circle the **size** you think was strongest during an earthquake.

Wide-base



Narrow-base



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

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



From	engineeringadventures@mos.org
Subject	Building from the Bottom Up
To	You
	9:57 AM

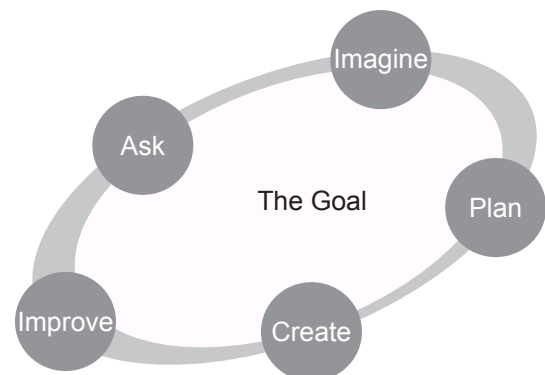
Hey engineers,

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!

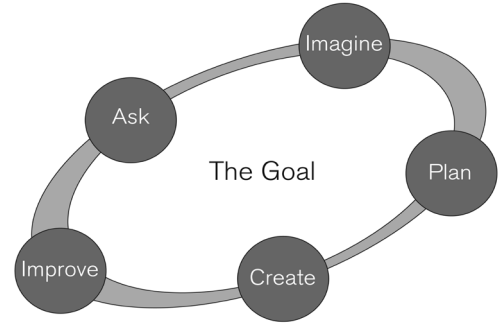
Jacob







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



.....

What materials did you use?

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.....

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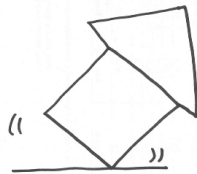
.....

