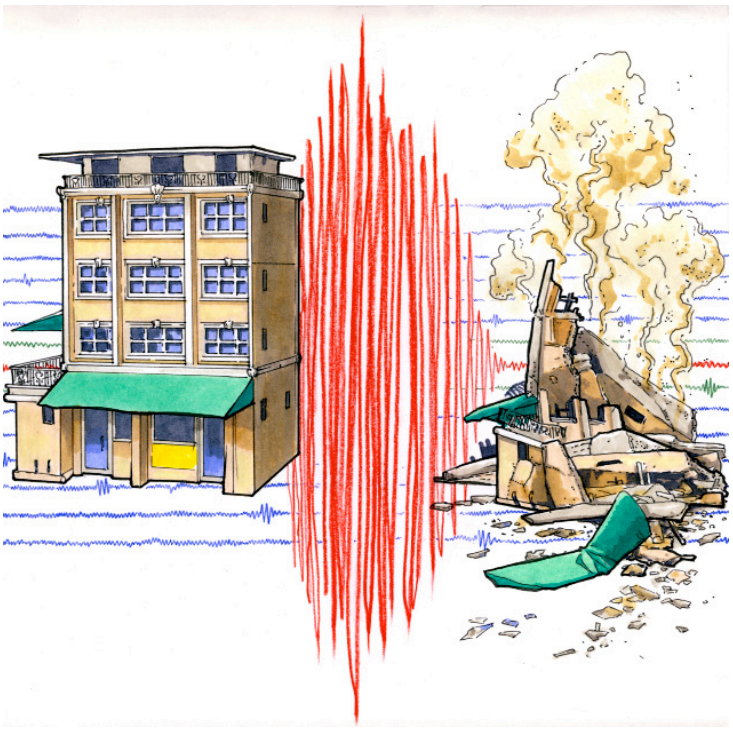
Draft 1/2013

Engineering Adventures

Shake Things Up: Engineering Earthquake Resistant Buildings

Earthquake Engineering for Kids in Out-of-School Time



Written by the Engineering is Elementary Team
Illustrated by Ross Sullivan-Wiley

EiE Engineering is Elementary®
Developed by the Museum of Science, Boston

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Developed by the Museum of Science, Boston

Pilot Sites for Shake Things Up:

This unit would not be possible without the valuable feedback from our pilot sites!

- Boys and Girls Club of Greater Sacramento, Sacramento, CA
- Boys and Girls Club of La Habra, La Habra, CA
- Boys and Girls Club of the South Coast Area, San Clemente, CA
- Bridgepoint Academy, Miami, FL
- Brown School Explorers, Somerville, MA
- Carolina Friends School, Durham, NC
- Charlestown Boys and Girls Club, Boston, MA
- City Gate, Washington, DC
- Columbus Afterschool, Medford, MA
- Comal ISD, New Braunfels, TX
- Cummings 21st Century Afterschool, Winthrop, MA
- Dazzling Discoveries, New York, NY
- Eagleview Elementary, Thornton, CO
- Education Connection, Westport, CT
- Ellis Memorial, Boston, MA
- For Kids Only Afterschool, Revere, MA
- For Kids Only Afterschool, Salem, MA
- High Rocks Educational Corporation, Hillsboro, WV
- Jefferson Village School, Jefferson, ME
- Jordan Boys and Girls Club, Chelsea, MA
- Latchkey Afterschool and the Frost School, Lawrence, MA
- Latchkey Afterschool and the Wetherbee School, Lawrence, MA
- Malden YMCA, Malden, MA
- Meadowvale Elementary School, Havre de Grace, MD
- Mustard Seed School, Hoboken, NJ
- Neah Bay Elementary COAST Program, Neah Bay, WA
- New Hingham Regional Elementary School, Chesterfield, MA
- Pittston Consolidated School, Gardiner, ME
- Roberts Elementary Afterschool, Medford, MA
- Russell Youth Center, Cambridge, MA
- Sacramento START/ Winn Elementary School, Sacramento, CA
- Saint Paul's Resource Center, Mattapan, MA
- Samuel Kennedy Elementary, Sacramento, CA
- Seashore Family Literacy Center, Waldport, OR
- Silvia Elementary, Fall River, MA
- South Boston Boys and Girls Club, Boston, MA
- Swampscott Middle School, Swampscott, MA
- Swift Waters After School, Boston, MA
- The Community Group, Lawrence, MA
- UCLA, Los Angeles, CA
- United South End Settlements, Boston, MA
- West Hills S.T.E.M. Academy, Bremerton, WA
- Woodlake Elementary, Sacramento, CA
- Yawkee Boys and Girls Club, Roxbury, MA
- YMCA Greater Boston, Boston, MA
- YMCA San Luis Obispo County - Shandon After School, CA
- YWCA Southeastern MA, New Bedford, MA

Unit Map

Here's an overview of the adventures in this unit and how they all fit together.

Prep Adventure 1: What is Engineering?
Kids engineer a tower and are introduced to the Engineering Design Process as a problem solving tool.

→

Prep Adventure 2: What is Technology?
Kids explore the idea that they, as engineers, can design and improve technology.

↓

Adventure 1: A Shaky Situation
Kids are introduced to the problem: how can we stop buildings from being damaged during an earthquake?

↓

Adventure 2: Building Skeletons
Kids explore how earthquakes impact buildings of different heights and shapes.

↓

Adventure 3: Stop the Slide
Kids engineer ways to stop their buildings from sliding off the shake table.

↓

Adventure 4: Getting Braces
Kids engineer ways to stop their buildings from changing shape during a test on the shake table.

↓

Adventure 5: Creating an Earthquake Resistant Structure
Kids plan, create, and test their buildings on the shake table.

→

Adventure 6: Improving an Earthquake Resistant Structure
Kids improve their initial designs, test them, and finalize their building codes.

↓

Adventure 7: Engineering Showcase
Kids present their final designs and share their knowledge of the Engineering Design Process.

Table of Contents

Introduction

Adventures

About Engineering is Elementary

Engineering is Elementary® (EiE) fosters engineering and technological literacy among children. Most humans spend over 95% of their time interacting with technology. Pencils, chairs, water filters, toothbrushes, cell phones, and buildings are all technologies—solutions designed by engineers to fulfill human needs or wants. To understand the world we live in, it is vital that we foster engineering and technological literacy among all people, even young children! Fortunately, children are born engineers. They are fascinated with building, taking things apart, and how things work. Engineering is Elementary harnesses children's natural curiosity to promote the learning of engineering and technology concepts.

The EiE program has four primary goals:
Goal 1: Increase children's technological literacy.
Goal 2: Increase educators' abilities to teach engineering and technology to elementary students.
Goal 3: Increase the number of schools and out-of-school time programs in the U.S. that include engineering at the elementary level.
Goal 4: Conduct research and assessment to further the first three goals and contribute knowledge about engineering teaching and learning at the elementary level.

The first product developed by the EiE program was the Engineering is Elementary curriculum series. This curriculum, designed specifically for use in elementary school classrooms, is research-based, standards-driven, and classroom-tested. The EiE curriculum integrates engineering and technology concepts and skills with elementary science topics and promotes K-12 science, technology, engineering, and mathematics (STEM) learning. For more information about EiE, visit: eie.org.

In 2011, EiE began development of Engineering Adventures (EA), a curriculum specifically for use in out-of-school time settings. While many of the underlying principles of the EiE and EA curricula are the same, EA is designed to address the unique challenges and advantages of the OST setting. More information about EA can be found on the next page, or online at: engineeringadventures.org.

Engineering is Elementary is a part of The National Center for Technological Literacy (NCTL) at the Museum of Science, Boston. The NCTL aims to enhance knowledge of technology and inspire the next generation of engineers, inventors, and innovators. Unique in recognizing that a 21st century curriculum must include today's human-made world, the NCTL's goal is to introduce engineering as early as elementary school and continue it through high school, college, and beyond. For more information about the NCTL, visit: nctl.org.

About Engineering Adventures

The mission of Engineering Adventures is to create exciting out-of-school time activities and experiences that allow *all* learners to act as engineers and engage in the engineering design process. Our goal is to positively impact children's attitudes about their abilities to engineer by providing materials uniquely appropriate for the varied landscapes of out-of-school time settings.

The main ideas that guide the developers of EA are listed below.

We believe kids will best learn engineering when they:

- engage in activities that are fun, exciting, and connect to the world in which they live.
- choose their path through open-ended challenges that have multiple solutions.
- have the opportunity to succeed in engineering challenges.
- communicate and collaborate in innovative, active, problem solving.

Through EA units, kids will learn that:

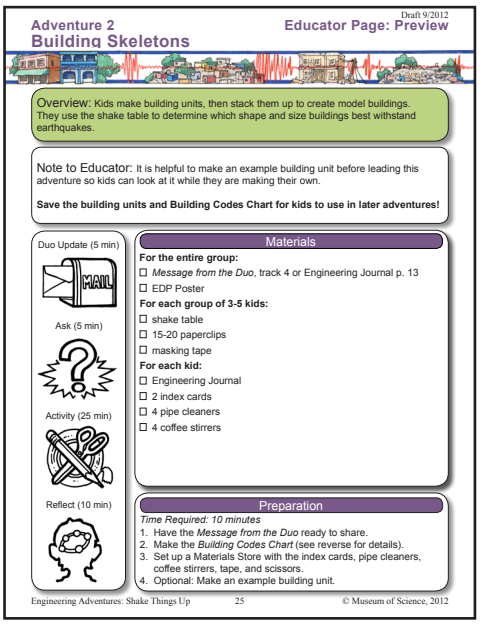
- they can use the Engineering Design Process to help solve problems.
- engineers design technologies to help people and solve problems.
- they have talent and potential for designing and improving technologies.
- they, too, are engineers.

As kids work through their engineering design challenges, they will have the opportunity to build their problem solving, teamwork, communication, and creative thinking skills. Most importantly, this curriculum is designed to provide a fun learning opportunity for kids!

For more information on Engineering Adventures, please visit: engineeringadventures.org.

Each Engineering Adventure Includes

A **Preview Page** with relevant background information, materials list, prep, and a preview of the journal pages needed.



Draft 9/2012

Adventure 2
Building Skeletons

Educator Page: Preview

Overview: Kids make building units, then stack them up to create model buildings. They use the shake table to determine which shape and size buildings best withstand earthquakes.

Note to Educator: It is helpful to make an example building unit before leading this adventure so kids can look at it while they are making their own.

Save the building units and Building Codes Chart for kids to use in later adventures!

Duo Update (5 min)

Ask (5 min)

Activity (25 min)

Reflect (10 min)

Materials

For the entire group:
- ☐ *Message from the Duo*, track 4 or Engineering Journal p. 13
- ☐ EDP Poster

For each group of 3-5 kids:
- ☐ shake table
- ☐ 15-20 paperclips
- ☐ masking tape

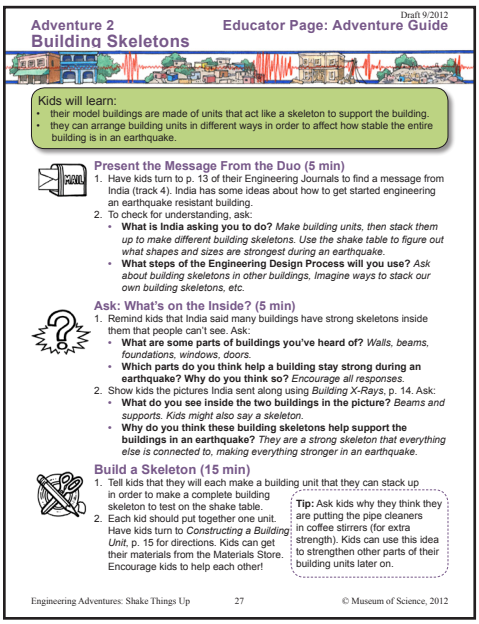
For each kid:
- ☐ Engineering Journal
- ☐ 2 index cards
- ☐ 4 pipe cleaners
- ☐ 4 coffee stirrers

Preparation

Time Required: 10 minutes
1. Have the *Message from the Duo* ready to share.
2. Make the *Building Codes Chart* (see reverse for details).
3. Set up a Materials Store with the index cards, pipe cleaners, coffee stirrers, tape, and scissors.
4. Optional: Make an example building unit.

Engineering Adventures: Shake Things Up 25 © Museum of Science, 2012

An **Adventure Guide** with step-by-step instructions, including discussion questions, extension ideas, and tips.



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Adventure 2
Building Skeletons

Educator Page: Adventure Guide

Kids will learn:
- their model buildings are made of units that act like a skeleton to support the building.
- they can arrange building units in different ways in order to affect how stable the entire building is in an earthquake.

Present the Message From the Duo (5 min)
1. Have kids turn to p. 13 of their Engineering Journals to find a message from India (track 4). India has some ideas about how to get started engineering an earthquake resistant building.
2. To check for understanding, ask:
   - **What is India asking you to do?** *Make building units, then stack them up to make different building skeletons. Use the shake table to figure out what shapes and sizes are strongest during an earthquake.*
   - **What steps of the Engineering Design Process will you use?** *Ask about building skeletons in other buildings, Imagine ways to stack our own building skeletons, etc.*

Ask: What's on the Inside? (5 min)
1. Remind kids that India said many buildings have strong skeletons inside them that people can't see. Ask:
   - **What are some parts of buildings you've heard of?** *Walls, beams, foundations, windows, doors.*
   - **Which parts do you think help a building stay strong during an earthquake? Why do you think so?** *Encourage all responses.*
2. Show kids the pictures India sent along using *Building X-Rays*, p. 14. Ask:
   - **What do you see inside the two buildings in the picture?** *Beams and supports. Kids might also say a skeleton.*
   - **Why do you think these building skeletons help support the buildings in an earthquake?** *They are a strong skeleton that everything else is connected to, making everything stronger in an earthquake.*

Build a Skeleton (15 min)
1. Tell kids that they will each make a building unit that they can stack up in order to make a complete building skeleton to test on the shake table.
2. Each kid should put together one unit. Have kids turn to *Constructing a Building Unit*, p. 15 for directions. Kids can get their materials from the Materials Store. Encourage kids to help each other!

Tip: Ask kids why they think they are putting the pipe cleaners in coffee stirrers (for extra strength). Kids can use this idea to strengthen other parts of their building units later on.

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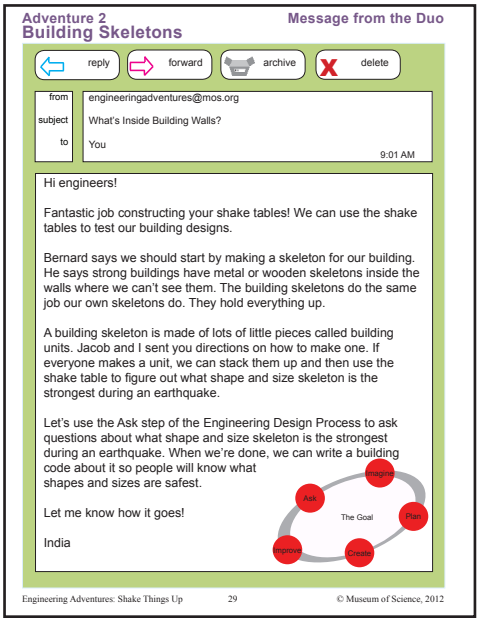
A **Message from the Duo**, India and Jacob, with information about the day's activity.



Adventure 2
Building Skeletons

Message from the Duo

reply | forward | archive | delete

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 our building designs.

Bernard says we should start by making a skeleton for our building. He says strong 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 called 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 during an earthquake. When we're done, we can write a building code about it so people will know what shapes and sizes are safest.

Let me know how it goes!

