Engineering Adventures®

Hop to It:
Safe Removal of Invasive Species

Mechanical Engineering for Out-of-School Time • Grades 3–5

Written by the Engineering is Elementary® Team
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EiE Engineering is Elementary® | Engineering Adventures®
Developed by the Museum of Science, Boston

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Pilot Sites for Hop to It

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

Arthur T. Cummings Elementary 21st Century Afterschool Winthrop, MA
Boys and Girls Clubs of Greater Sacramento Sacramento, CA
Cambridge Community Center Cambridge, MA
Columbus Elementary Afterschool Medford, MA
Condon Boys and Girls Club Boston, MA
Frank M. Silvia Elementary School Fall River, MA
Garden City Boys & Girls Club Houston, TX
Gerald and Darlene Jordan Boys & Girls Club Chelsea, MA
Gilbert W. McNeal Elementary Afterschool Bradenton, FL
Girls, Inc. of Lynn Lynn, MA
Henrico County Public Schools Henrico, VA
High Rocks Educational Corporation Hillsboro, WV
Hoosier Uplands Health, Education, and Aging Mitchell, IN
Huntington Avenue YMCA Boston, MA
Imaginarium Science Center Fort Myers, FL
International Spanish Language Academy Minnetonka, MN
Jackson/Mann K–8 School Boston, MA
Jenny Lind School Minneapolis, MN
Manatee County School District Bradenton, FL
McCarthy-Towne School Acton, MA
Meadowvale Elementary School Havre de Grace, MD
Metrowest YMCA School's Out Program Framingham, MA
Missouri River Education Cooperative Extended School Program Mandan, ND
Natick School District Natick, MA
North Suburban YMCA Woburn, MA
Resurrection Lutheran Church Roxbury, MA
Roberts Elementary Afterschool Medford, MA
The Salvation Army Boston, MA
Samuel Kennedy Elementary Sacramento, CA
Sierra Madre School Sierra Madre, CA
Sitton SUN Community School Portland, OR
Springfield Dept. of Recreation 21st Century Afterschool Springfield, MA
Sumner Boys and Girls Club Roslindale, MA
Tully Elementary Louisville, KY
Wang YMCA of Chinatown Boston, MA
The Wendell P. Clark Memorial YMCA Winchendon, MA
Woodlake Elementary After School Program Sacramento, CA
Woodrow Wilson 21st Century Afterschool Framingham, MA

Unit Map

Here is 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: Cane Toad Invasion

Kids are introduced to the problem: engineering a trap to catch invasive cane toads. They will also build some traps that need improvement in order to be successful.

↓

Adventure 2: Create a Cane Toad Trap

Using their knowledge of the cane toad problem, kids will use the steps of the Engineering Design Process to engineer their own cane toad traps.

↓

Adventure 3: Improve a Cane Toad Trap

Kids continue using the steps of the Engineering Design Process as they *create* their cane toad traps, test them, and *improve* their designs.

↓

Adventure 4: Engineering Showcase

Kids present their cane toad traps and knowledge of the Engineering Design Process by creating Public Service Announcements that tell others about the dangers of cane toads.

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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 learning 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:

- Increase children's technological literacy.
- Increase educators' abilities to teach engineering and technology.
- Increase the number of schools and out-of-school-time (OST) programs in the U.S. that include engineering.
- Conduct research and assessment to further the first three goals and contribute knowledge about teaching and learning engineering.

The first product developed by the EiE program was the Engineering is Elementary curriculum series. Designed for use in elementary school classrooms, this curriculum is hands-on, research-based, standards-driven, and classroom-tested. For more information about EiE, visit: www.eie.org.

In 2011, EiE began development of Engineering Adventures (EA), a curriculum created for 3rd–5th grade children in OST environments. EA is designed to provide engaging and thought-provoking challenges appropriate for the OST setting. More information about EA can be found online at: www.engineeringadventures.org.

In 2012 the Engineering Everywhere (EE) curriculum was created. EE is designed to empower middle-school-aged children in OST settings to become engineers and solve problems that are personally meaningful and globally relevant. For more information, visit: www.engineeringeverywhere.org.

EiE 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 through high school, college, and beyond. For more information, visit: www.nctl.org.

About Engineering Adventures

The mission of Engineering Adventures (EA) is to create exciting out-of-school-time activities and experiences that allow *all* 3rd–5th grade learners to act as engineers and engage in the Engineering Design Process. Our goal is to positively impact children's attitudes about their ability 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 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: www.engineeringadventures.org.