**Test your building unit at a 7.0 magnitude.**

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



slides



tips or falls



shears



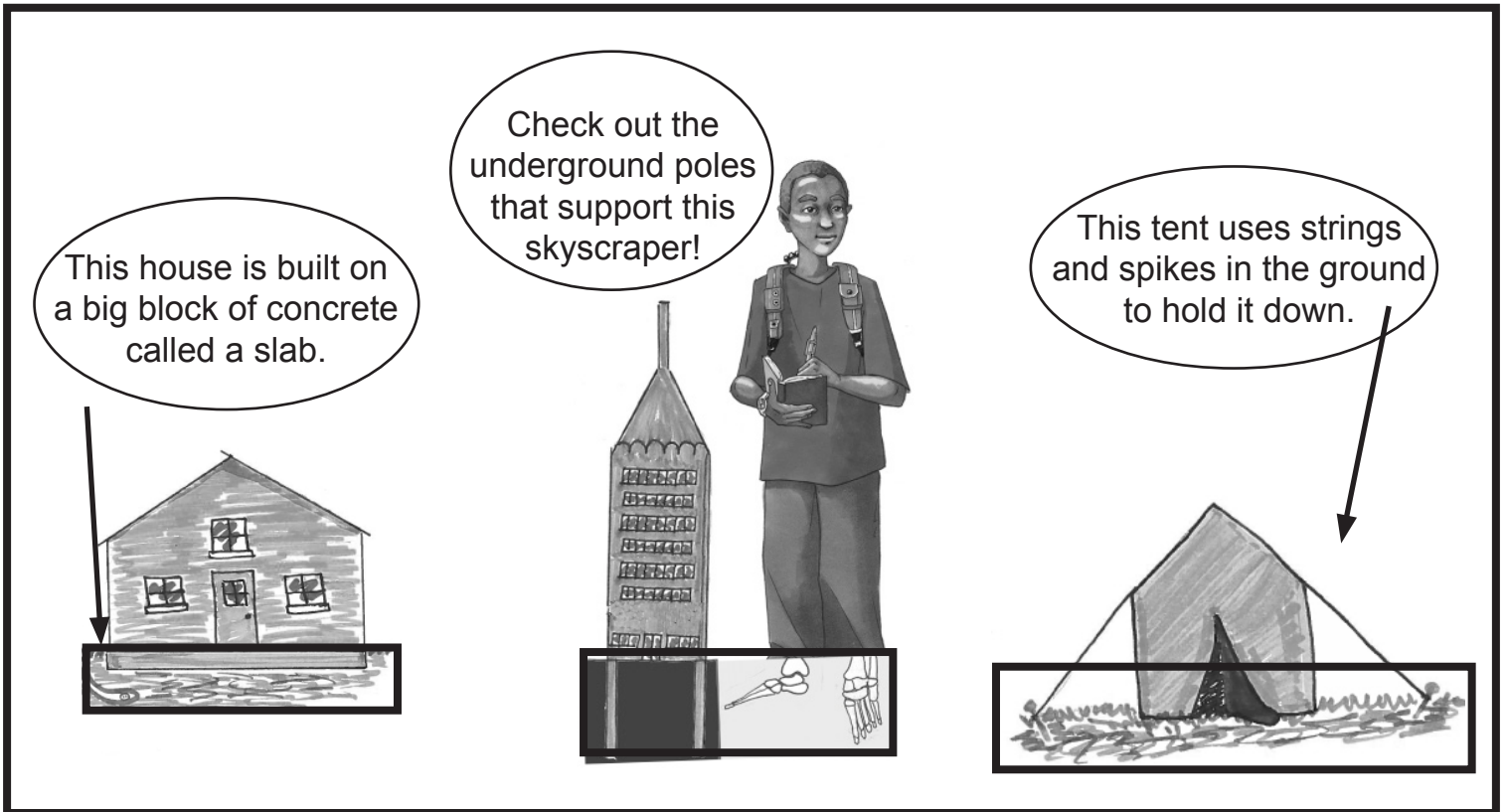
nothing

Would you feel safe inside this building?

Yes

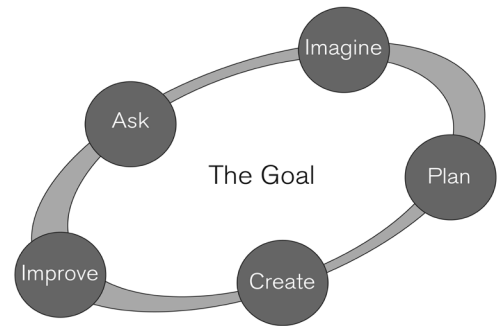
No





## 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?



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reply



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From

engineeringadventures@mos.org

Subject

Let's Make Our Building Stronger!

To

You

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?

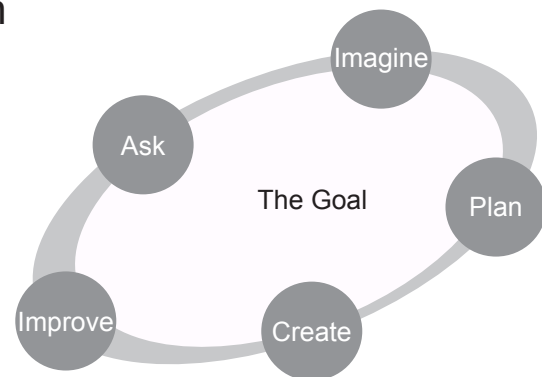
Bernard told us that the building units are floppy because the bottom moves fast and the top can't keep up. That makes the unit flop over and change shape. This is called shear. We need to engineer a way to make sure our building units don't shear during an earthquake!

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 ten materials or less? It's a challenge, but I think you're up to it.

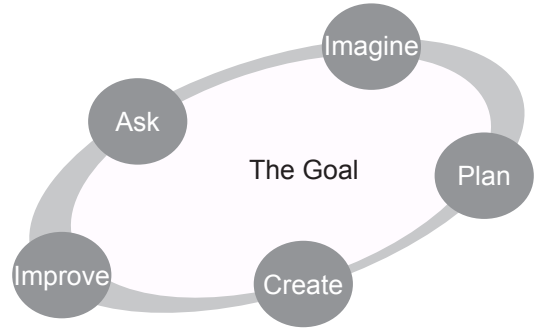
Good luck!