India

Imagine, Ask, The Goal, Plan, Improve, Create

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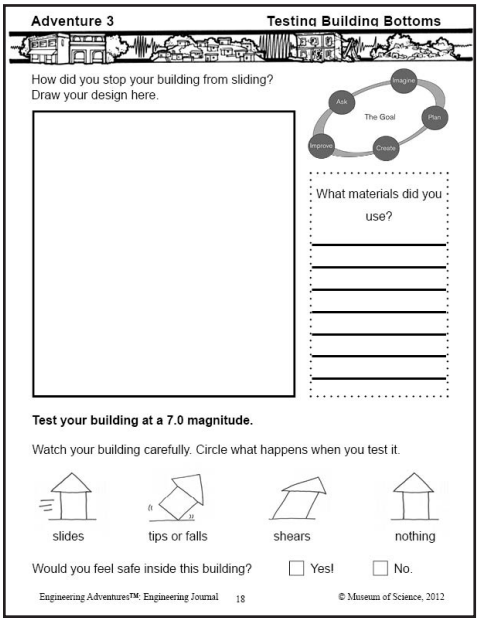
Engineering Journal pages that allow kids to record findings and reflect on their learning.



Adventure 3
Testing Building Bottoms

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

Imagine, Ask, The Goal, Plan, Improve, Create

What materials did you use?

Test your building at a 7.0 magnitude.

Watch your 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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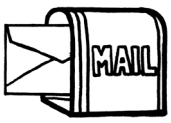
The Sections of the Adventures



Messages from the Duo

Messages from India and Jacob, a world traveling brother and sister Duo, are provided as a quick, exciting way to present the real-world context for the unit's engineering challenge. Providing a context helps kids to understand the challenge and motivates them to find solutions. If you have access to a CD or MP3 player, we strongly suggest using the audio recordings, although reading the emails aloud will convey the same information.

Set the Stage (or Ask)

The Set the Stage, or Ask, part of each adventure provides important information and questions that prepare kids for the main activity. During this section, you might ask questions prompting kids to share their prior knowledge, have them predict what they will find, or remind them of criteria that will help them as they engineer. This sets your kids up to succeed and feel confident in their ability to engineer.

Activities

The activities are designed to get kids thinking and working together to solve the unit's engineering design challenge. As the educator, it is your role to guide kids through these activities by encouraging them to pursue and communicate their own ideas, even if you think they may not work. In engineering, there are no right or wrong answers! Every problem has many possible solutions and multiple ways to reach them.

Reflect

Each adventure includes five to ten minutes at the end for kids to communicate with their peers by sharing their work. This gives kids the chance to discuss new ideas, think about their own work and the work of others, and reflect on what was learned. Group reflection can help reduce competition by encouraging kids to support each other as they move through the Engineering Design Process. For more individual reflection, each adventure also includes time for kids to record thoughts and ideas in their Engineering Journal.

Engineering Journals

Copy an Engineering Journal for each kid as you begin working on this EA unit. Kids will use them as directed in the Adventure Guide during every adventure.

The Engineering Journal is a central location for kids to record their thoughts and ideas as they move through the unit. It includes recording pages that will guide kids through the Engineering Design Process, poses questions, and prompts kids to reflect on their learning. The 5-10 minutes kids spend with their journals during each adventure will allow them to create a personalized record of their engineering learning.

The back page of each Engineering Journal is a passport page from the country or state in which the unit takes place. Kids are encouraged to stamp the passport page when they finish a unit and collect the pages from all of the units they've completed. A full passport can be found online at: www.mos.org/eie/engineeringadventures/passport.

What You Need to Know **Before** Teaching an EA Unit

Engineering is fun.

The EA team hears this from many OST educators and kids. Engineering is really a way of problem solving—a way of thinking about the world—that is often very fun and creative. Any time you need to solve a problem in order to reach a goal, you are engineering.

There are no right or wrong answers.

There are often many great ways to solve the same problem. Not only is this a good engineering lesson for the kids in your program, it's a good life lesson.

It's okay to try it out!

It can be very helpful to try out the engineering challenge yourself—either beforehand or right alongside the kids in your program as they work through the adventures. This can help you understand the challenges the kids might face.

Scheduling the Unit's Adventures

Each adventure requires 45-60 minutes of teaching time. We recommend that you budget at least 7-10 hours in order to complete this unit, as some adventures may occasionally go longer than expected.

You can schedule this unit in several ways: once a week, several times a week, or daily. It is also possible to group certain adventures together. The chart below shows which adventures are easily taught together. Use this chart to help you plan your schedule.

Prep Adventure 1: What is Engineering? Tower Power Prep Adventure 2: What is Technology? Technology Detectives	2-3 hours
Adventure 1: A Shaky Situation Adventure 2: Building Skeletons	2-3 hours
Adventure 3: Stop the Slide Adventure 4: Getting Braces	2-3 hours
Adventure 5: Creating an Earthquake Resistant Building Adventure 6: Improving an Earthquake Resistant Building	2-3.5 hours
Adventure 7: Engineering Showcase: Shake Things Up	1-1.5 hours

Tips and Tricks for Teaching the Unit

Post a Daily Agenda

Giving kids a sense of the day's adventure will help them to plan ahead and manage their time during the activity.

Facilitate Teamwork

Being able to work well in teams is an important skill for any engineer. You may want to assign team roles to help kids if they struggle with teamwork. Possible roles include: the recorder, the materials gatherer, the tester, and the presenter.

Invite Others to the Showcase

The showcase, always the last adventure in the unit, is a big deal! This is a chance for kids to highlight the engineering they've done and share their accomplishments with others. Consider inviting families, program staff, and other kids to come to the showcase.

Background

Earthquake Engineering

Earthquake engineering is the design, development, and production of earthquake resistant structures. In many parts of the world, the designs of most buildings do not need to consider the stresses of the ground shaking. However, buildings in areas prone to earthquakes need to be designed so that their structures can withstand this unique kind of stress. Earthquake engineers have developed a number of design strategies that help minimize the effects of the earth shaking. These strategies include strong and light building skeletons, strong bases, and bracing.

Engineers often use models to test designs on a small and manageable scale. In the field of earthquake engineering, engineers use a shake table in order to model how their earthquake resistant designs respond to vigorous shaking. In this unit, kids construct shake tables to test their own structures. To see how shake tables are used in the field, check out the Shake Table video from Discovery News (http://www.mos.org/eie/engineeringadventures/earthquakesvideos.php).

The ground can shake in many different ways during an earthquake. This unit focuses primarily on lateral movement, when the earth shakes from side to side. Scientists measure the intensity of an earthquake by using a device called a seismometer and a system of measurement called the Richter scale. In this unit, kids will use a special earthquake magnitude meter to standardize the degree of shaking that they test on their shake tables.

2010 Earthquake in Haiti

On January 24, 2010, a 7.0 magnitude earthquake struck the Caribbean nation of Haiti. The epicenter of the quake was located just 16 miles west of the capital city of Port-au-Prince. Because there are no building codes in Haiti, many structures were reinforced poorly. The earthquake resulted in massive destruction and loss of life. Rebuilding is still underway.

Online Resources

For more information about this unit, and other Engineering Adventures, visit:
http://www.mos.org/eie/engineeringadventures/units.php

Vocabulary

***Bonjou*:** French Creole for “Hello.”

Building code: A law or standard that mandates requirements for the construction of buildings.

Creole: Along with French, the official language of Haiti.

Earthquake engineer: An engineer who designs earthquake resistant structures.

Earthquake resistant building: A building that is designed specifically to resist the stresses caused by the ground shaking.

Engineer: Someone who uses his or her creativity and knowledge of math and science to design things that solve problems.

Engineering Design Process: The steps that engineers use to design something to solve a problem.

***Orevwa*:** French Creole for “Goodbye.”

Port-au-Prince: The capital city of Haiti.

Shear: A force that affects many structures during an earthquake. Shear occurs when the ground moves and the upper floors of buildings cannot keep up with the lower floors.

Richter scale: A tool earthquake engineers use to represent the strength and intensity of an earthquake.

Technology: Any thing, system, or process designed by humans to help solve a problem.

Materials List

(This kit is prepared for 8 groups of 3 children)

Quantity	Item
	Non-Consumable Items
1	Duo Audio CD or access to a computer
1	EDP Poster
1	stuffed animal toy
8	ruler, 12”
8	scissors
16	foam core board, 8.5” x 11”
16	tubes, plastic, 1.5” diameter, 10” long
128	hex nuts, 1/2”
	Consumable Items
1	string, cotton, roll
8	tape, masking
16	rubber band, 7”
28	medium binder clips
32	self-adhesive foam, 1”
100	craft stick
100	toothpicks
150	straws, drinking, no bend
200	coffee stirrers, 7”, plastic
200	pipe cleaners
300	brass fasteners, 1”
700	paper clip, #1 size
900	index cards, 3” x 5”
	NOT INCLUDED IN KIT
1	CD player or MP3 player
1	chart paper
1	clock or timepiece
30	markers/crayons

National Education Standards

		Prep Adventure 1: What is Engineering? Tower Power	Prep Adventure 2: What is Technology? Technology Detectives	Adventure 1: A Shaky Situation	Adventure 2: Building Skeletons	Adventure 3: Stop the Slide	Adventure 4: Getting Braces	Adventure 5: Creating an Earthquake Resistant Building	Adventure 6: Improving an Earthquake Resistant Building	Adventure 7: Engineering Showcase: Shake Things Up
National Science Education Standards	Science as Inquiry	✓			✓	✓	✓			
	Physical Science				✓	✓	✓			
	Life Science									
	Earth and Space Science			✓						
	Science and Technology	✓			✓	✓	✓	✓	✓	✓
	Science in Personal and Social Perspectives			✓	✓	✓	✓	✓	✓	✓
	History and Nature of Science									
ITEEA	The Nature of Technology		✓		✓	✓	✓	✓	✓	
	Technology and Society			✓						✓
	Design	✓			✓	✓	✓	✓	✓	
	Abilities for a Technological World	✓				✓	✓	✓	✓	✓
	The Designed World				✓	✓	✓	✓	✓	✓

Dear Family, Date: _____

We are beginning an engineering unit called Shake Things Up: Engineering Earthquake Resistant Buildings, which is part of the Engineering Adventures curriculum developed by the Museum of Science, Boston. Engineering Adventures is a curricular program that introduces children to the engineering design process and various fields of engineering. Throughout this unit, children will learn about earthquake engineering and work to solve an earthquake engineering design challenge. The unit is set in a real-world context: children will learn about the 2010 earthquake in Haiti, design a model earthquake resistant building, and write their own building codes.

There are many reasons to introduce children to engineering:

- **Engineering projects reinforce topics children are learning in school.** Engaging students in hands-on, real-world engineering experiences can enliven math, science, and other content areas.
- **Engineering fosters problem-solving skills**, including problem formulation, creativity, planning, and testing of alternative solutions.
- **Children are fascinated with building and with taking things apart to see how they work.** By encouraging these explorations, we can keep these interests alive. Describing their activities as "engineering" when children are engaged in the natural design process can help them develop positive associations with engineering, and increase their desire to pursue such activities in the future.
- **Engineering and technological literacy are necessary for the 21st century.** As our society increasingly depends on engineering and technology, our citizens need to understand these fields.

Because engineering projects are hands-on, materials are often required. Several materials necessary to this unit are listed below. If you have any of these materials available, please consider donating them to us.

If you have expertise about earthquake engineering or Haiti, or have any general questions or comments about the engineering and design unit we are about to begin, please let me know.

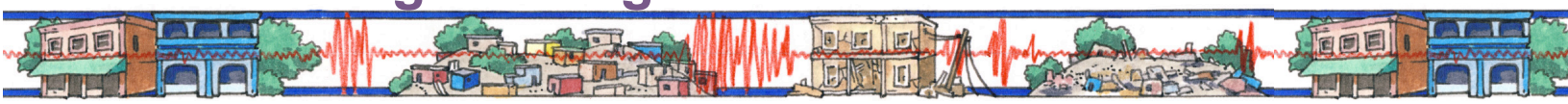
Sincerely,

If you have any of the following materials available and would like to donate them, I would greatly appreciate having them by the following date: _____ . Thank you!

_____ _____
_____ _____
_____ _____

Prep Adventure 1 Educator Page: Preview

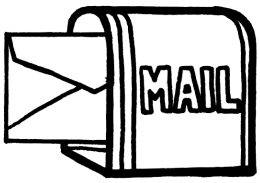
What is Engineering? Tower Power



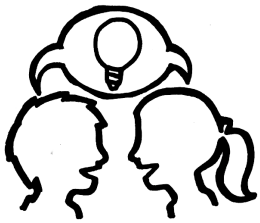
Overview: Kids will engineer an index card tower that will support a stuffed animal.

Note to Educator: Who are engineers? Engineers are people who use science, math, and creativity to solve problems. Today kids will be engineers as they use the Engineering Design Process to design towers.

Duo Update (5 min)

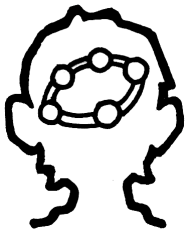


Set the Stage (10 min)



Activity (30 min)

Reflect (5 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 1 or Engineering Journal, p. 1
- ☐ EDP Poster
- ☐ *Heightened Emotions*, this guide, p. 7
- ☐ timer or clock
- ☐ 1 small stuffed animal

For each group of 3-5 kids:

- ☐ 1 pack of index cards (about 100 cards)
- ☐ 1 pair of scissors
- ☐ 1 ruler
- ☐ At least 1 foot of tape

For each kid:

- ☐ Engineering Journal

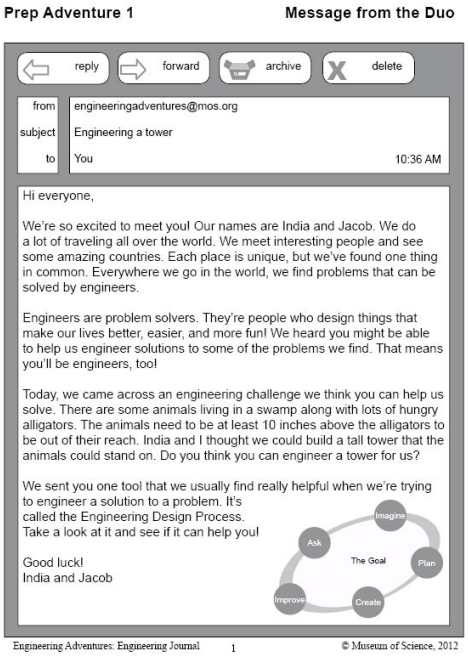
Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Make samples of the cards found on *Building with Cards,* Engineering Journal p. 2.

Journal Pages for Prep Adventure 1

Message From the Duo, p. 1



Prep Adventure 1 — Message from the Duo

reply | forward | archive | delete

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 for us?

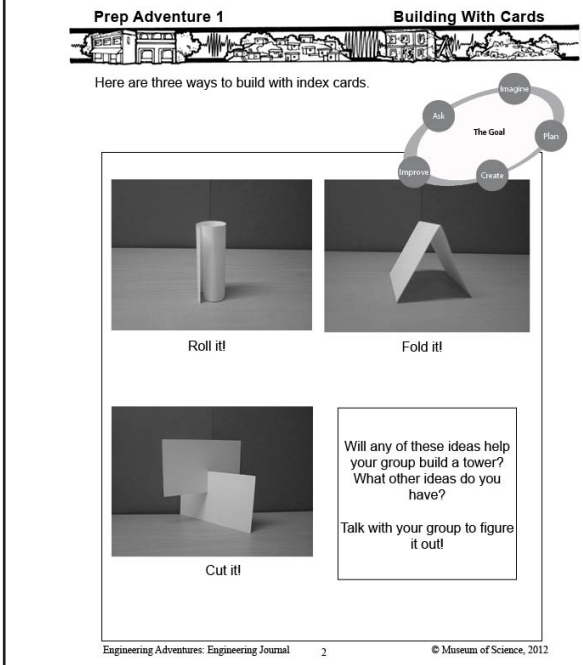
We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. Take a look at it and see if it can help you!