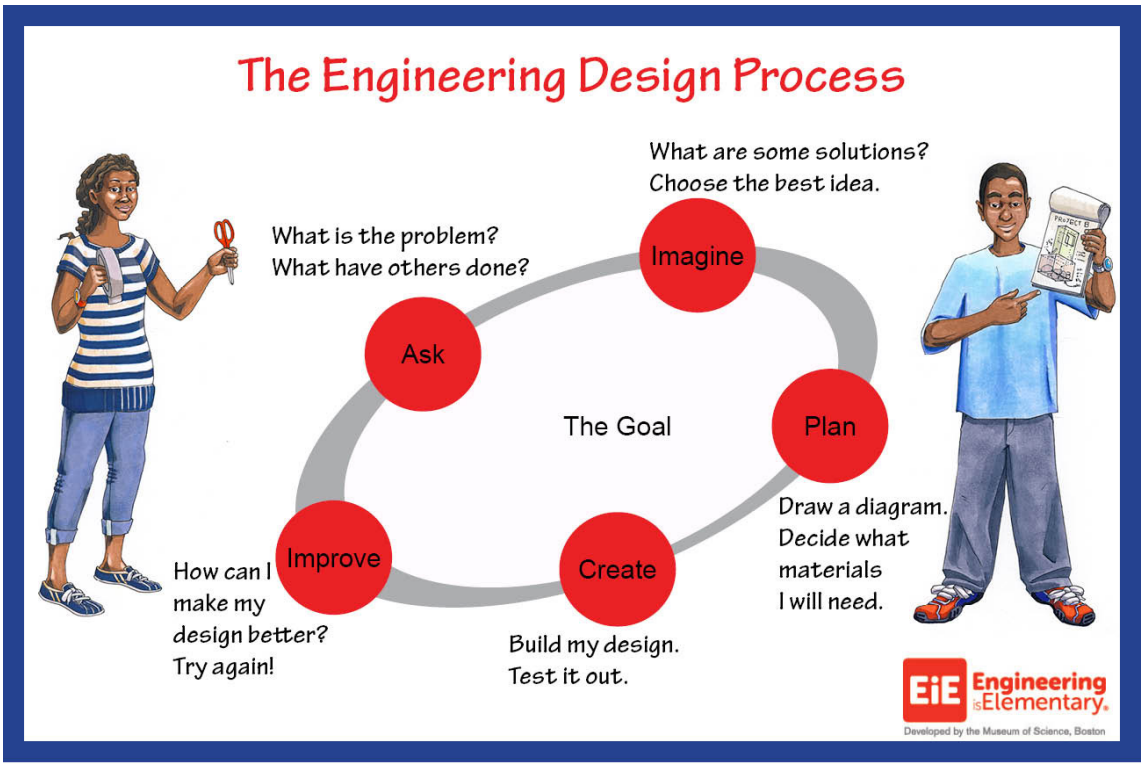
The Engineering Design Process

The Engineering Adventures Engineering Design Process (EDP) is the backbone of each Engineering Adventures (EA) unit. It is a five-step process that guides kids in solving engineering challenges. Our goal for each EA unit is for kids to understand the EDP can help them solve problems not only in engineering, but also in other areas of their lives.

While there are many other versions of the EDP that are used in academic and professional settings, the EiE team developed a five-step process that is accessible for elementary school kids. India and Jacob, a fictional world-traveling brother and sister duo, introduce and guide kids through the EDP in each unit. There are also questions for the educator to ask and sections in the Engineering Journal to provide an opportunity for kids to reflect on and discuss the process.

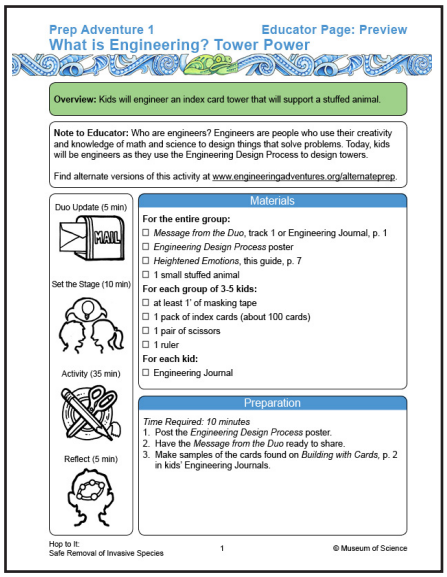
The EDP begins with the goal: the engineering challenge kids are asked to solve. The process is cyclical and flexible; kids can start a challenge at any step and may jump around to steps as they are engineering. For example, it is very common for kids to begin *creating* their technology, but then *ask* questions about materials and *imagine* new ways to *improve* their design. In EA units, kids generally start with the *ask* step, then have time to *imagine* and *plan* their designs, and *create* and *improve* their technologies.

To further highlight the EDP throughout the unit, the steps are italicized in this guide. Below is the EDP used in EA units.



Each Engineering Adventure Includes

Preview pages with relevant background information, materials lists, preparatory instructions, and a preview of the journal pages needed.


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 their creativity and knowledge of math and science to design things that solve problems. Today, kids will be engineers as they use the Engineering Design Process to design towers.

Find alternate versions of this activity at www.engineeringadventures.org/alternateprep.

Duo Update (5 min) · Set the Stage (10 min) · Activity (35 min) · Reflect (5 min)

Materials

For the entire group:
- ☐ *Message from the Duo*, track 1 or Engineering Journal, p. 1
- ☐ *Engineering Design Process* poster
- ☐ *Heightened Emotions*, this guide, p. 7
- ☐ 1 small stuffed animal

For each group of 3-5 kids:
- ☐ at least 1' of masking tape
- ☐ 1 pack of index cards (about 100 cards)
- ☐ 1 pair of scissors
- ☐ 1 ruler

For each kid:
- ☐ Engineering Journal

Preparation

Time Required: 10 minutes
1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Make samples of the cards found on *Building with Cards*, p. 2 in kids' Engineering Journals.

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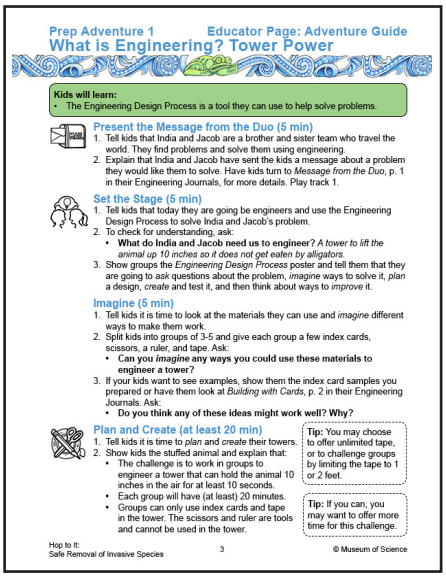
An **Adventure Guide** with step-by-step instructions, including discussion questions, extension ideas, and tips.