India





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



.....

What materials did you use?

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.....

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.....

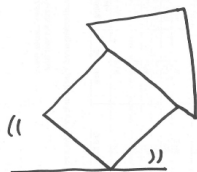
.....

**Test your building unit at a 7.0 magnitude.**

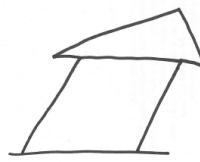
Watch your building unit carefully. Circle what happens when you test it.



slides



tips or falls



shears

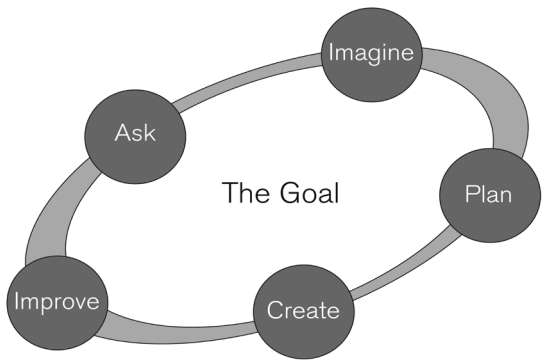
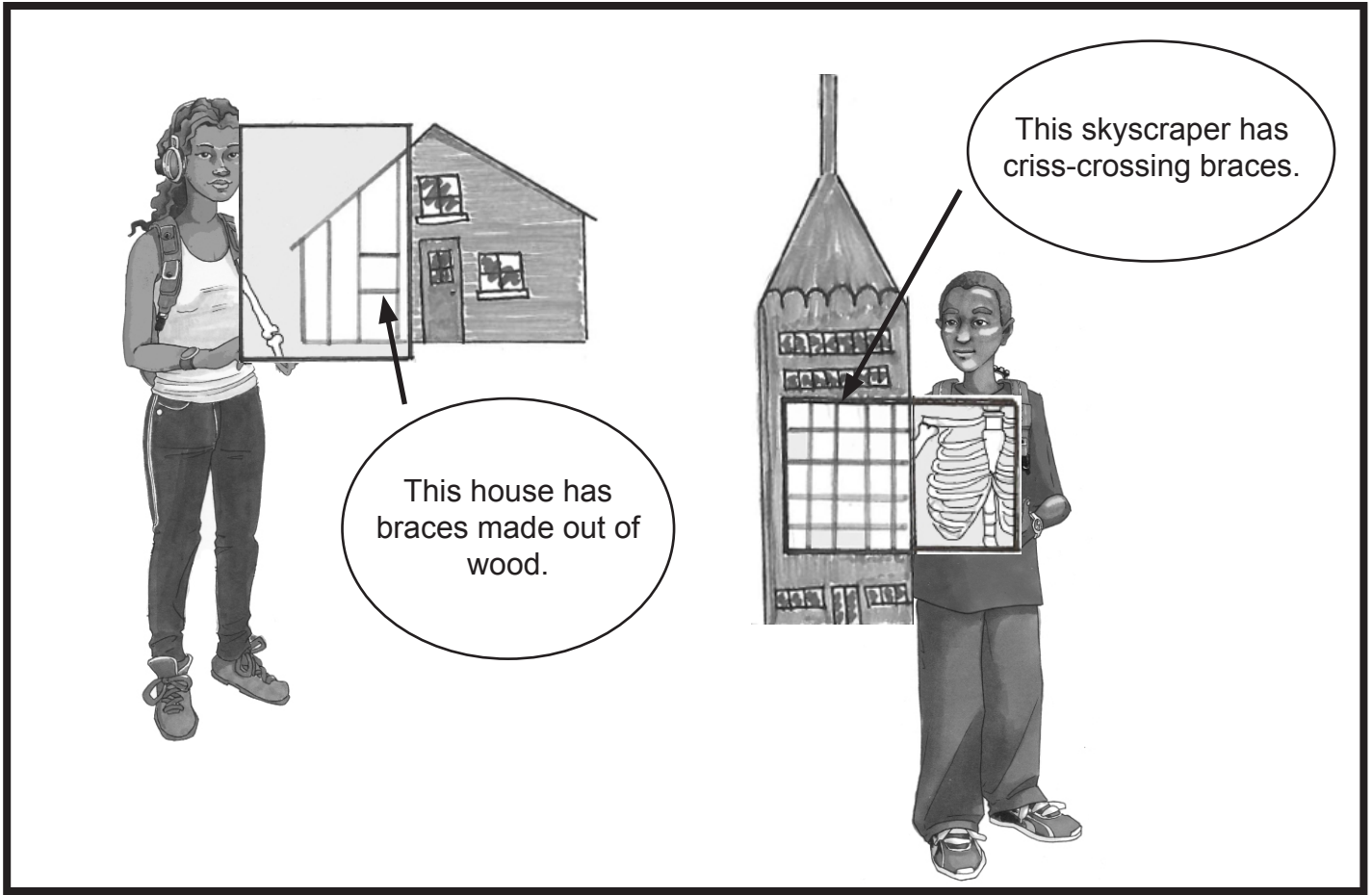