Imagine, Ask, The Goal, Plan, Improve, Create

Good luck!
India and Jacob

Engineering Adventures: Engineering Journal 1 © Museum of Science, 2012

Building with Cards, p. 2



Prep Adventure 1 — Building With Cards

Here are three ways to build with index cards.

Imagine, Ask, The Goal, Plan, Improve, Create

Roll it!

Fold it!

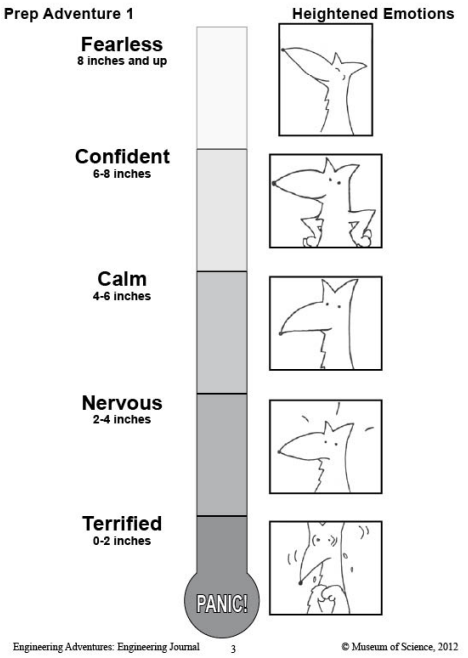
Cut it!

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!

Engineering Adventures: Engineering Journal 2 © Museum of Science, 2012

Heightened Emotions, p. 3



Prep Adventure 1 — Heightened Emotions

Fearless — 8 inches and up

Confident — 6-8 inches

Calm — 4-6 inches

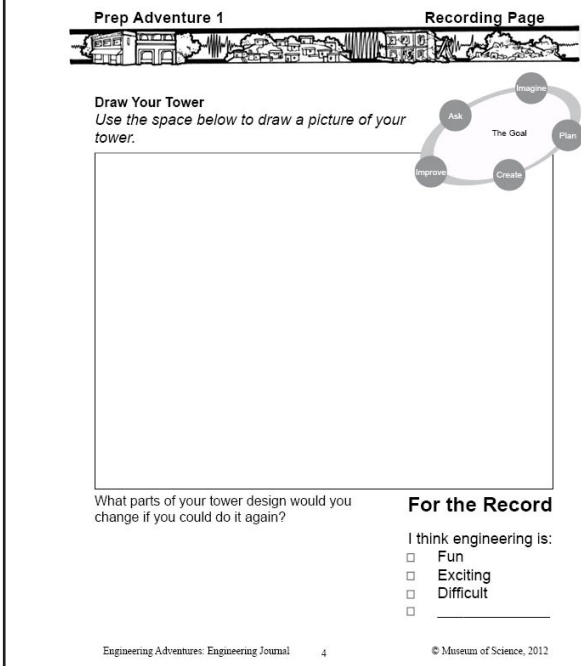
Nervous — 2-4 inches

Terrified — 0-2 inches

PANIC!

Engineering Adventures: Engineering Journal 3 © Museum of Science, 2012

Recording Page, p. 4



Prep Adventure 1 — Recording Page

Draw Your Tower

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

Imagine, Ask, The Goal, Plan, Improve, Create

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

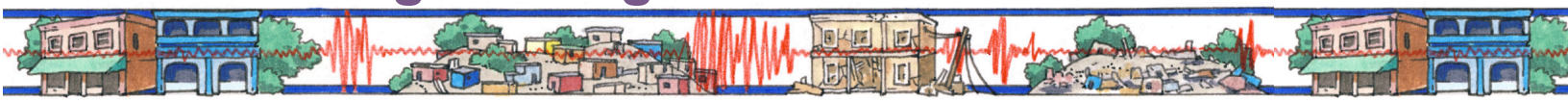
For the Record

I think engineering is:

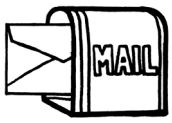
- ☐ Fun
- ☐ Exciting
- ☐ Difficult
- ☐ _____

Engineering Adventures: Engineering Journal 4 © Museum of Science, 2012

Prep Adventure 1 Educator Page: Adventure Guide
What is Engineering? Tower Power



Kids will learn:
- the Engineering Design Process is a tool they can use to help solve problems.



Present the Message From the Duo (5 min)

1. Tell kids that India and Jacob are a brother and sister who travel the world. They find problems and solve them using engineering.
2. Today, India and Jacob sent us a message about a problem they'd like us to solve. Have kids turn to Engineering Journal p. 1 for a message with more details (track 1).

Set the Stage (5 min)

1. Tell kids that today they are going be engineers and use the Engineering Design Process to solve India and Jacob's problem.
2. To check for understanding, ask:
   - **What do India and Jacob need us to engineer?** *A tower to lift the animal up 10 inches so it doesn't get eaten by alligators.*
3. Show groups the Engineering Design Process poster and tell them they are going to Ask questions about the problem, Imagine ways to solve it, Plan a design, Create and test it, and then think about ways to Improve it.

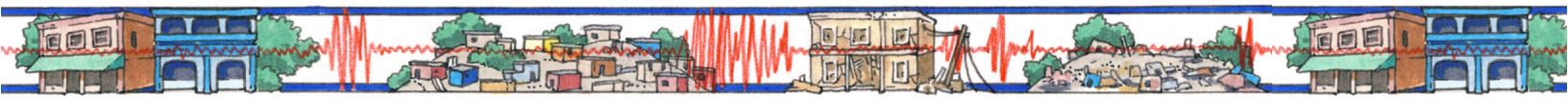
Imagine (5 min)

1. Tell kids it's time to look at the materials they can use and Imagine different ways to make them work.
2. Split kids in groups of 3-5 and give each group a pack of index cards, scissors, and tape. Ask:
   - **Can you Imagine any ways you could use these materials to engineer a tower?**
3. If your kids want to see examples, show them the index card samples you prepared, or have them look at *Building with Cards*, p. 2. Ask:
   - **Do you think any of these ideas might work well? Why?**

Plan and Create (at least 20 min)

1. Tell kids it is time to plan and create their towers.
2. Show the stuffed animal and explain that:
   - The challenge is to work in groups to engineer a tower that can hold the animal 10 inches in the air for at least 10 seconds.
   - Each group will have (at least) 20 minutes.
   - You can only use index cards and tape in the tower. The scissors are a tool only and cannot be used in the tower.

Tip: If you can, you may want to offer more time for this challenge.



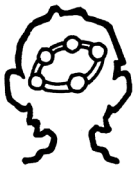
- You can hold the stuffed animal briefly, but you can't test it on your tower until the 20 minutes are up.

3. As groups work, circulate around the room. Ask questions like:
   - **Why do you think your design will work well?**
   - **Which step of the Engineering Design Process are you using right now? How do you know?**

Tip: You may choose to offer unlimited tape, or to challenge groups by limiting the tape to one or two feet.

Tower Showcase (10 min)

1. Have each group present their tower. Ask each group questions like:
   - **Can you tell me about your design?**
   - **Which steps of the Engineering Design Process did your group use?**
2. Use a ruler to measure the tower. Compare the measurement to the diagrams on *Heightened Emotions*. Give one kid the stuffed animal and have him or her place it on top of the tower. Count to 10 and observe what happens. Ask:
   - **What parts would you Improve if you could design your tower again? Why?**



Reflect (5 min)

1. Go through the Engineering Design Process poster with kids and have them talk about how they used each step to solve the problem. Ask questions like:
   - **How did you use this step of the Engineering Design Process to solve the problem?** *We Asked about the challenge; we Imagined ways to build with cards; we Planned when we decided what design to use; we Created and Improved when we built and fixed the tower.*
   - **Why do you think it's important to use these steps?** *It helps us keep track of our ideas and make sure we're meeting our goal.*
   - **Do you think you are an engineer?**
2. Tell kids that they've just used the same steps that engineers use to solve problems. This means that they are engineers, too! Tell kids they will have the opportunity to engineer solutions to even bigger problems with India and Jacob later on.
3. Give kids time to record their thoughts in their Engineering Journals on *Recording Page,* p. 4.

What is Engineering? Tower Power

reply | forward | archive | delete

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

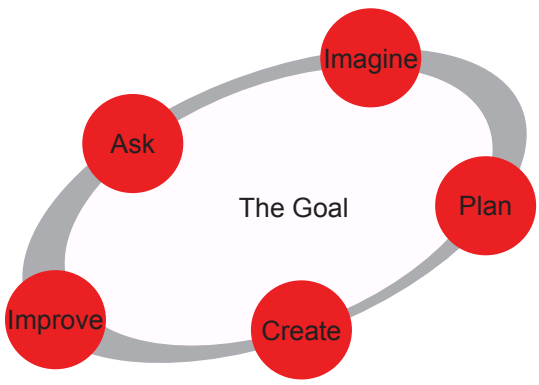
Hi everyone,

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?

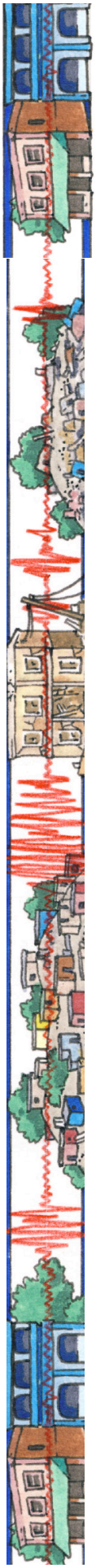
We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. Take a look at it and see if it can help you!



Good luck!
India and Jacob

Heightened Emotions

Prep Adventure 1
What is Engineering? Tower Power



Fearless
8 inches and up

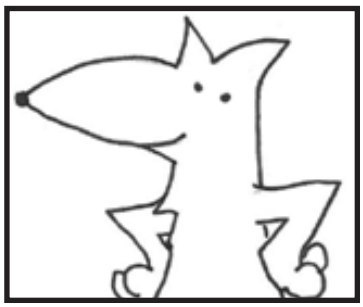
Confident
6-8 inches

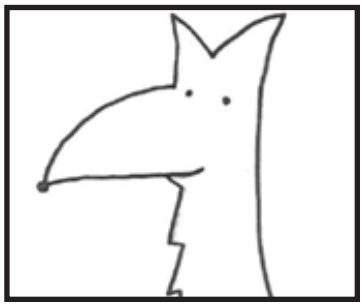
Calm
4-6 inches

Nervous
2-4 inches

Terrified
0-2 inches

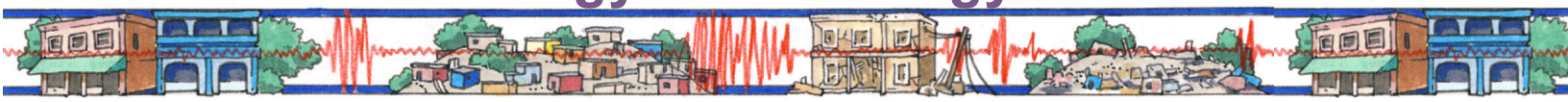
PANIC!





Prep Adventure 2 — Educator Page: Preview

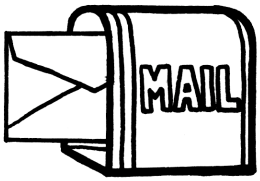
What is Technology? Technology Detectives



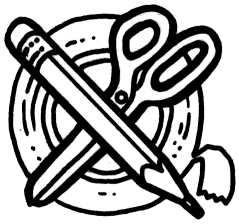
Overview: Kids will examine some technologies and imagine ways to improve them.

Note to Educator: Many people think of technologies as things that are only electronic, or things that are "high-tech." Technology is actually anything designed by people to help solve a problem or meet a need.

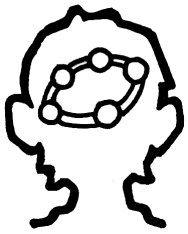
Duo Update (5 min)



Activity (15 min)



Reflect (20 min)



Materials

For the whole group:

- ☐ *Message from the Duo*, track 2 or Engineering Journal, p. 5
- ☐ EDP Poster
- ☐ large sheet of paper or other writing space
- ☐ a small rock or leaf
- ☐ a cloth or bag large enough to cover all technologies

Technologies (choose 8):

☐ electronic device, like a cell phone or calculator	☐ stuffed animal	☐ hair clip
	☐ hat	☐ button
	☐ scissors	☐ spoon
☐ water bottle	☐ sweater	☐ key
☐ roll of tape	☐ dice	☐ book
☐ ruler	☐ juicebox	☐ stapler
☐ construction paper	☐ bag	☐ glue stick

For each kid:

- ☐ Engineering Journal

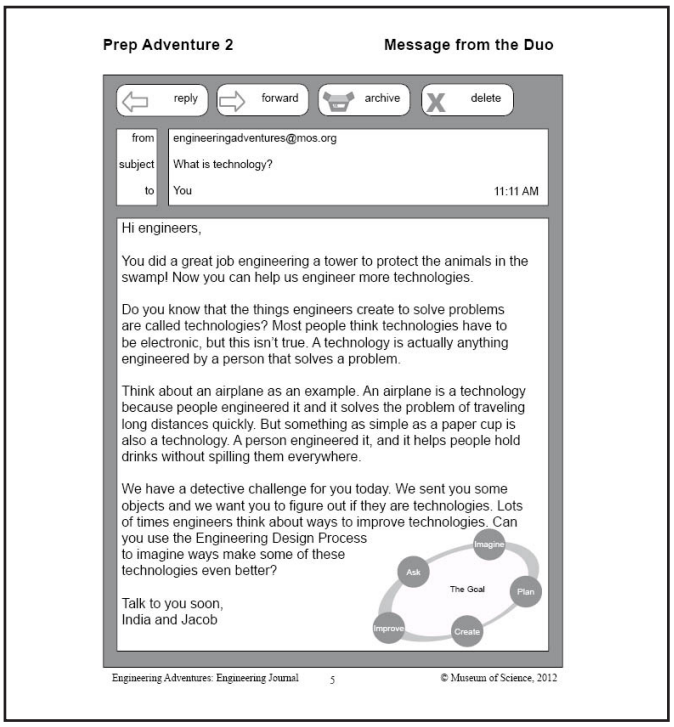
Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Place the eight technologies (see above) on a table or floor and cover with a cloth or bag. Do not put the rock or leaf under the cover.
3. On a sheet of large paper, make the *Technology Detective Tool* chart as shown on the next page.

Journal Pages for Prep Adventure 2

Message From the Duo, p. 5



Prep Adventure 2 — Message from the Duo

reply | forward | archive | delete

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.

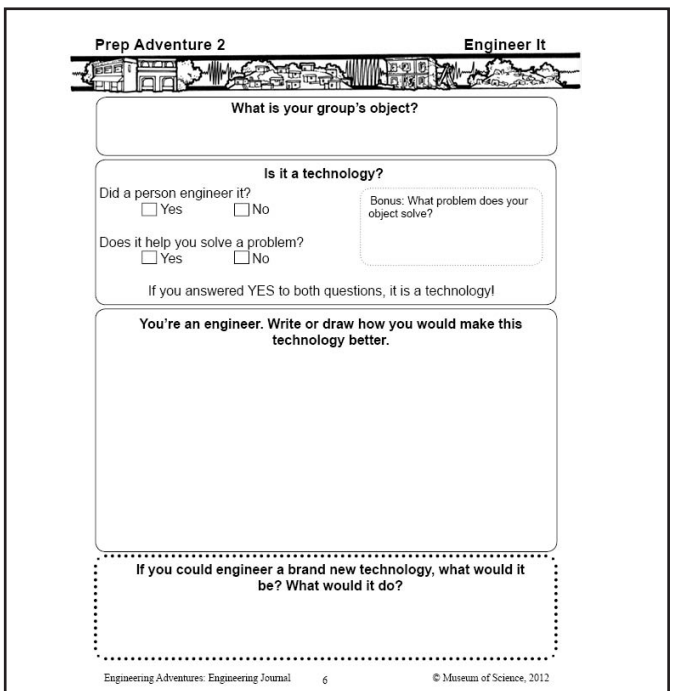
Think about an airplane as an example. An airplane is a technology because people engineered it and it solves the problem of traveling long distances quickly. But something as simple as a paper cup is also a technology. A person engineered it, and it helps people hold drinks without spilling them everywhere.