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 team who travel the world. They find problems and solve them using engineering.
2. Explain that India and Jacob have sent the kids a message about a problem they would like them to solve. Have kids turn to *Message from the Duo*, p. 1 in their Engineering Journals, for more details. Play 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 does not get eaten by alligators.*
3. Show groups the *Engineering Design Process* poster and tell them that 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 is time to look at the materials they can use and *imagine* different ways to make them work.
2. Split kids into groups of 3-5 and give each group a few index cards, scissors, a ruler, 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 in their Engineering Journals. 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 kids 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.
   - Groups can only use index cards and tape in the tower. The scissors and ruler are tools and cannot be used in the tower.

Tip: You may choose to offer unlimited tape, or to challenge groups by limiting the tape to 1 or 2 feet.

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

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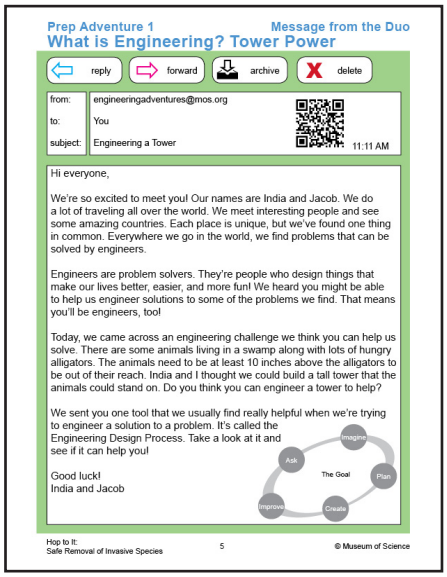
A **Message from the Duo**, India and Jacob, with information about the day's activity.


Prep Adventure 1 Message from the Duo
What is Engineering? Tower Power

reply · forward · archive · delete

from: engineeringadventures@mos.org
to: You
subject: Engineering a Tower
11:11 AM

Hi everyone,

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

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

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

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

Imagine · Plan · Create · Improve · Ask · The Goal

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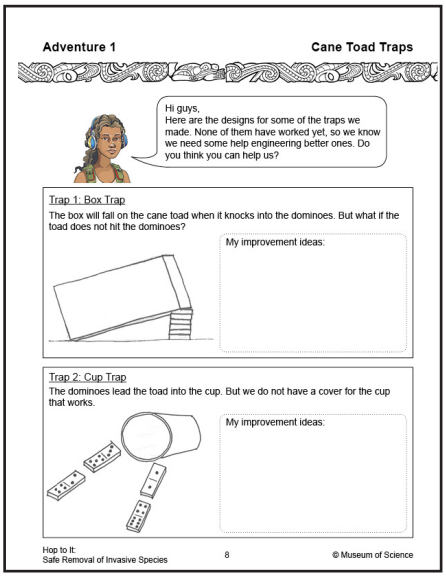
Engineering Journal pages that allow kids to record their findings and reflect on their learning.


Adventure 1 Cane Toad Traps

Hi guys,
Here are the designs for some of the traps we made. None of them have worked yet, so we know we need some help engineering better ones. Do you think you can help us?

Trap 1: Box Trap
The box will fall on the cane toad when it knocks into the dominoes. But what if the toad does not hit the dominoes?

My improvement ideas:

Trap 2: Cup Trap
The dominoes lead the toad into the cup. But we do not have a cover for the cup that works.

My improvement ideas:

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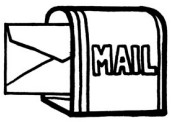
The Sections of the Adventures



Messages from the Duo

Messages from India and Jacob, a fictional 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, MP3 player, or iOS device, we strongly suggest using the audio recordings, although reading the emails aloud will convey the same information.

Set the Stage (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.

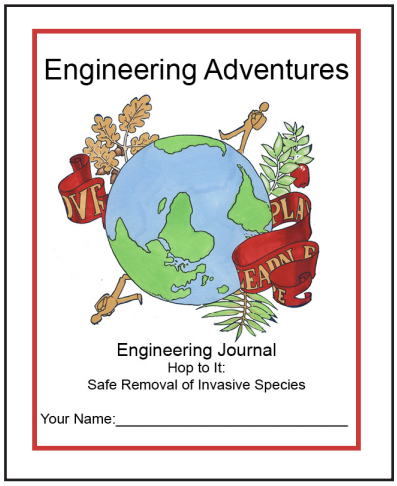
Activities

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 5-10 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



Make a copy of the Engineering Journal for each kid as you begin working on this EA unit. 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.

There are a few ways you can use the Engineering Journal. You may want to have groups share one Engineering Journal as a central recording spot for all group data and findings. This allows group members who enjoy writing and recording to do so. You may also encourage groups to share the responsibility by having group members rotate who records for each adventure.

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 have completed.

Alternate Prep Adventures

The two prep adventures, “What is Engineering?” and “What is Technology?” introduce kids to engineering and technology. “What is Engineering?” gives kids the chance to collaborate, experience a mini hands-on engineering challenge, share their designs, and learn about the Engineering Design Process. This adventure sets the stage for what kids can expect in the rest of the unit.

“What is Technology?” has kids interact with technologies, working with the definition that a technology is anything designed by humans to help solve a problem. Most kids think of technology as things that can be plugged into the wall. They do not realize that the items that they interact with every day—including pencils, paper, and water bottles—are also technologies. This adventure introduces the definition of technology that the kids will refer to as they engineer their own technologies to solve the problem presented in the unit.

There are alternate activities for both of these adventures available online in the Resources section at www.engineeringadventures.org/alternateprep. If kids complete multiple units, you may want to use an alternate activity to refresh the concepts in these activities. There may also be an activity that is more active or would be a better fit for the kids in your program. If you have questions about these activities, please email engineeringadventures@mos.org.

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 a way of problem solving—a way of thinking about the world—that is 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, it is a good life lesson for the kids in your program.