nothing

Would you feel safe inside this building?

Yes

No



## Think About It

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

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From engineeringadventures@mos.org  
Subject Ready, Set, Engineer!  
To You 12:12 PM

Hey engineers!

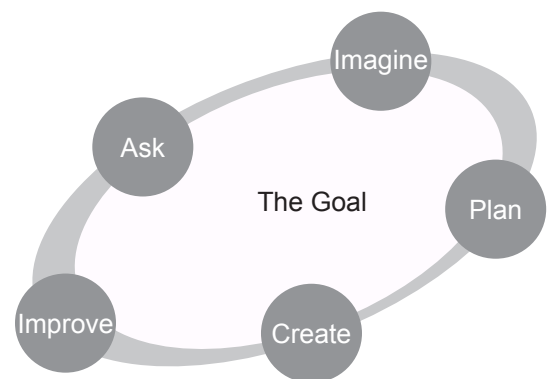
Now that we've practiced making our building units earthquake resistant, Bernard has challenged us to engineer a model of an entire earthquake resistant building! Our model buildings need to survive at least a 7.0 magnitude earthquake, like the one that hit Haiti in 2010.

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!

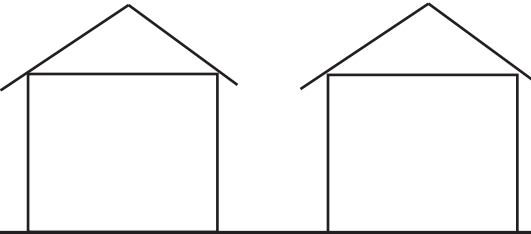
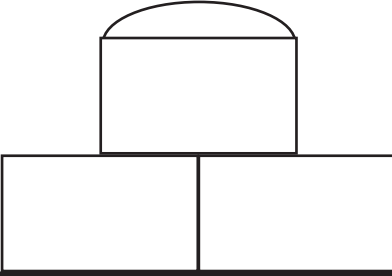
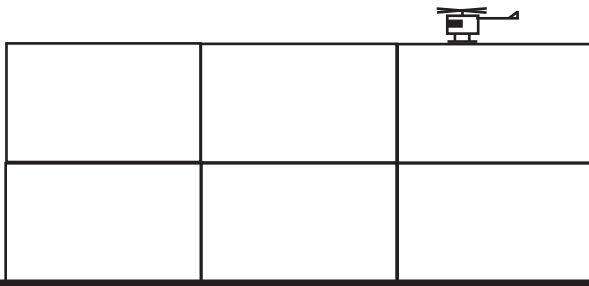
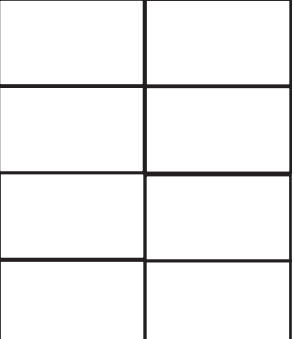
Jacob





Choose your building! Pay attention to the budget. The budget tells you how many items you can buy from the materials store.