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

Engineering Adventures: Engineering Journal 5 © Museum of Science, 2012

Engineer It, p. 6



Prep Adventure 2 — Engineer It

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.

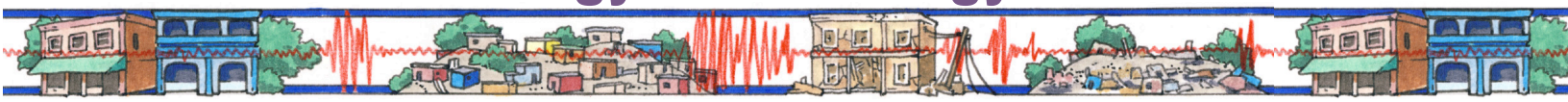
If you could engineer a brand new technology, what would it be? What would it do?

Engineering Adventures: Engineering Journal 6 © Museum of Science, 2012

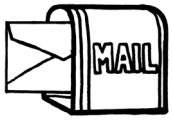
Chart for Prep Adventure 2

Technology Detective Tool
Did a person engineer it?
Does it help you solve a problem?
If you answered YES to both, it is a technology!

Prep Adventure 2 Educator Page: Adventure Guide
What is Technology? Technology Detectives



Kids will learn:
- technology is anything designed by people to help solve a problem or meet a need.
- engineers design and improve technologies.



Present the Message From the Duo (5 min)

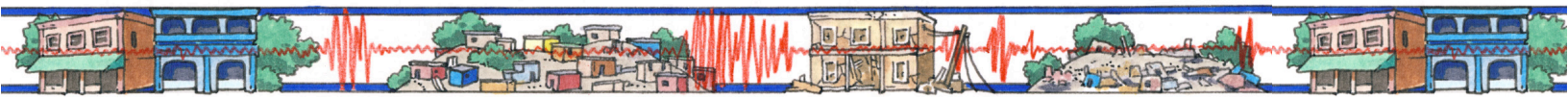
1. Tell kids that India and Jacob sent them a message with more information about what engineers do. Have kids turn to p. 5 of their Engineering Journals to follow along and play track 2. To check for understanding, ask:
   - **India and Jacob said that a technology is anything designed by people to solve a problem. What are some technologies you can think of?** *Accept all answers at this point.*
2. Give the kids about 1 minute to name all the technologies they can think of. If kids are only naming electronics, remind kids that India and Jacob mentioned that things like paper cups are also technology.

Tip: You may want to write down what the kids say is technology, so you can refer back to it at the end of the adventure.

Undercover Detectives (15 min)

1. Explain to kids that now they'll get the chance to think about more technologies—some that might surprise them.
2. Tell kids that under the cover on the table are some objects that might be technologies, or might not. They will use detective skills and teamwork to figure out which objects are technologies and what problems they solve.
3. Split kids into groups of 3-5.
4. Show them the *Technology Detective Tool* and explain they can use it to help figure out if the objects are technologies.
5. Pull the cloth and give groups a minute to decide what object they will take.
6. Have each group choose one object they would like to focus on in their groups.
7. Tell kids that they will now think like an engineer. They will use the *Technology Detective Tool* to decide whether their object is a technology. Then they will imagine ways to improve the object they chose.
8. Have kids open their Engineering Journals to *Engineer It,* p. 6. Give groups about 10 minutes to complete the first three boxes. If groups are struggling, ask:

Tip: If kids are having trouble understanding what it means to engineer something, let them know that words like invent, design, and improve have a similar meaning.The more you use the term engineer, the more comfortable they will become with it!



- **How can you make your technology more fun?**
- **How can you make your technology easier to use?**

Reflect (20 min)

1. Tell kids they are going to present their ideas about their technologies to their fellow detectives. Encourage them to use the *Technology Detective Tool* and *Engineer It* to help them present. Ask each group:
   - **What is your technology?**
   - **How do you know it is a technology?** *Refer to Technology Detective Tool.*
2. After all groups have presented, check for understanding about technology. Ask:
   - **Were all the objects you saw technologies? Why or why not?** *Yes, because people engineered them, and they help solve a problem.*
3. Tell kids you have one more object for them to think about. Show them the rock/leaf. Ask:
   - **Is this a technology? Why or why not?** *No, because a person did not engineer it.*
4. Tell kids that they engineered today by thinking about technologies that already exist and how to improve them. Engineers also think about brand new technologies that no one has thought of before!
5. Have kids think about the engineering they've already done. Ask:
   - **Why do you think the tower you made before was a technology?**
6. Tell kids that in this unit they will be working in groups to engineer technologies that will help solve a problem.
7. Give kids a few moments to complete the last box on *Engineer It.* Thinking about things they might engineer in the future will help kids see themselves as engineers.

Tip: A rock, leaf, or other natural objects on their own are not technologies. If people turn those objects into tools, however, they could become technologies! For example, using a rock to grind corn or making it into an arrow head makes the rock a technology.

Tip: If you have enough time, encourage kids to share their ideas with a partner.

What is Technology? Technology Detectives

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	What is technology?
to	You
	11:23 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.

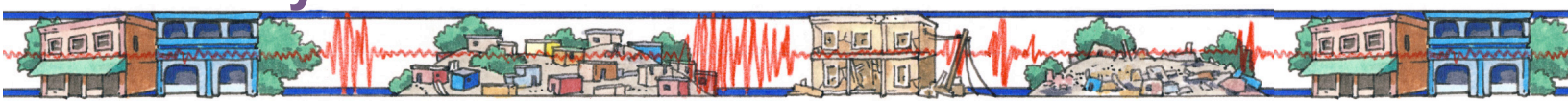
Think about an airplane as an example. An airplane is a technology because people engineered it and it solves the problem of traveling long distances quickly. But something as simple as a paper cup is also a technology. A person engineered it, and it helps people hold drinks without spilling them everywhere.

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

Adventure 1
A Shaky Situation

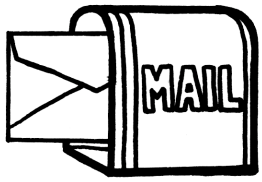
Educator Page: Preview



Overview: Kids will watch a video and read an article about the 2010 earthquake in Haiti. Then they will build a shake table that simulates earthquakes and explore how it works.

Note to Educator: Haiti was struck by a magnitude 7.0 earthquake in January 2010. There was massive destruction partly because of the lack of building codes and the use of unreinforced walls in buildings. As you introduce the earthquake to your kids, be aware that some kids may have experienced a major earthquake and the reminder of that may be disturbing. Consider providing additional support to those kids who need it.

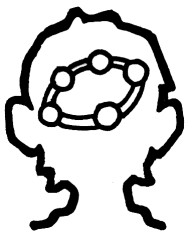
Duo Update (5 min)



Ask (15 min)

Activity (15 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 3 or Eng. Journal p. 7
- ☐ EDP Poster
- ☐ Internet access or *Shake Things Up* DVD and DVD player
- ☐ assorted classroom items (e.g. toys, pencils, bottles of water)

For each group of 3-5 kids:

- ☐ *Magnitude Meter*, p. 21 of this guide
- ☐ index card, 3" x 5"
- ☐ masking tape
- ☐ 2 sheets of foam core board, 8.5" x 11"
- ☐ 2 rubber bands, 7"
- ☐ 4 blocks of self adhesive foam, 1" thick
- ☐ 2 plastic tubes
- ☐ 16 hex nuts, ½"

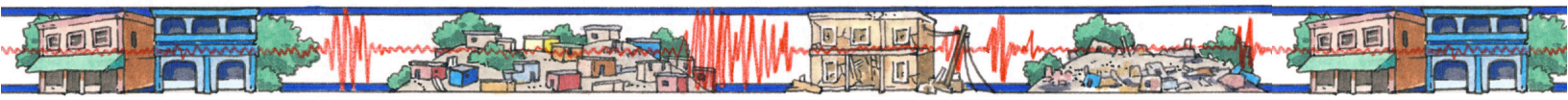
For each kid:

- ☐ Engineering Journal
- ☐ marker

Preparation

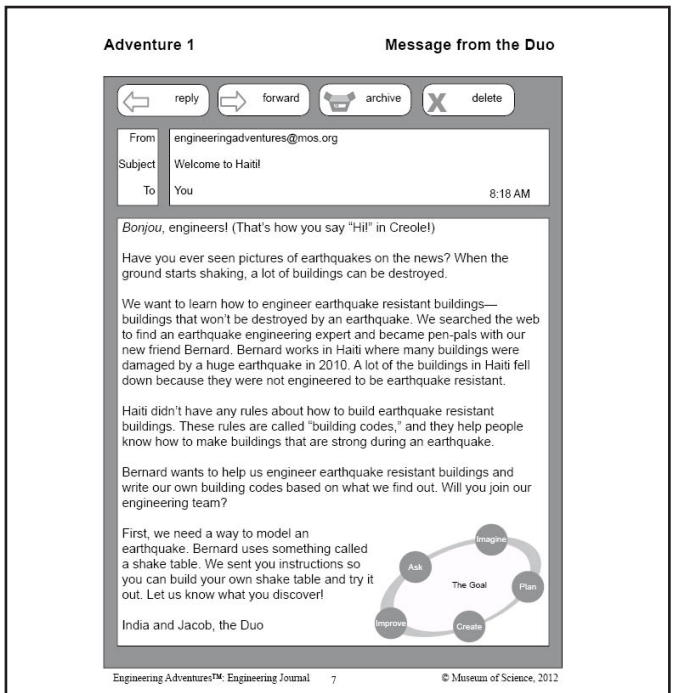
Time Required: 20 minutes

1. Have the *Message from the Duo* ready to share.
2. Load the *Reconstructing Haiti* video on the Engineering Adventures website or queue the DVD.
3. Copy and cut out *Magnitude Meters* for each group of 3 to 5 kids.
4. Tape each *Magnitude Meter* to an index card.
5. For each group of 3 to 5 kids, prepare a stack of the materials listed above (so you can pass them out quickly).



Journal Pages for Adventure 1

Message From the Duo, p. 7



Adventure 1 **Message from the Duo**

reply | forward | archive | delete

From: engineeringadventures@mos.org
Subject: Welcome to Haiti!
To: You 8:18 AM

Bonjou, engineers! (That's how you say "Hi!" in 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.

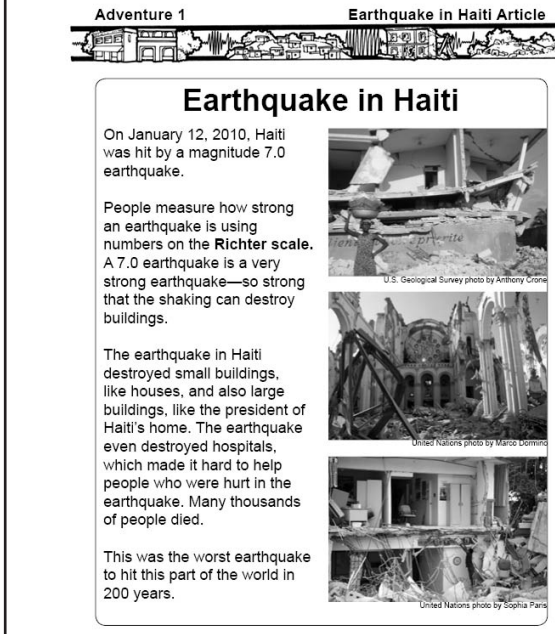
Haiti didn't have any rules about how to build earthquake resistant buildings. These rules are called "building codes," and they help people know how to make buildings that are strong during an earthquake.

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 Article, p. 8



Adventure 1 **Earthquake in Haiti Article**

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 in the earthquake. Many thousands of people died.

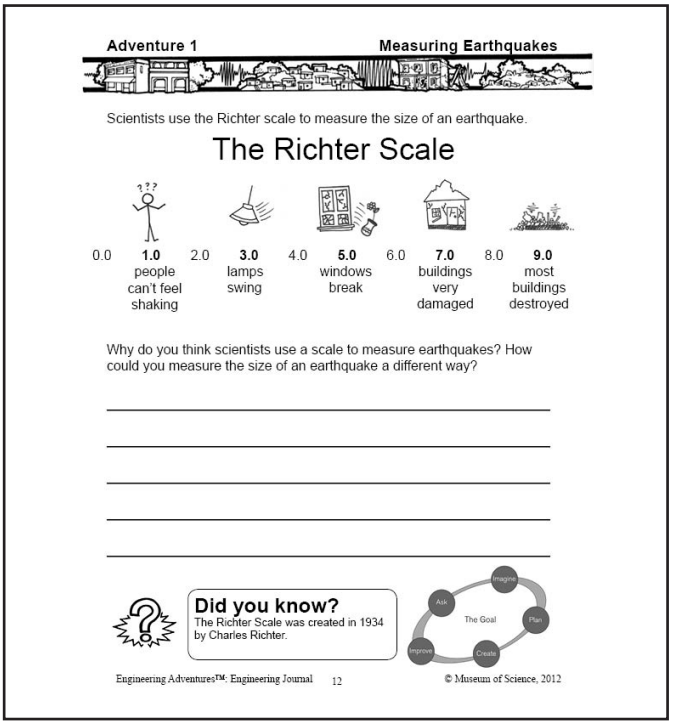
This was the worst earthquake to hit this part of the world in 200 years.

U.S. Geological Survey photo by Anthony Crone

United Nations photo by Marco Dormino

United Nations photo by Sophia Paris

Measuring Earthquakes, p. 9



Adventure 1 **Measuring Earthquakes**

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

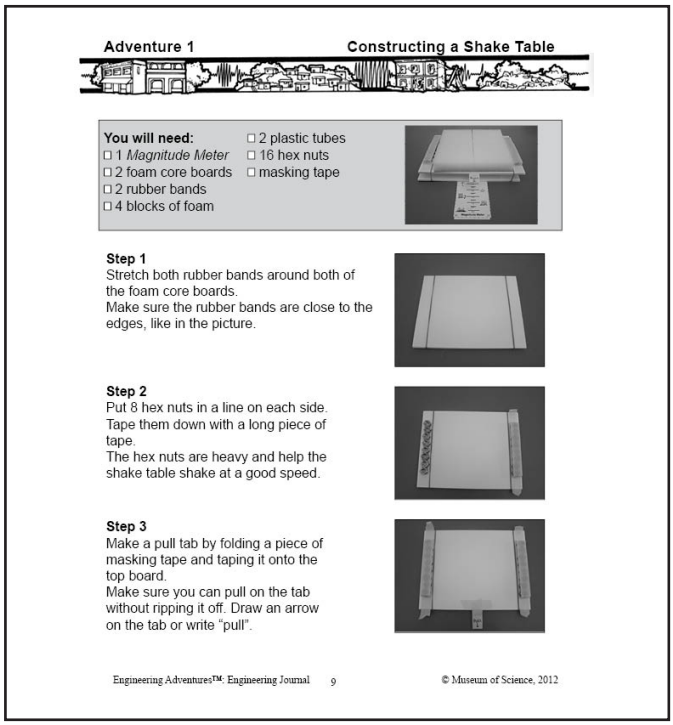
The Richter Scale

0.0	**1.0**	2.0	**3.0**	4.0	**5.0**	6.0	**7.0**	8.0	**9.0**
	people can't feel shaking		lamps swing		windows break		buildings very damaged		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?

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

Constructing a Shake Table, pp. 10-12



Adventure 1 **Constructing a Shake Table**

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

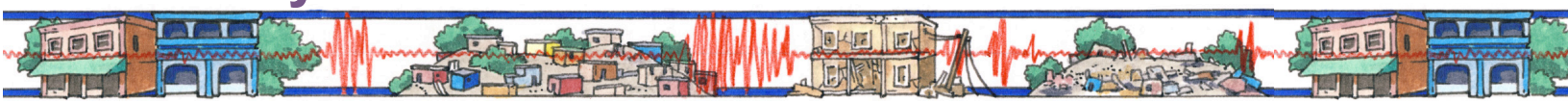
Step 1
Stretch both rubber bands around both of the foam core boards.
Make sure the rubber bands are close to the edges, like in the picture.