It is 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 Adventures

Each adventure requires 45-60 minutes of teaching time. We recommend that you budget at least 6-10 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: Cane Toad Invasion	1 hour
Adventure 2: Create a Cane Toad Trap Adventure 3: Improve a Cane Toad Trap	2-3 hours
Adventure 4: Engineering Showcase	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.

Timing

As groups are working, call out regular time intervals, so kids know how much time they have left to complete their task. This is especially helpful if kids have more than 20 minutes to work on a task. Letting them know when 5-minute increments have passed will allow them to budget their time and reassess where they are in their design.

Invite Others to the Showcase

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

Mobile Apps

Mobile apps can be a fun way to engage kids in out-of-school-time environments. The Engineering Adventures team has created iOS apps (compatible with most iPhones, iPod Touches, and iPads) that are designed to supplement the hands-on engineering experiences that your program provides.

You can download the Engineering Adventures apps onto your personal device or devices that belong to your site. You may also choose to encourage kids to download the apps onto their devices, so they may continue to practice their engineering skills on their own time. Encourage them to receive permission from their parents before doing so.

Technology Flashcards

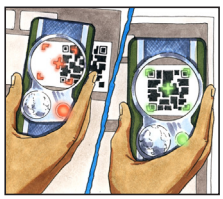
The Technology Flashcards app is designed to be used in conjunction with Prep Adventure 2. The app features a flashcard game that reinforces the idea that a technology is anything designed by a human to help solve a problem. The game allows kids to learn from their misconceptions in real time by providing them with instant feedback on why selected items are classified as technologies or not.

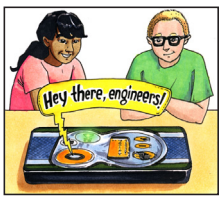
Search for “Technology Flashcards” in the App Store or visit: www.tinyurl.com/flashcardsapp.

Messages from the Duo

The Messages from the Duo app is a new way for kids to listen to the audio communications from India and Jacob at the beginning of each adventure. Kids can use the scanner function in the app to scan the QR code at the top of each Message from the Duo page in the Engineering Journal. The audio of the message will play automatically as if India and Jacob are communicating directly to the kids over walkie-talkie! The app gives kids an opportunity to listen to the messages on their own for enhanced comprehension or to share with others. Educators may also choose to use the app as an alternative to a CD player or reading the messages aloud.

Search for “Messages from the Duo” in the App Store or visit: www.tinyurl.com/MFTDapp.





Background

Mechanical Engineering

Mechanical engineering is one of the largest and most diverse fields of engineering. Mechanical engineers are people who use their creativity and knowledge of science and math to solve problems related to various kinds of machines.

If you take a look around, chances are that mechanical engineers have had a hand in many technologies around you. It is a common misconception that mechanical engineers only work on large-scale, complex machines, such as airplanes, cars, and robots. In fact, mechanical engineers are just as likely to work on small machines, such as staplers or coffee makers. No matter what machines mechanical engineers work on, they need to think about how the parts of the machines move, whether heat and/or friction are created, and all of the forces that act on the machine. All of these factors are important to ensure that the machine will work safely, efficiently, and reliably.

In this unit, kids are asked to act as mechanical engineers to design a trap to catch a cane toad. They will be given simple materials they can use in creative ways to engineer a machine that works. A criterion for their machine is that the starting point must be at least 4 feet away from the part of the machine that catches the toad; therefore, kids will need to think about how all of the parts of their machine interact with each other to ultimately activate the part of the machine that catches the toad.

Invasive Species and Cane Toads

An invasive species is a species that is not native to an ecosystem and is harmful to the ecosystem, the economy, or human health. Invasive species can be plants, animals, or other organisms. Many invasive species have been accidentally introduced to new ecosystems by hitching a ride on a cargo plane, on the bottom of a rowboat, or even within the baggage of an unsuspecting traveler. However, invasive species are often intentionally introduced by people who hope that the benefits of the species will outweigh the drawbacks. Unfortunately, this is not always the result.

People introduced cane toads to Australia hoping they would eat beetles that were destroying sugarcane crops. However, the cane toads quickly spread and multiplied. The cane toad has few natural predators in Australia, and most native animals have not yet adapted to avoid it—it is poisonous when eaten. The introduction of cane toads has resulted in a decimation of the population of certain native species and an alteration of the food chain. To this day, cane toads are considered a threat to the ecosystem of Australia, and many organizations are working to remove cane toads from the country.

Educator Resources

For a list of resources about invasive species and cane toads, visit:

http://www.eie.org/hoptoit.

Vocabulary

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

Engineering Design Process: The steps that engineers use to design technologies to solve problems.

Habitat: The environment where an animal or plant lives.

Invasive species: An animal that does not naturally live in an area and whose introduction may cause harm to the environment or human health.

Machine: An object that has parts that work together to complete a task.

Mechanical engineer: An engineer who designs parts of machines so they work together to solve a problem.

Native species: An animal that naturally lives in an area.

Technology: Anything designed by humans to help solve a problem.

Materials List

This kit is prepared for 8 groups of 3 kids.