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

	<p><b>Houses</b></p> <ul style="list-style-type: none"> <li>• 2 houses on the shake table</li> <li>• both houses need a sloped roof</li> </ul> <p><b>Budget for Materials</b></p> <ul style="list-style-type: none"> <li>• 15 items or less</li> </ul>
	<p><b>Library</b></p> <ul style="list-style-type: none"> <li>• 2 units on the bottom, 1 on top</li> <li>• needs a dome roof</li> </ul> <p><b>Budget for Materials</b></p> <ul style="list-style-type: none"> <li>• 30 items or less</li> </ul>
	<p><b>Hospital</b></p> <ul style="list-style-type: none"> <li>• 2 units high, 3 units wide</li> <li>• needs a helicopter landing pad</li> </ul> <p><b>Budget for Materials</b></p> <ul style="list-style-type: none"> <li>• 40 items or less</li> </ul>
	<p><b>Apartment Building</b></p> <ul style="list-style-type: none"> <li>• 4 units high, 2 units wide</li> </ul> <p><b>Budget for Materials</b></p> <ul style="list-style-type: none"> <li>• 50 items or less</li> </ul>

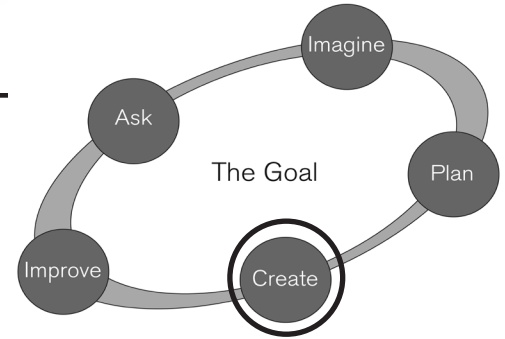




What building are you engineering? \_\_\_\_\_

What is your budget? \_\_\_\_\_ materials.

Draw a plan for your model building.



How many of each material will you use?

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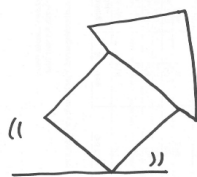
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Test your building at a 7.0 magnitude.

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

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From: engineeringadventures@mos.org  
Subject: Tried and Tested  
To: You 1:41 PM

Hello!

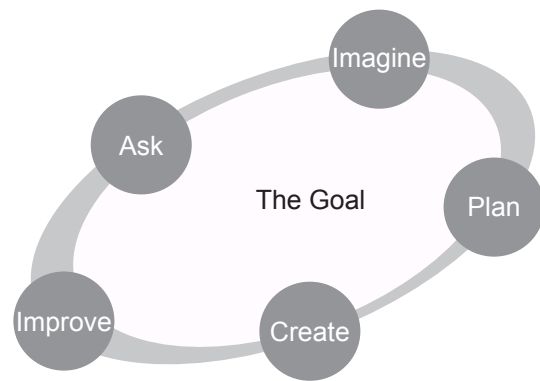
It is almost time for us to leave Haiti, and we want to make sure we have time to show Bernard our earthquake resistant designs. First, let's use the Improve step of the Engineering Design Process to make sure our buildings are really earthquake resistant.