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.

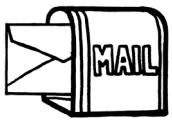
Step 3
Make a pull tab by folding a piece of masking tape and taping it onto the top board.
Make sure you can pull on the tab without ripping it off. Draw an arrow on the tab or write "pull".

Adventure 1
A Shaky Situation

Educator Page: Adventure Guide



Kids will learn:
- the 2010 earthquake in Haiti damaged many buildings that were not earthquake resistant.
- they can use shake tables to model the back and forth motion of an earthquake.



Present the Message From the Duo (5 min)

1. Have kids turn to *Message from the Duo*, p. 7 of their Engineering Journals to read a message from India and Jacob about a big problem they need help solving (track 3).
2. To check for understanding, ask:
   - **What did India and Jacob tell us about buildings that are not earthquake resistant?** *They can fall down during earthquakes.*

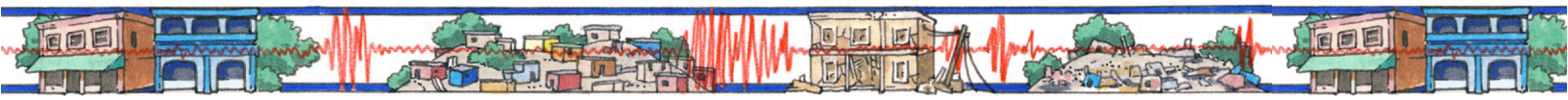
Ask: What do Earthquake Engineers Do? (15 min)

1. Tell kids they are going to watch a video about an earthquake engineer from Haiti.
2. Show kids the video *Reconstructing Haiti.*
3. To check for understanding, ask:
   - **How do you think you would feel if you were Pierre?** *Upset, worried about future earthquakes, motivated to engineer safer buildings, etc.*
   - **Why do you think earthquake engineering is important?** *People can get hurt if their buildings are not earthquake resistant.*
4. Have kids read *Earthquake in Haiti Article*, p. 8, and look at the photos (or do this as a read-aloud).
5. To check for understanding, ask:
   - **What types of buildings were destroyed in the earthquake?** *Small buildings like houses, and larger buildings like the president's house and hospitals.*
   - **As earthquake engineers, what can we can do to prevent this from happening again?** *Engineer earthquake resistant buildings.*

Make a Shake Table (15 min)

1. Tell kids they will make shake tables to help them model earthquakes of different strengths. They can use these shake tables to test the buildings they will engineer.
2. Walk through *Measuring Earthquakes,* p. 9. Tell kids that the magnitude, or strength, of earthquakes is measured on the Richter scale.

Tip: Challenge kids to create different sizes of earthquakes by shaking pieces of foam core board with their hands before they build their shake tables. How would a gentle tremor be different from a massive earthquake?

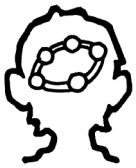


3. Walk through *Constructing a Shake Table*, pp. 10-12.
4. Place kids in groups of 3 to 5 and pass out their shake table materials. Each group should make one shake table using the directions.
5. Demonstrate how to use the shake table by holding down the bottom board, pulling back the tab on the top board to the desired magnitude, and letting go.
6. Let kids experiment for several minutes by putting approved objects from the room on their shake tables and observing what happens at different magnitutes.

Tip: Objects may fly off shake tables. Use caution.

See it!: Download the iPhone app iSeismometer to gather real-time data of the shaking motion!

Tip: Try using a large binder clip to attach the shake tables to a table or chair.



Reflect (10 min)

1. Gather kids around the Engineering Design Process poster and have them reflect on their findings. Ask questions like:
   - **What did you notice when you shook items on the shake table?**
   - **What difference did you see between a small magnitude earthquake and a large magnitude earthquake?**
   - **How do you think you will use the steps of the Engineering Design Process to engineer an earthquake resistant building?** *Ask about how to make buildings earthquake resistant, Imagine ideas, Plan designs, Create and test them, Improve them, etc.*
2. Tell kids that for the rest of this unit, they will be earthquake engineers. They will engineer a model building that can withstand a 7.0 earthquake on the shake table. They will also write building codes so that others can learn how to build an earthquake resistant building.
3. Give kids time to record thoughts on *Measuring Earthquakes*, p. 9. Having kids record their ideas will help them remember what they learned and apply it in the next adventure.

Message from the Duo

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Welcome to Haiti!
to	You
	8:18 AM

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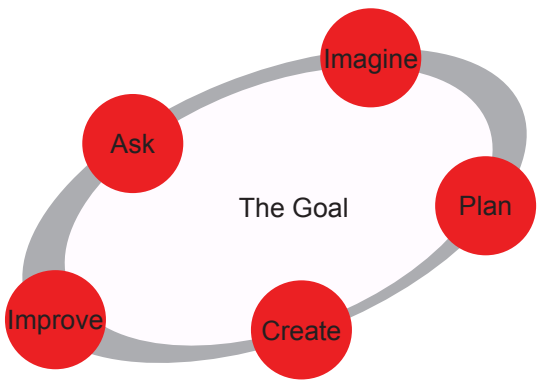
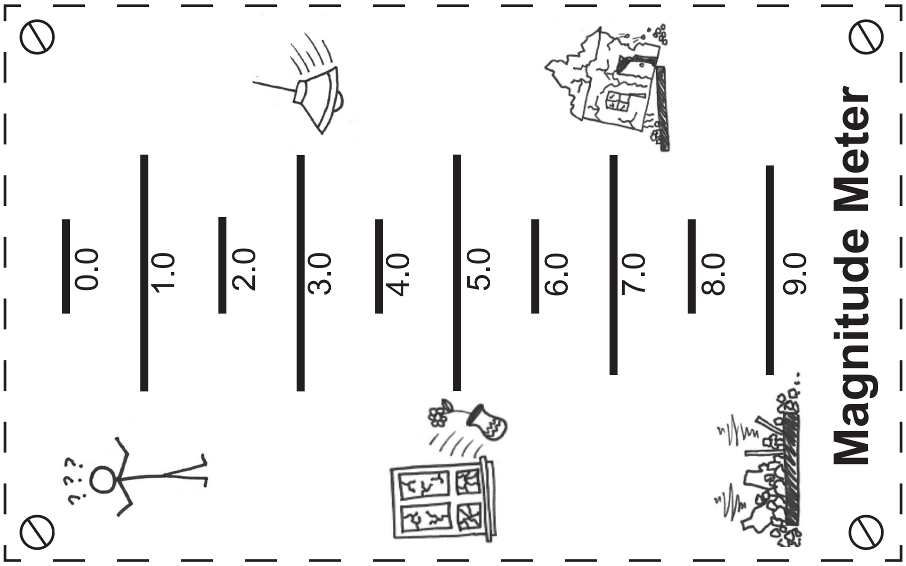
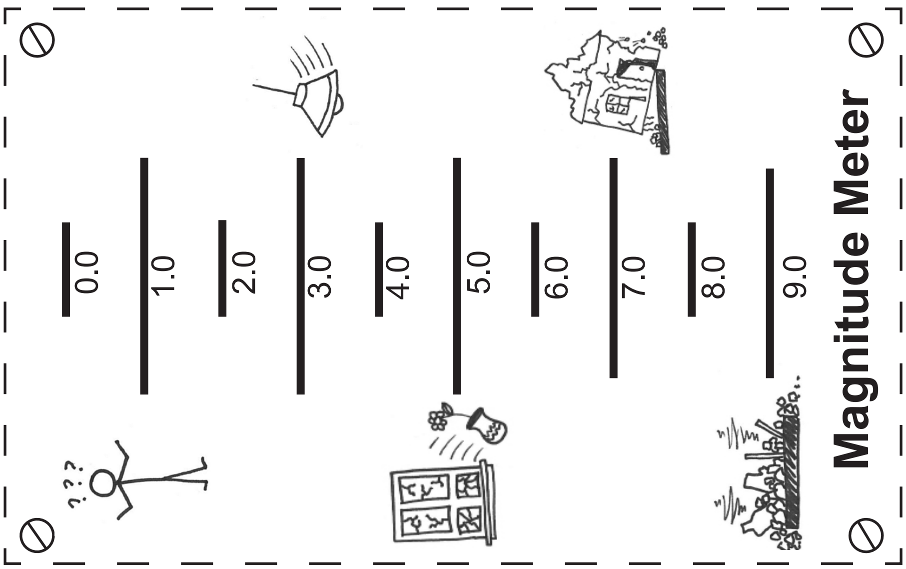
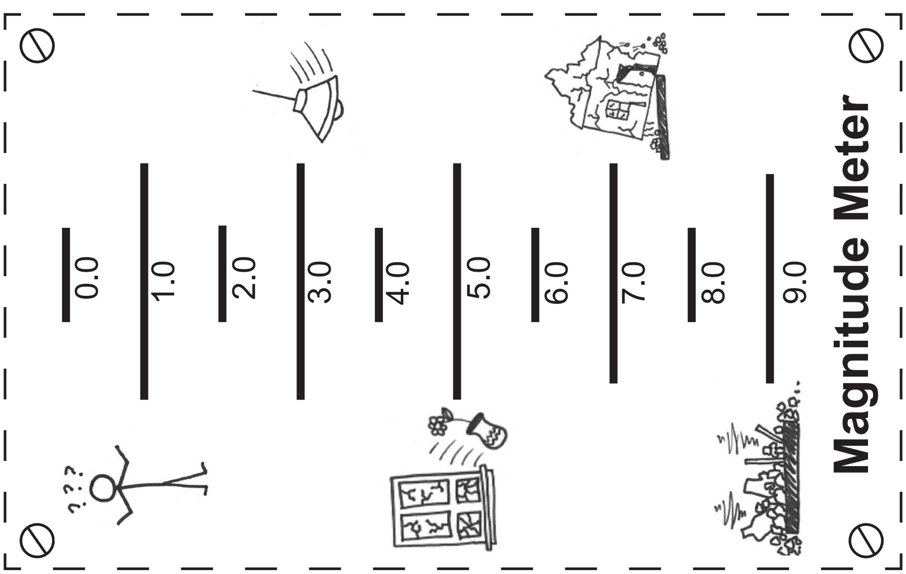


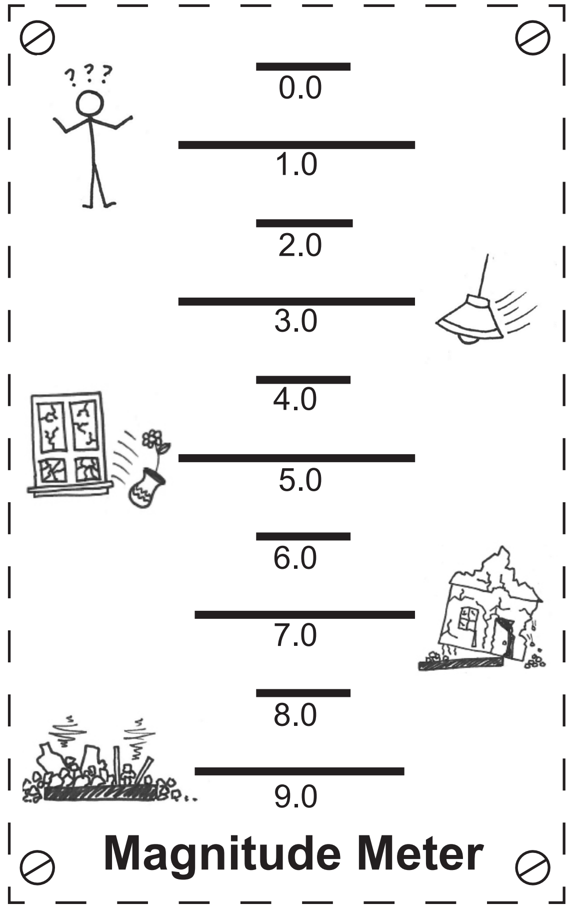
India and Jacob, the Duo

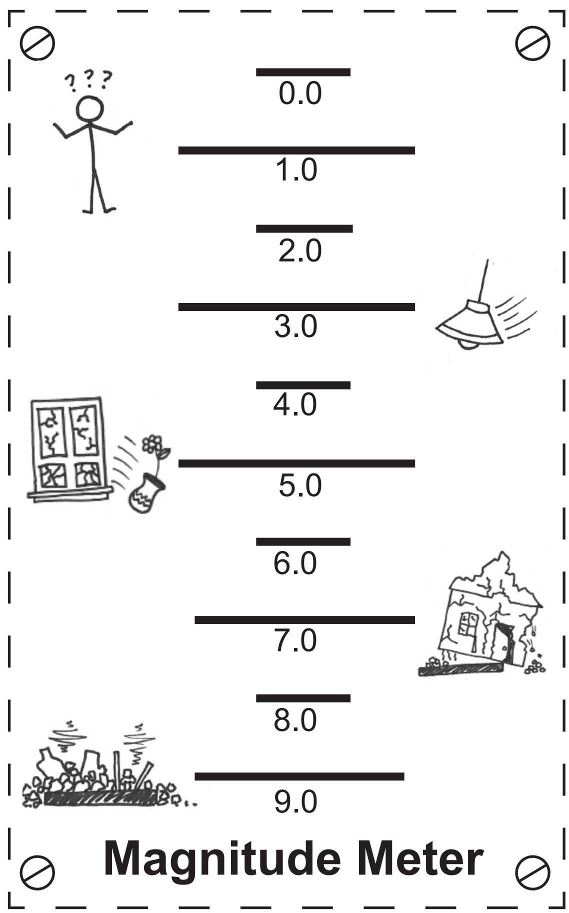
Cut out one *Magnitude Meter* for each group.





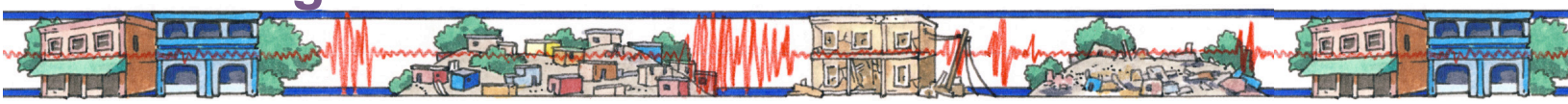






Adventure 2
Building Skeletons

Educator Page: Preview

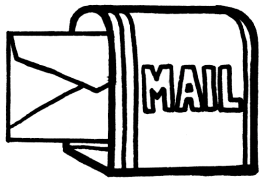


Overview: Kids make building units, then stack them up to create model buildings. They use the shake table to determine which shape and size buildings best withstand earthquakes.

Note to Educator: Even though kids are focusing on model buildings in this unit, the thought processes they're using and the problems they are thinking about are the same as the ones earthquake engineers use and think about when working with real buildings.

Save the building units and Building Codes Chart for kids to use in later adventures!

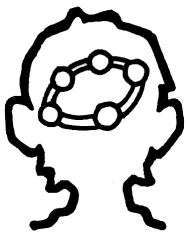
Duo Update (5 min)



Ask (5 min)

Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 4 or Engineering Journal p. 13
- ☐ EDP Poster

For each group of 3-5 kids:

- ☐ masking tape
- ☐ shake table
- ☐ 15-20 paperclips

For each kid:

- ☐ Engineering Journal
- ☐ 2 index cards
- ☐ 4 coffee stirrers (see below for preparation)
- ☐ 4 pipe cleaners (see below for preparation)

Preparation

Time Required: 20 minutes

1. Have the *Message from the Duo* ready to share.
2. Make the *Building Codes Chart* (see p. 24 for details).
3. Set up a Materials Store with the index cards, pipe cleaners, coffee stirrers, tape, and scissors.
4. Prepare the materials by sliding a pipe cleaner into each coffee stirrer. Prepare four of these for each kid.
5. Optional: Make an example building unit.