Quantity	Item
Non-consumable Items	
1	*Catch that Toad* movie on DVD or internet access
1	*Engineering Design Process* poster
1	*Messages from the Duo* audio CD or app
1	stuffed toy
2	wind-up toy toads
8	rulers, 12”
8 pairs	scissors
10	dowels, wooden, approx. ¼” x 12”
24	table tennis balls
30	clothespins
55	dominoes
Consumable Items	
1 roll	aluminum foil
1 roll	cellophane tape
4 rolls	string
8	boxes, 12” x 7” x 4”
8	hand towels or pieces of cloth
8 rolls	tape, masking
16 sheets	cardboard
30	cups, paper, 10 oz.
30	paper towel tubes
30	rubber bands
60	craft sticks
60	paper clips, jumbo
60	straws, plastic
100	pipe cleaners
800	index cards, 3” x 5”
NOT INCLUDED IN KIT	
1	CD player, MP3 player, or iOS device
1	chart paper
1	clock/timepiece for scheduling
1	cloth or bag large enough to cover technologies, see p. 9
1	DVD player/TV

Quantity	Item
NOT INCLUDED IN KIT	
1	rock or leaf
8 sheets	paper, 8.5” x 11”
8	technologies, see p. 9
24	markers or crayons

National Education Standards

Engineering Adventures (EA) units are written with the goal of teaching engineering skills and critical thinking practices. Many EA units also touch upon a variety of science topics and principles. The engineering standards taught in this unit and the science topic links in this unit are noted in the following table.

		Prep Adventure 1: What is Engineering? Tower Power	Prep Adventure 2: What is Technology? Technology Detectives	Adventure 1: Cane Toad Invasion	Adventure 2:Create a Cane Toad Trap	Adventure 3: Improve a Cane Toad Trap	Adventure 4: Engineering Showcase: Hop to It
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						

		Prep Adventure 1: What is Engineering? Tower Power	Prep Adventure 2: What is Technology? Technology Detectives	Adventure 1: Cane Toad Invasion	Adventure 2:Create a Cane Toad Trap	Adventure 3: Improve a Cane Toad Trap	Adventure 4: Engineering Showcase: Hop to It
Next Generation Science Standards (Gr. 3–5)	3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.				✓	✓	
	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.			✓			✓
	3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.			✓			✓
	3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.			✓			✓
	3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	✓		✓	✓	✓	✓
	3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	✓		✓	✓	✓	✓
	3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	✓		✓	✓	✓	✓

How to Recognize Success Rubric Template

How do you know if you are leading an Engineering Adventures activity successfully? This tool will help you keep track of your kids' successful moments and will ask you to identify how your own actions enabled your kids to succeed.

Elements of success	What does this look like?	How does the guide help me facilitate this?
Kids are engaged and challenged by the activity. They persist through difficulties.	• Kids are on-task. • Kids are trying out their ideas. • Kids identify what is working well in their designs. • Kids troubleshoot their own work. • Kids *improve* their designs.	• Use the Message from the Duo to **set a real-world context** that will engage kids in the activity. • Use the bold prompts to **ask open-ended questions** to help kids troubleshoot their work. • Use the bold prompts to **ask kids about what they think is working well** in their designs and what they would like to *improve*. This will help kids feel more confident about their problem-solving abilities.
Kids do most of the talking, sharing their ideas with each other during the entire activity.	• Kids bring their own ideas to the activity and are comfortable sharing them. • Kids brainstorm and debate within their groups. • Kids share their designs with others. • Kids talk about how their ideas are changing over time.	• Use the bold prompts in the guide to **encourage kids to share and explain their thinking**. • Have kids **work in groups** so they can brainstorm and create a design together. • Use the bold prompts in the Reflect section to **help kids share their new ideas about designs.**
Kids value their engineering work as a process, not just as the end result.	• Kids go beyond talking about their design to talking about how they thought of it and why they designed it. • Kids use the Engineering Design Process to describe their actions.	• Use the bold prompts in the guide to **ask kids how they use the Engineering Design Process.** Spending time talking and thinking about their process will help kids see the value in it. • Use the bold prompts to **ask kids about *improving*** their designs, even if their designs are working well. • **Encourage kids to reflect individually** in their Engineering Journals to give them time for their experiences to sink in and be remembered.

How to Recognize Success Rubric Template

How do you know if you are leading an Engineering Adventures activity successfully? This tool will help you keep track of your kids' successful moments and will ask you to identify how your own actions enabled your kids to succeed.

Date: Adventure:

Elements of success	Evidence: Did I see this during the activity?	What was my role in making this happen?
Kids are engaged and challenged by the activity. They persist through difficulties.		
Kids do most of the talking, sharing their ideas with each other during the entire activity.		
Kids value their engineering work as a process, not just as the end result.		

Dear Family, Date: _____

We are beginning an engineering unit called *Hop to It: Safe Removal of Invasive Species*, 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 engineering and the Engineering Design Process. Throughout this unit, children will learn about mechanical engineering and work to engineer traps for cane toads. The unit is set in a real-world context: children will learn about the invasive cane toad species in Australia and why it is important to stop the spread of cane toads to other areas, such as New Zealand.

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 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 kids 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 for this unit are listed below. If you have any of these materials available, please consider donating them to us.

If you have expertise about mechanical engineering, Australia, or New Zealand, or if you 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!

_____ _____

_____ _____

_____ _____

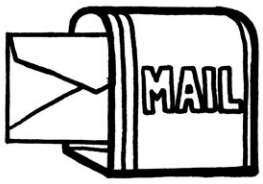
What is Engineering? Tower Power

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

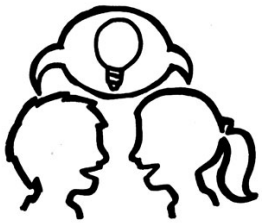
Note to Educator: Who are engineers? Engineers are people who use their creativity and knowledge of math and science to design things that solve problems. Today, kids will be engineers as they use the Engineering Design Process to design towers.

Find alternate versions of this activity at www.engineeringadventures.org/alternateprep.