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,

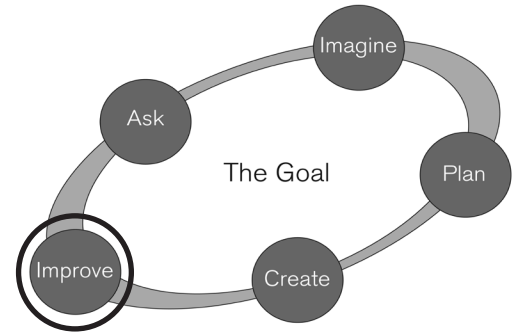
India





Look back at your first design on page 25. What do you want to Improve?

Draw your plan for Improving your model building.



What materials will you use?

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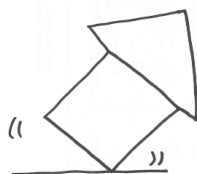
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**Test your building at a 7.0 magnitude.**

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



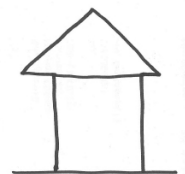
slides



tips or falls



shears



nothing

Would you feel safe inside this building?

Yes

No

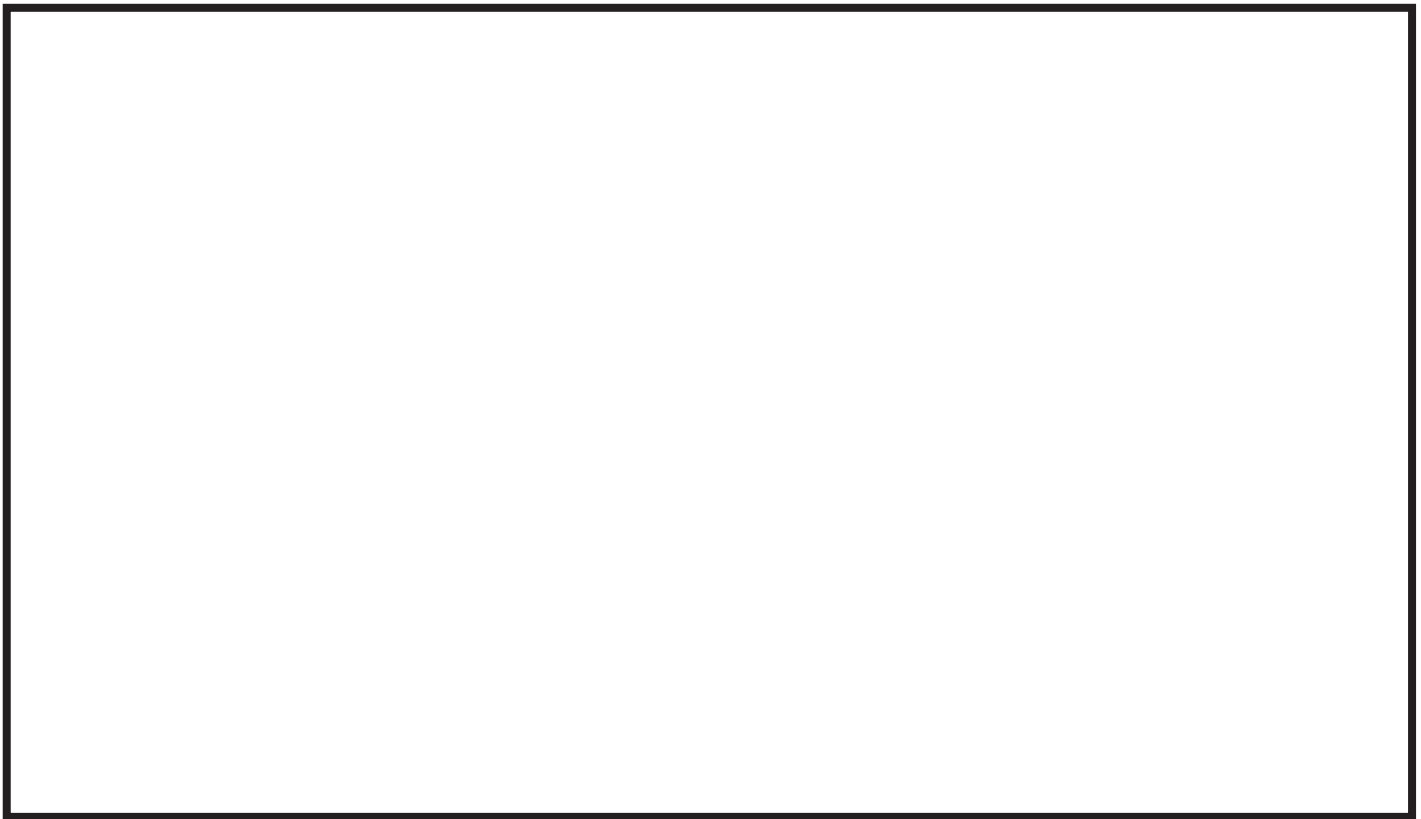


India and Jacob, the Duo  
c/o Museum of Science, EiE  
1 Science Park  
Boston, MA 02114

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  
Subject On Solid Ground  
To You 2:28 PM

Hey engineers!

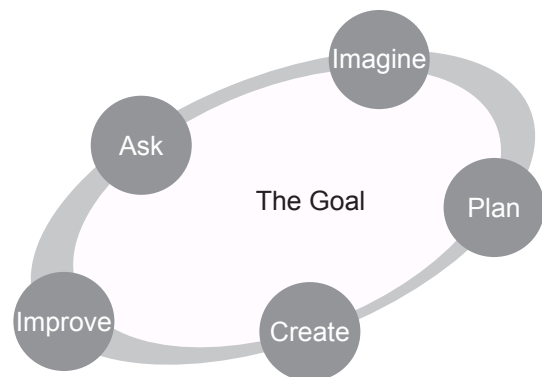