Journal Pages and Chart for Adventure 2

Message From the Duo, p. 13

Adventure 2 **Message from the Duo**

reply | forward | archive | delete

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 our building designs.

Bernard says we should start by making a skeleton for our building. He says strong 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 called 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 during an earthquake. When we're done, we can write a building code about it so people will know what shapes and sizes are safest.

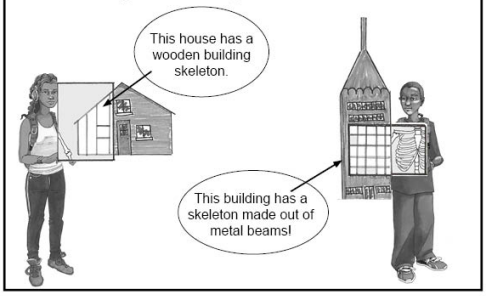
Let me know how it goes!

India

Building X-Rays, p. 14

Adventure 2 **Building X-Rays**

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



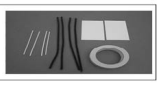
Your Turn to Ask

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

Constructing a Unit, p. 15

Adventure 2 **Constructing a Building Unit**

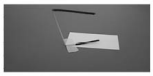
You will need:
- ☐ 4 pipe cleaners
- ☐ 4 coffee stirrers
- ☐ 2 index cards
- ☐ tape



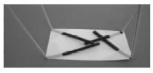
Step 1
Push each pipe cleaner into one coffee stirrer.

Step 2
Fold over the ends of the pipe cleaner.

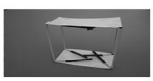
Step 3
Tape the pipe cleaner to the corner of an index card. Tape as close to the corner as you can.



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!



Buildings Big and Small, p. 16

Adventure 2 **Buildings Big and Small**

Stack your units up to make building skeletons.

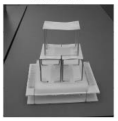
Test them at different magnitudes to find out what sizes and shapes are strongest.

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.

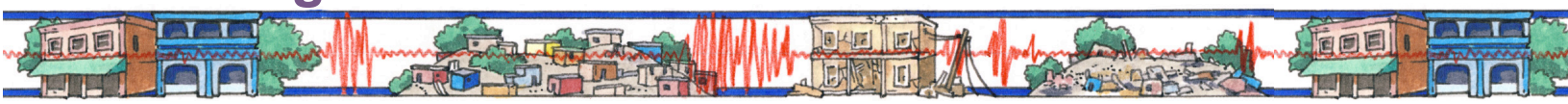
What other shapes and sizes do you want to test? Try them out with your group!

Building Codes Chart

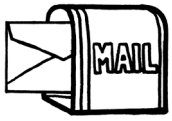
Our model building codes are:

Adventure 2
Building Skeletons

Educator Page: Adventure Guide



Kids will learn:
- their model buildings are made of units that act like a skeleton to support the building.
- they can arrange building units in different ways to affect how stable the entire building is in an earthquake.



Present the Message From the Duo (5 min)

1. Have kids turn to p. 13 of their Engineering Journals to find a message from India (track 4). India has some ideas about how to get started engineering an earthquake resistant building.
2. To check for understanding, ask:
   - **What is India asking you to do?** *Make building units, then stack them up to make building skeletons. Use the shake table to figure out what shapes and sizes are strongest during an earthquake.*
   - **What steps of the Engineering Design Process will you use?** *Ask about building skeletons in other buildings, Imagine ways to stack our units to make building skeletons.*

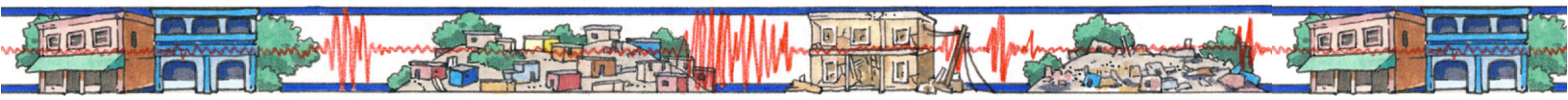
Ask: What's on the Inside? (5 min)

1. Remind kids that India said many buildings have strong skeletons inside them that people can't see. Ask:
   - **What are some parts of buildings you've heard of?** *Walls, beams, foundations, windows, doors.*
   - **Which parts do you think help a building stay strong during an earthquake? Why do you think so?** *Encourage all responses.*
2. Show kids the pictures India sent along using *Building X-Rays*, p. 14. Ask:
   - **What do you see inside the two buildings in the picture?** *Beams and supports. Kids might also say a skeleton.*
   - **Why do you think these building skeletons help support the buildings in an earthquake?** *They are a strong skeleton that everything else is connected to, making everything stronger in an earthquake.*

Build a Skeleton (15 min)

1. Tell kids that they will each make a building unit that they can stack up in order to make a complete building skeleton to test on the shake table.
2. Each kid should put together one unit. Have kids turn to *Constructing a Building Unit*, p. 15, for directions. Kids can get their materials from the Materials Store. Encourage kids to help each other!

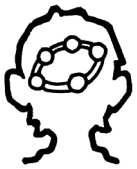
Tip: Ask kids why they think there are coffee stirrers around the pipe cleaners (for extra strength). Kids can use this idea to strengthen other parts of their building units later on.



Test It Out (10 min)

1. Tell kids it's time to figure out what shapes and sizes of building skeletons are strongest in an earthquake.
2. Have kids form groups of 3 to 5. Pass out a shake table and paperclips to each group. They can use the paperclips to attach building units together.
3. Groups can arrange their building units to make building skeletons that are different shapes and sizes. Encourage groups to test several ideas on their shake table. If kids get stuck, they can use *Buildings Big and Small*, p. 16, as an example.

Tip: Kids will notice that the building units aren't very strong. They fall off the shake table and collapse easily. Tell kids they will engineer solutions to these problems later on. For now, kids may use masking tape to attach their building skeleton to the shake table in order to test different sizes and shapes.



Reflect (10 min)

1. Remind kids that India wants them to use what they found out today to write a building code that will teach others what shape and size building skeletons best survived the earthquake.
2. Show kids the Building Codes chart. Tell kids they will keep track of what is working well in their model buildings on this chart as they move through the unit. Ask:
   - **What shapes and sizes did you try that best survived the earthquakes? Why do you think so?**
   - **Based on this, what do you want your building code to say?** *The building code should refer to something kids found out today about shape and size. For example, if kids found that short building skeletons are safest during an earthquake, their building code could read, "Building skeletons should be as short as possible."*
3. Write the building code on the *Building Codes Chart*. Keep this chart to use later in the unit! Ask:
   - **How could you use these ideas to engineer real buildings that need to survive during an earthquake?** *Accept all responses.*
4. Gather kids around the Engineering Design Process poster. Ask:
   - **What steps of the Engineering Design Process did you use today? How did these steps help you?** *Possible responses include: Ask about building skeletons, Imagine possible skeletons, Create building skeletons.*
5. Give kids time to record their thoughts on *Building X-Rays*, p. 14. Having kids record their ideas will help them remember what they learned and apply it in the next adventure.

Message from the Duo

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

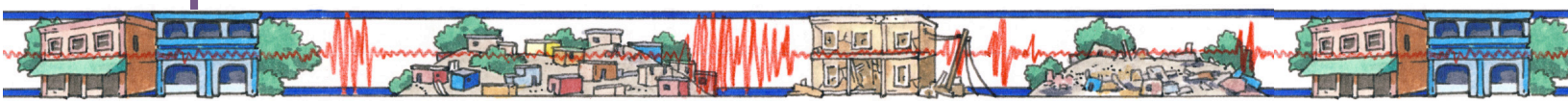
Let's use the Ask step of the Engineering Design Process to ask questions about what shape and size skeleton is the strongest. When we're done, we will write a building code about it so people know what shapes and sizes are good choices.

Let me know how it goes!

India

Adventure 3
Stop the Slide

Educator Page: Preview

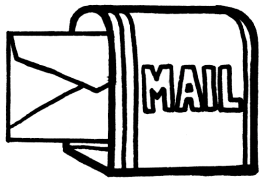


Overview: Kids work in groups to experiment with ways to stop their building units from sliding.

Note to Educator: This adventure can be combined with the next adventure, in which kids engineer ways to stop their building units from shearing during an earthquake. If you have additional time, consider combining these two adventures.

Save the building units and Building Codes Chart for kids to use in later adventures!

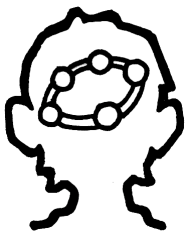
Duo Update (5 min)



Ask (5 min)

Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 5 or Engineering Journal p. 17
- ☐ *Building Codes Chart* from the previous adventure
- ☐ EDP Poster
- ☐ 50 brass fasteners
- ☐ box of paper clips
- ☐ box of toothpicks
- ☐ roll of string

For each group of 3-5 kids:

- ☐ building unit
- ☐ scissors
- ☐ shake table

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 10 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Building Codes Chart* (see p. 30 for details).
3. Cut an approximately 12 inch piece of string for each group.
4. Set up a Materials Store with toothpicks, brass fasteners, string, and paper clips.

Journal Pages and Chart for Adventure 3

Message From the Duo, p. 17

Adventure 3 **Message from the Duo**

reply | forward | archive | delete

From	engineeringadventures@mos.org
Subject	Building from the Bottom Up
To	You

9:57 AM

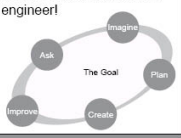
Hey engineers,

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.

We used tape to attach the building units to our shake table last time, but Bernard pointed out that in a real building, tape would never work. Think about it: can you imagine taping a building to the grass or the dirt? We need to think of new ways to attach our units to the ground so they won't slide around during an earthquake.

We sent you some materials so you can engineer your own technologies to solve this problem. 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. Create and test some different ideas and let us know what you engineer!

Jacob



Engineering Adventures™: Engineering Journal 17 © Museum of Science, 2012

Testing Building Bottoms, p. 18

Adventure 3 **Testing Building Bottoms**

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

What materials did you use?

Test your building at a 7.0 magnitude.

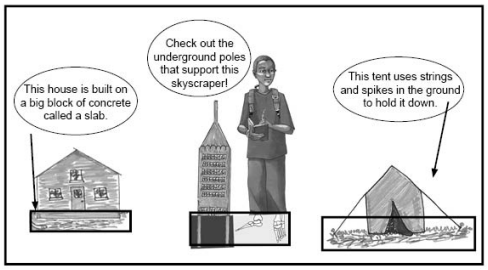
Watch your building carefully. Circle what happens when you test it.

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

Engineering Adventures™: Engineering Journal 18 © Museum of Science, 2012

Building Bottom X-Rays, p. 19

Adventure 3 **Building Bottom X-Rays**



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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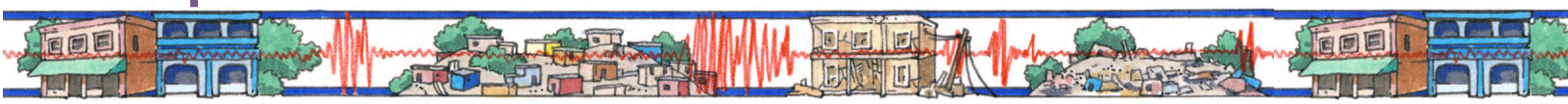
Building Codes Chart (from Adv 2)

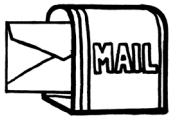
Our model building codes are:

Adventure 3
Stop the Slide

Educator Page: Adventure Guide



Kids will learn:
- they can engineer many ways to stop the building units from sliding during an earthquake.



Present the Message From the Duo (5 min)

1. Have kids turn to p. 17 of their Engineering Journals and read the message from Jacob (track 5). Jacob wants them to engineer ways to keep their building units from sliding during an earthquake.
2. To check for understanding, ask:
   - **What is Jacob asking you to do?** *We need to figure out how to attach our building units to the ground.*
   - **What steps of the Engineering Design Process will help you?** *We can Ask, Imagine, Create, and Improve if we need to.*

Ask and Imagine: How to Stop the Slide? (5 min)

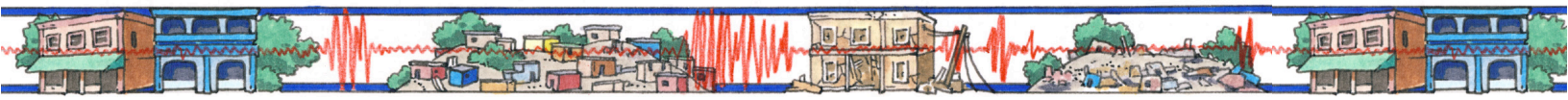
1. Remind kids that Jacob said the units slid right off the shake table. Have one group demonstrate this by placing one unit on a shake table and testing at increasing magnitudes until the unit slides off the shake table.
2. Have kids get into groups of 3 to 5 and give each group a building unit, a piece of string, a toothpick, a paperclip, and a brass fastener.
3. To get kids thinking, ask:
   - **How do you think you could use these materials to make sure your units don't slide during an earthquake?** *Challenge kids to come up with as many ideas as possible. Encourage them to discuss the pros and cons of each idea and material.*
4. Tell kids their goal is to figure out how to stop their building module from sliding during a magnitude 7.0 earthquake, like the one in Haiti.

Try it Out: Plan and Create (25 min)

1. Give kids 5 minutes to plan. Challenge kids to come up with a plan using the fewest materials possible. Later on in the unit, kids will work within a budget, so it is good practice to start using fewer materials now.
2. Send one member of each group to gather materials and a shake table.
3. Give kids 20 minutes to create and test their designs at magnitude 7.0.
4. Kids should record what they find on *Testing Building Bottoms*, p. 18.

Reflect (10 min)

1. Have kids look at *Building Bottom X-Rays*, p. 19. To get kids talking about their designs, ask:
   - **What is the same about these drawings and the ideas you tried?**
   - **What stopped your unit from sliding? Why did that work well?**



2. Remind kids that Jacob wants them to use what they found out today to write a building code that will teach others how to stop building units from sliding.
3. Ask:
   - **What do you want your building code to say?** *The building code should refer to something kids found out today. For example, if kids found that toothpicks worked well to attach their building unit to the shake table, their building code could read, "Building units should be attached to the ground with toothpicks."*
   - **How do you think you could use these ideas to stop real buildings from sliding during an earthquake?** *Accept all responses.*
4. Write the building code on the *Building Codes Chart*. Keep this chart to use later in the unit.
5. Gather kids around the Engineering Design Process poster. Ask:
   - **What steps of the Engineering Design Process did you use today? How did these steps help you?**
6. Give kids time to record their thoughts on *Building Bottom X-Rays*, p. 19. Having kids record their ideas will help them remember what they learned and apply it in the next adventure.

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Building from the Bottom Up
to	You
	9:57 AM

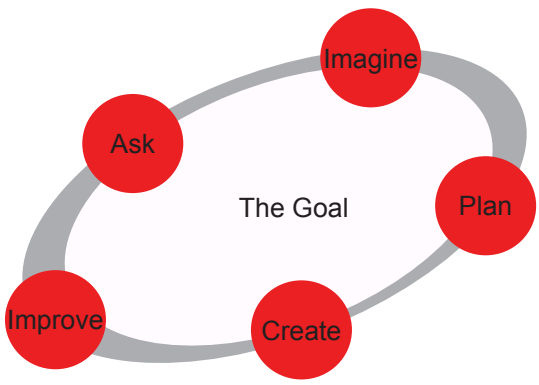
Hey engineers,

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.