Duo Update (5 min)

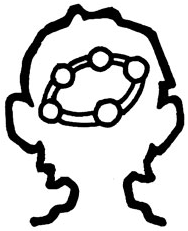


Set the Stage (10 min)



Activity (35 min)

Reflect (5 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 1 or Engineering Journal, p. 1
- ☐ *Engineering Design Process* poster
- ☐ *Heightened Emotions*, this guide, p. 7
- ☐ 1 small stuffed animal

For each group of 3-5 kids:

- ☐ at least 1' of masking tape
- ☐ 1 pack of index cards (about 100 cards)
- ☐ 1 pair of scissors
- ☐ 1 ruler

For each kid:

- ☐ Engineering Journal

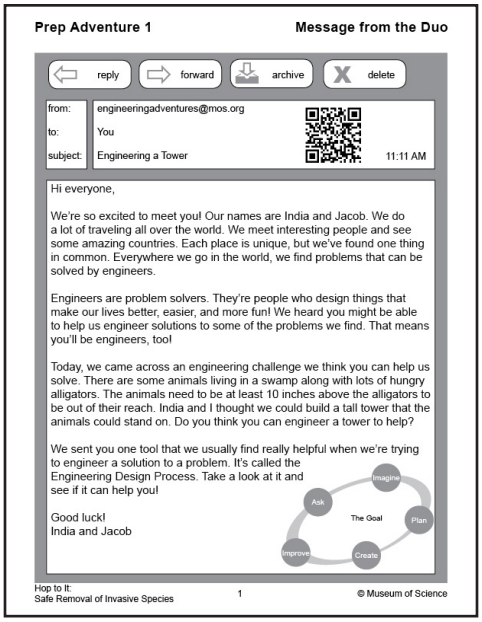
Preparation

Time Required: 10 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Make samples of the cards found on *Building with Cards,* p. 2 in kids' Engineering Journals.

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
to: You
subject: Engineering a Tower 11:11 AM

Hi everyone,

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

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

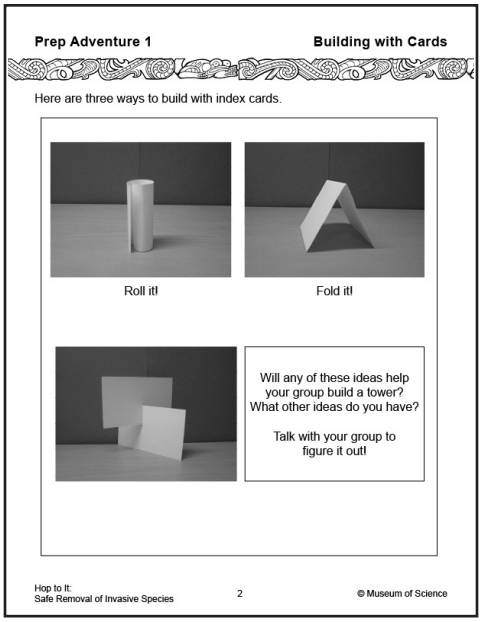
Today, we came across an engineering challenge we think you can help us solve. There are some animals living in a swamp along with lots of hungry alligators. The animals need to be at least 10 inches above the alligators to be out of their reach. India and I thought we could build a tall tower that the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

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

Good luck!
India and Jacob

Hop to It: Safe Removal of Invasive Species 1 © Museum of Science

Building with Cards, p. 2



Prep Adventure 1 **Building with Cards**

Here are three ways to build with index cards.

Roll it!

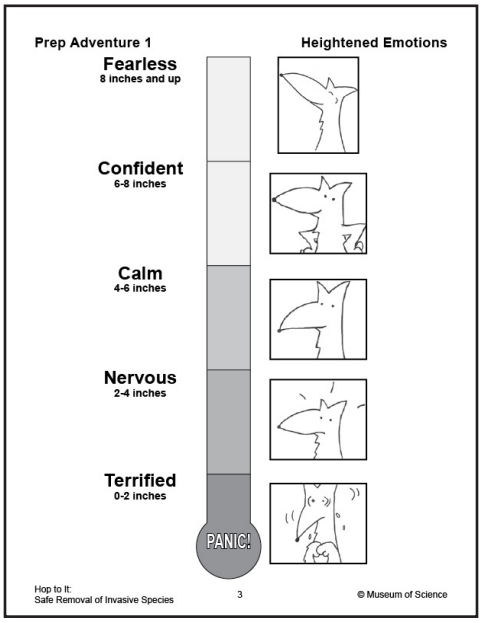
Fold it!

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!

Hop to It: Safe Removal of Invasive Species 2 © Museum of Science

Heightened Emotions, p. 3



Prep Adventure 1 **Heightened Emotions**

Fearless
8 inches and up

Confident
6-8 inches

Calm
4-6 inches

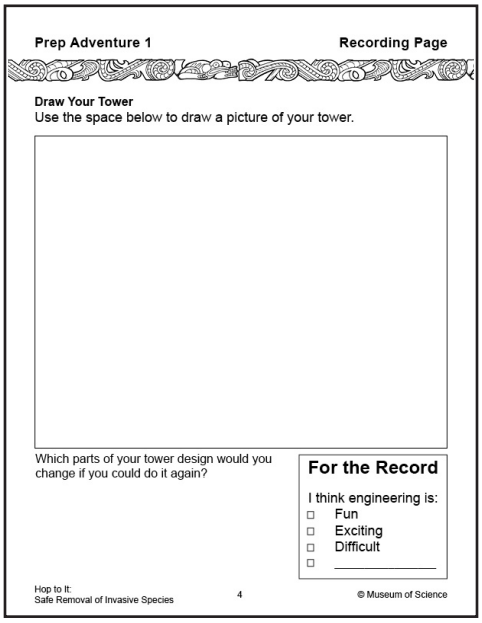
Nervous
2-4 inches

Terrified
0-2 inches

PANIC!