We have had such a great time in Haiti. We've learned so much from Bernard and from each other about how to engineer an earthquake resistant building. We are ready to show Bernard how earthquake resistant our model buildings are in a 7.0 magnitude earthquake. We're also going to show him the building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

Until next time,

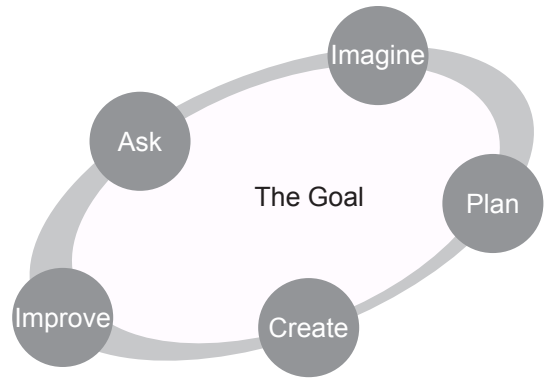
India and Jacob, the Duo





What do you want to engineer next?

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Draw your technology here!

What materials do you want to use?

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### My engineering checklist:

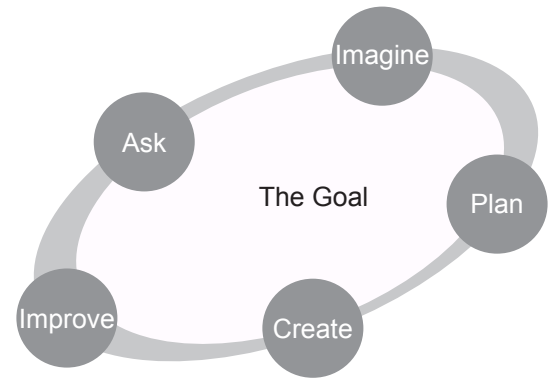
- Find friends to work with.
- Ask** questions about how to start.
- Imagine** lots of ideas.
- Make a **Plan**.
- Create** and test the plan.
- Improve** until you think it is ready.

**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.





# Haiti

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.

Haiti is a mountainous country. Its people speak French and Creole.

Gonâve Js.

Port au Prince

Dominican Republic

Hispaniola Js.

Caribbean Sea