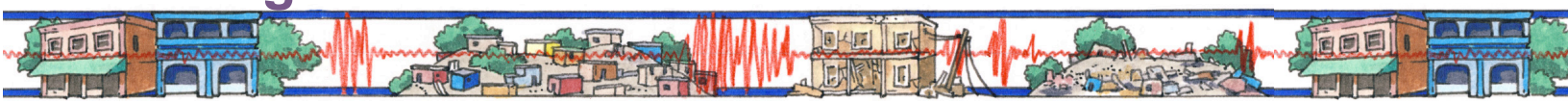
Once you figure out an idea that works well, write a building code about it and send it to us, so we can see what you're working on!

Jacob



Adventure 4
Getting Braces

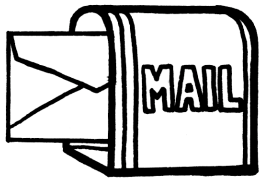
Educator Page: Preview



Overview: Kids will engineer a way to prevent their buildings from shearing.

Note to Educator: The side-to-side motion of an earthquake can cause the top and bottom of a building to move in different directions, causing damage. This damaging force is called shear. Earthquake engineers can minimize the impact of shear on buildings by reinforcing them with braces.

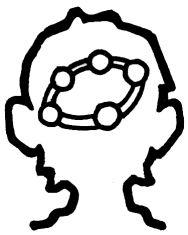
Duo Update (5 min)



Ask (5 min)

Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 6 or Eng. Journal p. 20
- ☐ *Building Codes Chart* from the previous adventure
- ☐ EDP poster
- ☐ box of toothpicks
- ☐ roll of string
- ☐ 30 medium binder clips
- ☐ 100 brass fasteners
- ☐ 100 coffee stirrers
- ☐ 100 paper clips
- ☐ 100 pipe cleaners
- ☐ 100 straws

For each group of 3-5 kids:

- ☐ several building units
- ☐ marker
- ☐ ruler
- ☐ shake table

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 15 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Building Codes Chart* (see p. 36 for details).
3. Cut an approximately 12 inch piece of string for each group.
4. Set up a Materials Store with all materials for the entire group.

Journal Pages and Chart for Adventure 4

Message From the Duo, p. 20

Adventure 4 **Message from the Duo**

reply | forward | archive | delete

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 this happens because the bottom moves fast and the top can't keep up. This 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 so that other people can use our ideas to make new buildings safer. It's a challenge, but I think you're up to it.

Good luck!

India

Testing Braces, p. 21

Adventure 4 **Testing Braces**

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

What materials did you use?

Test your building at a 7.0 magnitude.

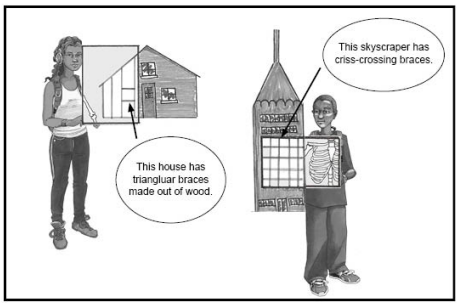
Watch your building carefully. Circle what happens when you test it.

slides | tips or falls | shears | nothing

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

Brace X-Rays, p. 22

Adventure 4 **Brace X-Rays**



Think About It

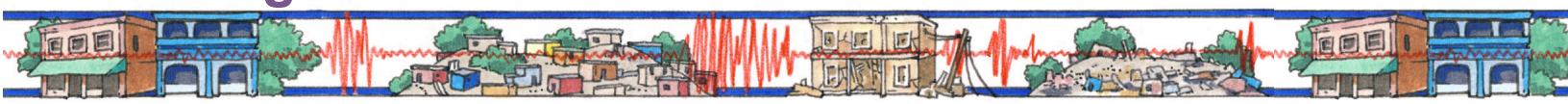
Would you like to be an earthquake engineer? Explain your choice.

Building Codes Chart (from Adv 3)

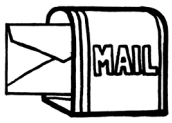
Our model building codes are:

Adventure 4
Getting Braces

Educator Page: Adventure Guide



Kids will learn:
- there are many different ways to engineer braces to strengthen the building units.



Present the Message From the Duo (5 min)

1. Have kids turn to p. 20 of their Engineering Journals to read the next message from India (track 6). Today India wants them to experiment with ways to brace the walls of their structure.
2. To check for understanding, ask:
   - **What does India want us to do?** *Find a way to stop the building units from shearing and write a building code about it.*

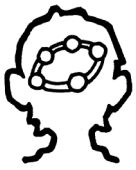
Ask: What Materials are Strong? (5 min)

1. Have kids get into groups of 3 to 5 and give each a building unit, a toothpick, a piece of string, a coffee stirrer, a pipe cleaner, a straw, and a brass fastener.
2. To get kids thinking, ask:
   - **How do you think you could use these materials to make sure your building unit doesn't shear during an earthquake?** *Challenge kids to come up with as many ideas as possible. Encourage them to discuss the pros and cons of each idea and material.*

Create: Stop the Shear (25 min)

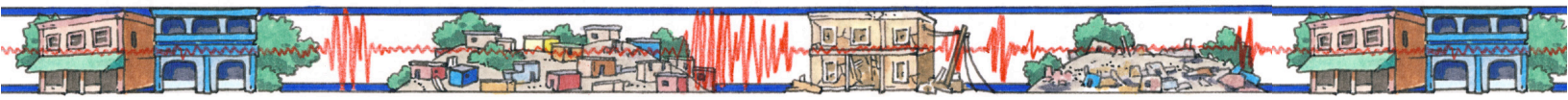
1. Tell kids that their goal is to design a technology that stops the building units from shearing during a 7.0 magnitude earthquake, like the one in Haiti.
2. Challenge kids to stop the shear using ten materials or less. Each item at the Materials Store counts as one material.
3. Have one member from each group collect a shake table and the materials they need.
4. Kids should create and test their designs at a 7.0 magnitude earthquake.
5. Kids should record what they find on *Testing Braces*, p. 21.

Tip: For materials like string and tape that come in a roll, one foot of each counts as one item from the store.



Reflect (10 min)

1. Have kids look at *Brace X-Rays*, p. 22. To get kids talking about their designs, ask:
   - **What is the same about these drawings and the ideas you tried?**
   - **What ideas did you try that stopped your unit from shearing? Why do you think that works well?** *Allow groups to share their designs, and*



demonstrate using their shake tables.

2. Remind kids that India wants them to use what they found out today to write a building code that will teach others how to stop the shear. Ask:
   - **What do you want our building code to say?** *The building code should refer to something kids found out today. For example, if kids found that tying string around the building unit worked well to stop the shear, their building code could read, "Wrap string around each building unit."*
3. Write the building code on the *Building Codes Chart*. Keep this chart to use later in the unit. Ask:
   - **How could you use these ideas to engineer real buildings that won't shear during an earthquake?** *Accept all responses.*
4. Gather kids around the Engineering Design Process poster. Ask:
   - **What steps of the Engineering Design Process did you use today? How did these steps help you?**
5. Give kids time to record their thoughts on *Brace X-Rays*, p. 22. Having kids record their ideas will help them remember what they learned and apply it in the next adventure.
6. Let kids know that next time, they will be engineering a new building from scratch. They will use all of their expertise in earthquake engineering to make sure the building they engineer is earthquake resistant.

Message from the Duo

reply | forward | archive | delete

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!

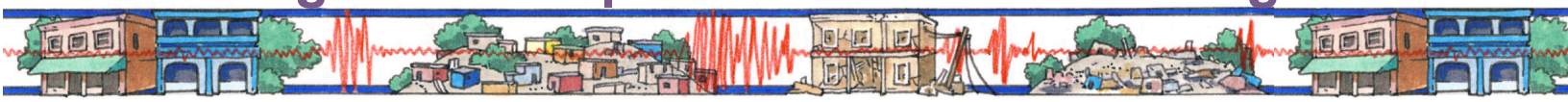
How can we engineer a way to stop the shear during an earthquake? Jacob and I are going to use the Engineering Design Process to help us Imagine, Plan, Create, and test some technologies that we think will stop the shear. Then, we'll write a building code about what we find out.

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

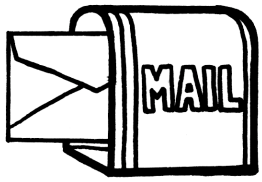
Adventure 5 Educator Page: Preview
Creating an Earthquake Resistant Building



Overview: Kids will work in groups to engineer a model earthquake resistant building that can withstand a 7.0 magnitude earthquake.

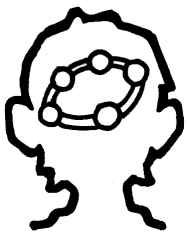
Note to Educator: **Be sure to save the buildings each group engineers for Adventures 6 and 7!**

Duo Update (5 min)



Activity (30 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 7 or Eng. Journal p. 23
- ☐ *Building Codes Chart* from the previous adventure
- ☐ EDP Poster
- ☐ masking tape
- ☐ roll of string
- ☐ 8 rulers
- ☐ 100 coffee stirrers
- ☐ 100 craft sticks
- ☐ 100 index cards
- ☐ 100 pipe cleaners
- ☐ 100 straws
- ☐ 100 toothpicks
- ☐ 200 brass fasteners
- ☐ 200 paper clips, #1 size

For each group of 3-5 kids:

- ☐ building units
- ☐ scissors
- ☐ shake table

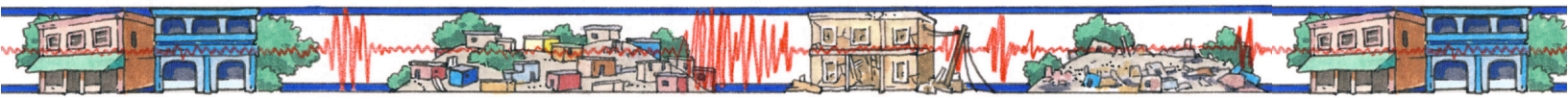
For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 20 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Building Codes Chart* (see p. 42 for details).
3. Set up a Materials Store with materials for the entire group.
4. Clear the shake tables of designs from previous adventures.
5. Prepare extra building units, as each group will need several.



Journal Pages and Chart for Adventure 5

Message From the Duo, p. 23

Adventure 5 **Message from the Duo**

reply | forward | archive | delete

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 an entire earthquake resistant building! Our 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. Then we can plan our design, just like an engineer would. We will use the Plan step of the Engineering Design Process to help us design our technology. Then we will be ready to Create and test!

Let us know how it goes!

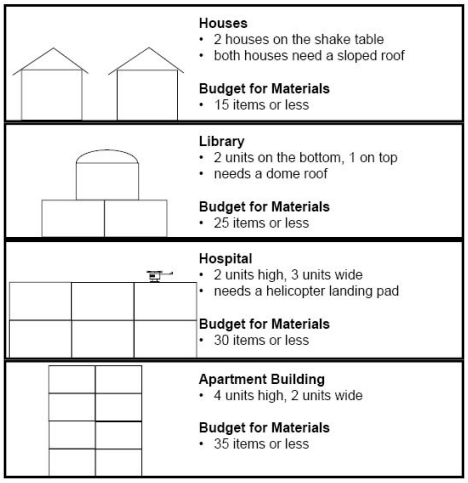
Jacob

Choose Your Building, p. 24

Adventure 5 **Choose Your Building**

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.



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 dome roof

Budget for Materials
- 25 items or less

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

Budget for Materials
- 30 items or less

Apartment Building
- 4 units high, 2 units wide

Budget for Materials
- 35 items or less

Plan and Test, p. 25

Adventure 5 **Plan and Test**

What building are you engineering? _____

What is your budget? _____ materials.

Draw a plan for your building.

How many of each material will you use?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Test your building at a 7.0 magnitude.

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

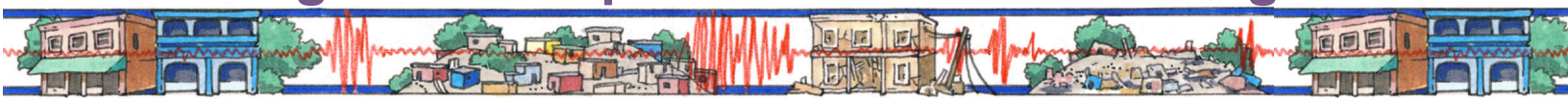
slides | tips or falls | shears | nothing

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

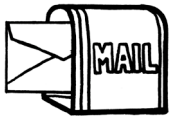
Building Codes Chart (from Adv 4)

Our model building codes are:

Adventure 5 Educator Page: Adventure Guide
Creating an Earthquake Resistant Building



Kids will learn:
- the Plan step of the Engineering Design Process can help them figure out what materials they need before building.
- they can use the Engineering Design Process to design technologies to solve problems.



Present the Message From the Duo (5 min)

1. Tell kids Jacob wants them to use all of their engineering skills to engineer their final model earthquake resistant building. Have kids turn to p. 23 of their Engineering Journals and read the message from Jacob (track 7).
2. To check for understanding, ask:
   - **What is Jacob asking you to do?** *He wants us to engineer a model building that will withstand a 7.0 magnitude earthquake. We also have to follow our building codes.*
   - **Which steps of the Engineering Design Process to you think will be the most helpful?** *The Plan, Create, and Improve steps.*

Plan (10 min)

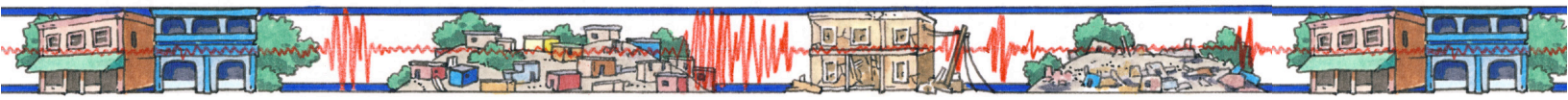
1. Tell kids that just like India and Jacob, they will use their building codes to make a plan for how they will create their building.
2. Walk kids through *Choose Your Building*, p. 24. Point out that each building has certain rules they must follow, along with a budget limiting the number of materials they can use. Groups can choose to engineer one of these buildings, or they can design their own.
3. Point out the posted *Building Codes Chart*. Tell kids that they should try to follow these rules as they engineer their building, to make sure it is earthquake resistant.
4. Have kids work in groups to draw and label their design on *Plan and Test*, p. 25. Groups should show you their plan before collecting materials at the Material Store.

Tip: For materials like string and tape that come in a roll, one foot of each counts as one item from the store.

Tip: Check to see if kids understand the budget rules. Ask: Could I use 10 straws, two feet of tape, and six clips to build my houses? *NO! That's 18 items, and you can only use 15 for the houses.*

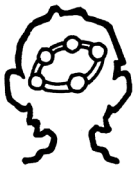
Create (20 min)

1. Give kids 20 minutes to create their buildings. Kids may need to make more building units, if there are not enough to go around.
2. Let kids know that they can exchange materials they are not using, but that they may not go over their materials budget.
3. As kids are test their structures, have them record their results on *Plan and*



Test, p. 25.

4. As kids create, ask:
   - **Can you tell me about your design?**
   - **What step of the Engineering Design Process are you using right now? How do you know?**



Reflect (10 min)

1. Bring kids together and have them share what they've worked on. As each group shares their designs, ask questions like:
   - **What did you do to make your model building earthquake resistant?**
   - **Do you think your design is working well? How do you know?**
   - **What would you like to improve for next time?**
2. Review the *Building Codes Chart*. Ask:
   - **Based on what you just did, are there any building codes you want to change?**
   - **Are there any new building codes you want to add?**
3. Gather kids around the Engineering Design Process poster. Ask:
   - **What steps of the Engineering Design Process did you use today? How did these steps help you?**
4. Give kids time to complete *Plan and Test*, p. 25. Having kids record their ideas will help them remember what they learned and apply it as they improve their designs in the next adventure.

Creating an Earthquake Resistant Building

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Ready, Set, Engineer!
to	You
	12:12 PM

Hey engineers!