Hop to It: Safe Removal of Invasive Species 3 © Museum of Science

Recording Page, p. 4



Prep Adventure 1 **Recording Page**

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

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

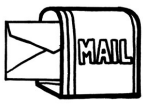
For the Record

I think engineering is:
- ☐ Fun
- ☐ Exciting
- ☐ Difficult
- ☐ _____

Hop to It: Safe Removal of Invasive Species 4 © Museum of Science

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 team who travel the world. They find problems and solve them using engineering.
2. Explain that India and Jacob have sent the kids a message about a problem they would like them to solve. Have kids turn to *Message from the Duo*, p. 1 in their Engineering Journals, for more details. Play 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 does not get eaten by alligators.*
3. Show groups the *Engineering Design Process* poster and tell them that 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 is time to look at the materials they can use and *imagine* different ways to make them work.
2. Split kids into groups of 3-5 and give each group a few index cards, scissors, a ruler, 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 in their Engineering Journals. 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 kids 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.
   - Groups can only use index cards and tape in the tower. The scissors and ruler are tools and cannot be used in the tower.

Tip: You may choose to offer unlimited tape, or to challenge groups by limiting the tape to 1 or 2 feet.

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

- Groups can hold the stuffed animal briefly, but they cannot test it on their tower until the 20 minutes are up.

3. Give each group one pack of index cards and let them begin.
4. 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?**

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 group's tower. Compare the measurement to the diagrams on *Heightened Emotions*. Give one kid from the group the stuffed animal and have them place it on top of their tower. Count to 10 and observe what happens. Whether or not their tower stands, 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; and we* created *and* improved *when we built and fixed the tower.*
   - **Why do you think it is important to use these steps?** *It helps us keep track of our ideas and make sure we are meeting our goal.*
   - **Do you think you are an engineer?**
2. Tell kids that they have just used the same steps that engineers use to solve problems. This means that they are engineers, too! Tell kids that 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 on *Recording Page*, p. 4 in their Engineering Journals. Allowing kids to draw and write about their work in this adventure will help them remember what they learned.

What is Engineering? Tower Power

reply | forward | archive | delete

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

11:11 AM

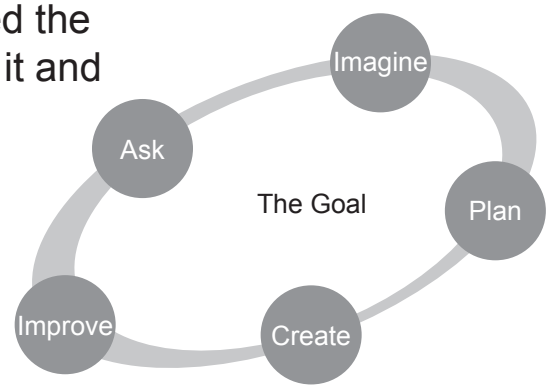
Hi everyone,

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

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

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

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

Prep Adventure 1
What is Engineering? Tower Power

Heightened Emotions

Fearless
8 inches and up

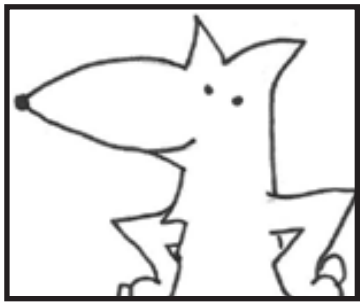
Confident
6-8 inches

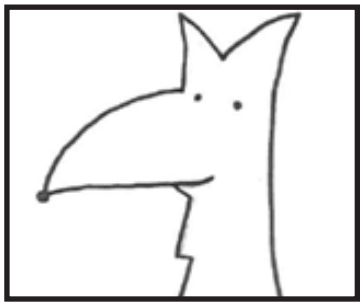
Calm
4-6 inches

Nervous
2-4 inches

Terrified
0-2 inches

PANIC!





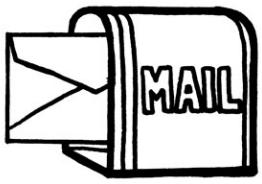
What is Technology? Technology Detectives

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

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

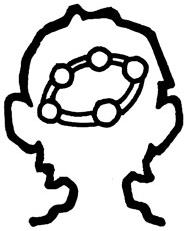
Find alternate versions of this activity at www.engineeringadventures.org/alternateprep.

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
- ☐ *Engineering Design Process* poster
- ☐ a cloth or bag large enough to cover all technologies
- ☐ a small rock or leaf
- ☐ chart paper or other writing space

Technologies (choose 8):

- ☐ bag
- ☐ book
- ☐ button
- ☐ construction paper
- ☐ dice
- ☐ electronic device (e.g., phone, calculator)
- ☐ glue stick
- ☐ hair clip
- ☐ hat
- ☐ juice box
- ☐ key
- ☐ roll of tape
- ☐ ruler
- ☐ scissors
- ☐ spoon
- ☐ stapler
- ☐ stuffed animal
- ☐ sweater
- ☐ water bottle

For each kid:

- ☐ Engineering Journal

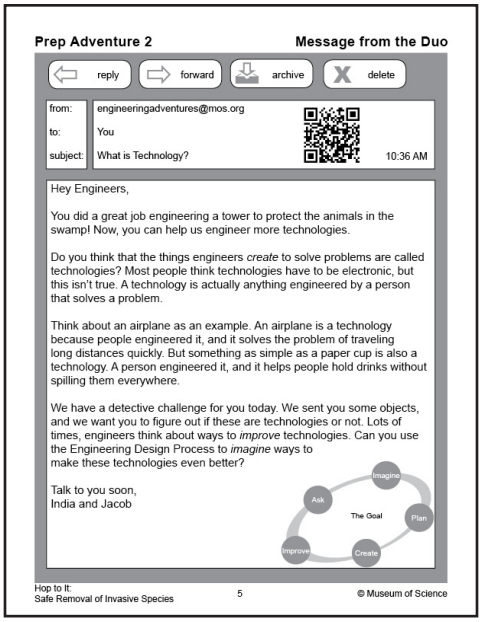
Preparation

Time Required: 10 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Place eight technologies (see above) on a table or floor and cover them with a cloth or bag.
4. On a large sheet of 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
to: You
subject: What is Technology? 10:36 AM

Hey 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 think 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.