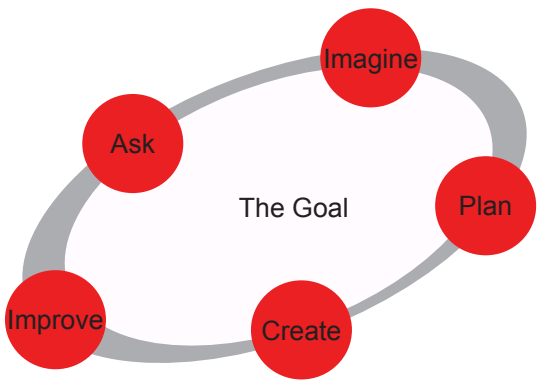
Now that we've practiced making our building units earthquake resistant, Bernard has challenged us to engineer a model of an entire earthquake resistant building! Our model buildings need to survive at least a 7.0 magnitude earthquake, like the one that hit Haiti in 2010.

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.

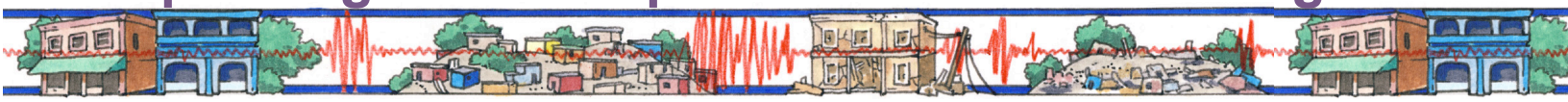
We wanted to start creating right away, but Bernard reminded us that we need to make sure we're following our building codes. We will use the Plan step of the Engineering Design Process to help us design our technology according to our building codes. Then we will be ready to Create and test!

Let us know how it goes!

Jacob



Adventure 6 Educator Page: Preview
Improving an Earthquake Resistant Building

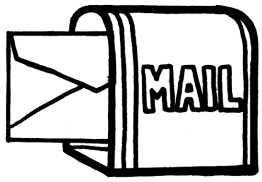


Overview: Kids will work in groups to improve their model buildings and finalize their building codes.

Note to Educator: Consider giving kids extra time to Improve their buildings if you have the flexibility to do so.

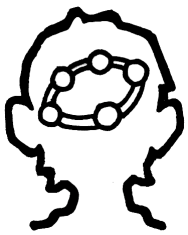
Be sure to save the buildings for the showcase in Adventure 7!

Duo Update (5 min)



Activity (30 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 8 or Eng. Journal p. 26
- ☐ *Building Codes Chart* from the previous adventure
- ☐ EDP Poster
- ☐ chart paper and marker

Materials Store (remaining materials from Adv. 5):

- ☐ masking tape
- ☐ roll of string
- ☐ 100 coffee stirrers
- ☐ 100 craft sticks
- ☐ 100 index cards
- ☐ 100 pipe cleaners
- ☐ 100 straws
- ☐ 100 toothpicks
- ☐ 200 brass fasteners
- ☐ 200 paper clips, #1 size

For each group of 3-5 kids:

- ☐ building units
- ☐ scissors
- ☐ shake table

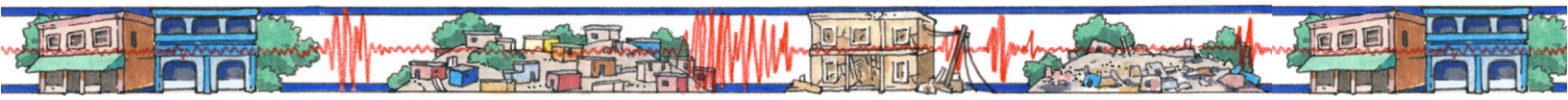
For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 15 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Building Codes Chart* (see p. 48 for details).
3. Set up a Materials Store with materials for the entire group.



Journal Pages and Chart for Adventure 6

Message From the Duo, p. 26

Adventure 6 **Message from the Duo**

reply | forward | archive | delete

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, lets 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 how to make an earthquake resistant building, even if they are not engineers. This is a gift that will last a long time!

We'd love to give him your building codes, too. Take a look at them 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

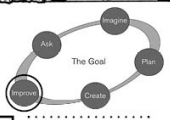
Engineering Adventures™: Engineering Journal 26 © Museum of Science, 2012

Improve, p. 27

Adventure 6 **Improve Page**

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

Draw your plan for improving your building.



What materials will you use?

Test your building at a 7.0 magnitude.

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

slides | tips or falls | shears | nothing

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

Engineering Adventures™: Engineering Journal 27 © Museum of Science, 2012

Letter to the Duo, p. 28

Adventure 6 **Letter to the Duo**

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,

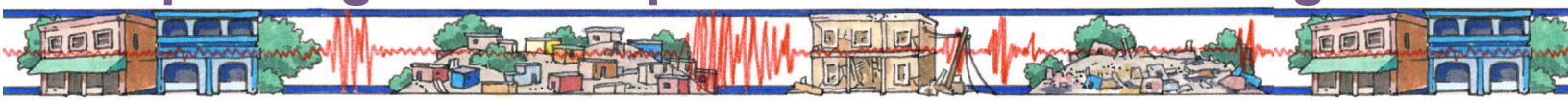
_____

Engineering Adventures™: Engineering Journal 28 © Museum of Science, 2012

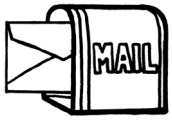
Building Codes Chart (from Adv 5)

Our model building codes are:

Adventure 6 Educator Page: Adventure Guide
Improving an Earthquake Resistant Building



Kids will learn:
- engineers often go back and improve their designs.
- building codes are rules created to help make sure structures are safe and strong.



Present the Message From the Duo (5 min)

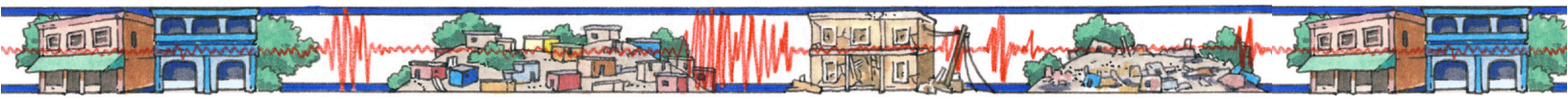
1. Tell kids India wants them to improve their earthquake resistant buildings and send a surprise to Bernard. Have kids turn to p. 26 of their Engineering Journals to read the message from India (track 8).
2. To check for understanding, ask:
   - **What is India asking you to do?** *To improve our model buildings so they are earthquake resistant, and to send Bernard our building codes.*

Improve (30 min)

1. Have a volunteer go over the *Building Codes Chart.* Ask groups:
   - **Are there any building codes you want to change?**
   - **Are there any building codes you want to add?**
2. Have each group refer back to their *Plan and Test* from Adventure 5, p. 25. Give kids 5 minutes to talk in their groups about the following questions:
   - **Which building codes are you using in your building?**
   - **How do you want to improve your building today?**
3. Have groups make a new plan using *Improve*, p. 27, and collect materials at the Material Store. Once groups have collected their materials, they should start their improvements, and test as they go, recording their results on *Improve*.
4. As kids work, ask:
   - **What are you improving? How do you think this will make your model building more earthquake resistant?**
   - **What step of the Engineering Design Process do you think you are using right now? How do you know?**

Reflect (10 min)

1. Gather kids together and have them share what they've worked on. As each group shares their designs, ask questions like:
   - **What steps of the Engineering Design Process did you use today? How did these steps help you?**
   - **How did you improve your model buildings?**
   - **Do you think your design is working well? How do you know?**
2. Review the *Building Codes Chart*. Remind kids that even though they are focusing their building codes on their small models, they are thinking about the same types of problems that earthquake engineers think about when



they engineer full-size buildings. Ask:

- **Based on what you just did, are there any building codes you want to change or add?**

3. Remind kids that India and Jacob want to share their building codes with Bernard. Have kids write a letter to India and Jacob using *Letter to the Duo,* p. 28. Kids will draw their final design and write about the building code they think is the most important.
4. Congratulate kids on using the engineering work they've done so far and encourage them to invite friends and family members to the Engineering Showcase in Adventure 7. During the showcase, groups will share their final designs and test all of the designs together, as part of a big city.

Tip: Kids can email the Duo directly at EngineeringAdventures@mos.org.

Improving an Earthquake Resistant Building

reply | forward | archive | delete

from	engineeringadventures@mos.org
subject	Tried and Tested
to	You
	1:41 PM

Hello!

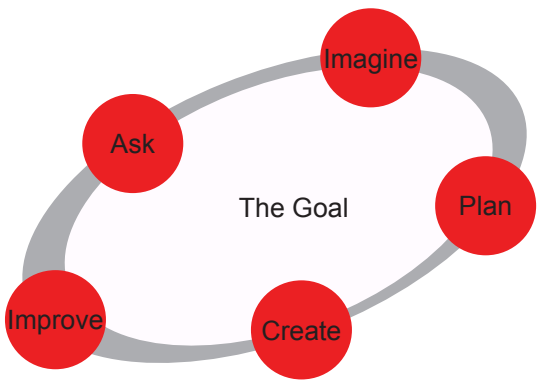
It is almost time for us to leave Haiti, and we want to make sure we have time to show Bernard our earthquake resistant designs. First, let's use the Improve step of the Engineering Design Process to make sure our buildings are really earthquake resistant.

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!

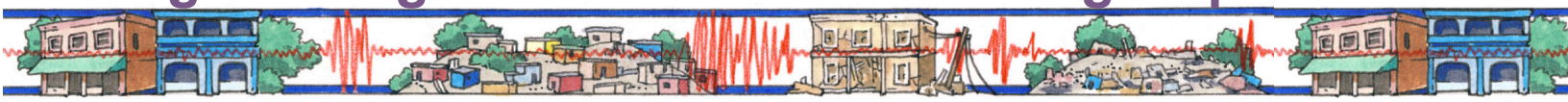
Let us know how it goes,

India



Adventure 7
Engineering Showcase: Shake Things Up

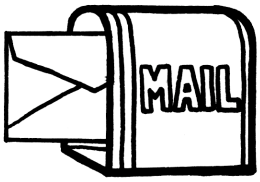
Educator Page: Preview



Overview: Kids will present their work and explain how they used the Engineering Design Process to engineer their model buildings. Kids then combine their shake tables to create a city and test how earthquake resistant the city is.

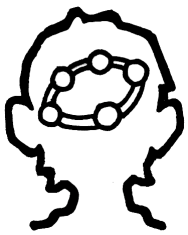
Note to Educator: The Engineering Showcase is a time for kids to show off what they have learned and all of their hard work! Consider inviting guests to watch groups present their model buildings, share their building codes, and see how well the city fares when all of the shake tables are combined.

Duo Update (5 min)



Activity (30 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 9 or Engineering Journal p. 29
- ☐ *Building Codes Chart* from the previous adventure
- ☐ EDP Poster
- ☐ 28 medium binder clips

For each group of 3-5 kids:

- ☐ final building from Adventure 6
- ☐ shake table

For each kid:

- ☐ Engineering Journal

Preparation

Time Required: 5 minutes

1. Have the *Message from the Duo* ready to share.
2. Post the *Building Codes Chart* (see p. 54 for details).

Journal Pages and Chart for Adventure 7

Message From the Duo, p. 29

Adventure 7 **Message from the Duo**

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 also from our own work about how to engineer an earthquake resistant building. We are ready to show Bernard how earthquake resistant our buildings are, especially 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 show 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

My Next Engineering Adventure, p. 30

Adventure 7 **My Next Engineering Adventure**

What do you want to engineer next?

_____

Draw your technology here!

What materials do you want to use?

My engineering checklist:

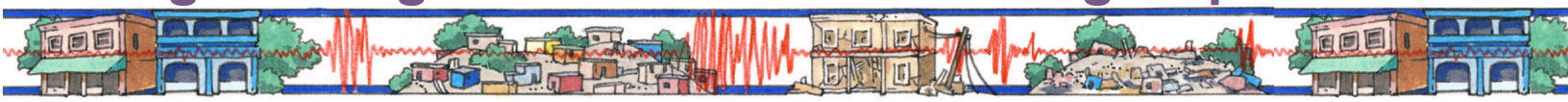
- ☐ Find friends to work with.
- ☐ **Ask** questions about how to start.
- ☐ **Imagine** lots of ideas.
- ☐ Make a **Plan**.
- ☐ **Create** and test the plan.
- ☐ **Improve** until you think it is ready.

Use the next page to keep track of your work!

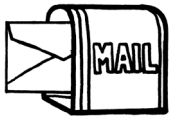
Building Codes Chart (from Adv 6)

Our model building codes are:

Engineering Showcase: Shake Things Up



Kids will learn:
- every step of the Engineering Design Process was used in creating each model building.



Present the Message From the Duo (5 min)

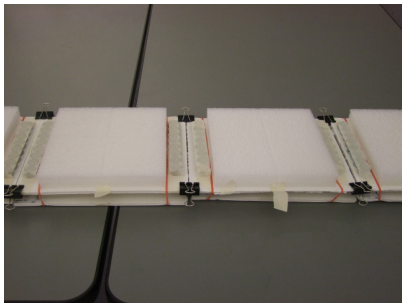
1. Tell kids that India and Jacob are excited for the kids to show off their work! Have kids turn to p. 29 of their Engineering Journals to read the message from India and Jacob (track 9).
2. To check for understanding, ask:
   - **What are India and Jacob asking you to do?** *Share our building codes and then combine all of the shake tables to see how earthquake resistant our city is in a 7.0 earthquake.*

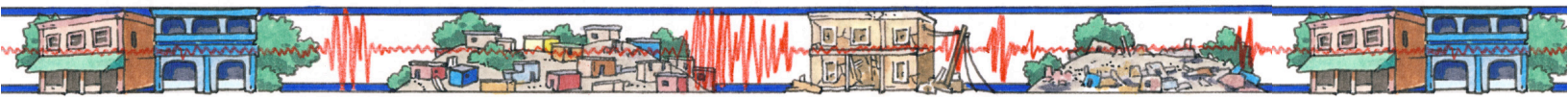
Engineering Showcase (20 min)

1. Have volunteers present the list of building codes from *Building Codes Chart*. Ask questions like:
   - **Why do you think this building code is important?**
   - **How did you come up with this building code?**
   - **Why would this be important to think about in a full-size building?**
2. Have each group set up their shake table and model building from Adventure 6.
3. Have all groups take turns sharing about their buildings. Each group should demonstrate how well their design survives a 7.0 magnitude earthquake on the shake table. As groups present, ask questions like:
   - **Can you tell us about your design? How did you engineer your model building so that it is earthquake resistant?**
   - **What steps of the Engineering Design Process helped you the most as you engineered your model building? Why?**

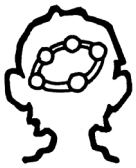
Bring it all Together (10 min)

1. Tell kids that they will combine all of the shake tables to make a city that they can test in a 7.0 earthquake.
2. Have some volunteers help you create the city. Attach each shake table to another along the upper layer with two medium binder clips. Connect the shake tables until they are all in a single line (see photograph for an example).
3. Once all of the tables are connected, have volunteers hold the bottom layer of the shake tables down, while others pull the top layer back





to a 7.0 magnitude earthquake. Release and see how the city fares!



Reflect (10 min)

1. Gather kids together to do a final share of their work throughout the unit. Ask the group questions like:
   - **Were you surprised by what happened when our city experienced an earthquake? Why or why not?**
   - **How do you think the building codes we created could help people engineer full-size earthquake resistant buildings?** *Yes, because full-size buildings also have to be attached to the ground and have bracing.*
   - **What would you Improve about your building if you had more time?**
2. Show kids the Engineering Design Process poster. Remind kids that they used all of these steps as they engineered their buildings. Ask:
   - **How do you think you can use the steps of the Engineering Design Process to solve other problems? What is an example?**
   - **What do you want to engineer next?**
3. Give kids time to complete *My Next Engineering Adventure*, p. 30. Having kids record their ideas will help them consolidate what they learned throughout the unit and apply their new skills in their own lives.

Engineering Showcase: Shake Things Up

reply | forward | archive | delete

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