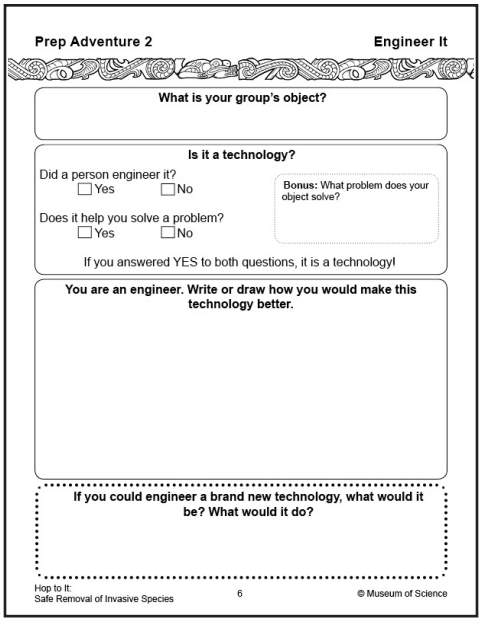
Think about an airplane as an example. An airplane is a technology because people engineered it, and it solves the problem of traveling long distances quickly. But something as simple as a paper cup is also a technology. A person engineered it, and it helps people hold drinks without spilling them everywhere.

We have a detective challenge for you today. We sent you some objects, and we want you to figure out if these are technologies or not. Lots of times, engineers think about ways to *improve* technologies. Can you use the Engineering Design Process to *imagine* ways to make these technologies even better?

Talk to you soon,
India and Jacob

Hop to It: Safe Removal of Invasive Species 5 © Museum of Science

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

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

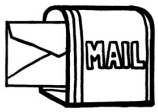
Hop to It: Safe Removal of Invasive Species 6 © Museum of Science

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!

What is Technology? Technology Detectives

Kids will learn:
- Technology is anything designed by people to help solve a problem.
- Engineers *create* 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 *Message from the Duo*, p. 5 of their Engineering Journals, to see the message. Play track 2.
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.*
3. Give kids about 1 minute to name all the technologies they can think of. If they are only naming electronics, remind kids that India and Jacob mentioned that things like paper cups are also technology.

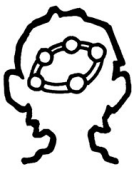
Tip: You may want to write down a list of the technologies kids say so you can refer back to it at the end of the adventure.

Undercover Detectives (15 min)

1. Explain that kids will now 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 may or may not be technologies. 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* chart 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 which 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 engineers. They will use the *Technology Detective Tool* chart to decide whether their object is a technology. Then, they will *imagine* ways to *improve* the object they chose.

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!

8. Have kids open to *Engineer It,* p. 6 of their Engineering Journals. Give groups about 10 minutes to complete the first three boxes. If groups are struggling, ask:
   - **How can you make your technology more fun?**
   - **How can you make your technology easier to use?**



Reflect (20 min)

1. Tell kids that they are going to present their technology ideas to their fellow detectives. Encourage them to use the *Technology Detective Tool* chart and *Engineer It,* page 6 in their Engineering Journals, to help them present. Ask each group:
   - **What is your technology?**
   - **How do you know it is a technology?** *Refer to the* Technology Detective Tool *chart.*
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 problems.*
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 were engineers today by thinking about technologies that already exist and how to *improve* them. Engineers also *imagine* brand new technologies that no one has thought of before!
5. Have kids think about the engineering they have 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 the *Engineer It* page of their Engineering Journals. 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 arrowhead 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
to:	You
subject:	What is Technology?

10:36 AM

Hey Engineers,

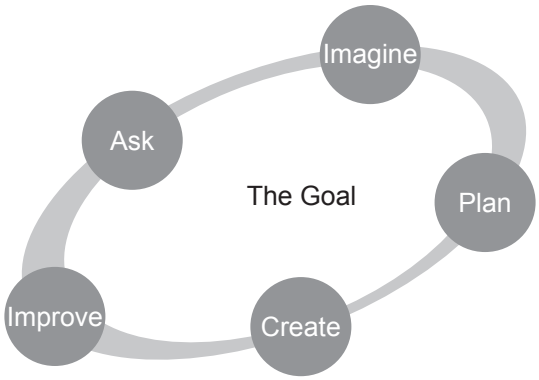
You did a great job engineering a tower to protect the animals in the swamp! Now, you can help us engineer more technologies.

Do you think 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 these are technologies or not. Lots of times, engineers think about ways to *improve* technologies. Can you use the Engineering Design Process to *imagine* ways to make these technologies even better?

Talk to you soon,
India and Jacob

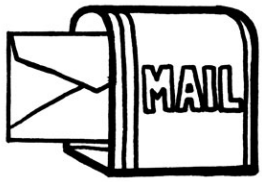


Cane Toad Invasion

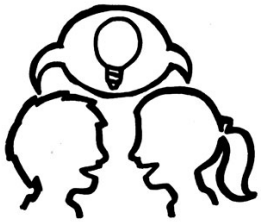
Overview: Kids watch a film that highlights the negative effects of the cane toad invasion in Australia. Then, they follow instructions to make some cane toad traps that need improvement.

Note to Educator: Cane toads are large land toads that people brought from Central and South America to Australia in 1935. They are called an invasive species because they are not naturally from Australia, and they cause harm to the native animals (animals that have always lived in Australia) and the Australian ecosystem.

Duo Update (5 min)

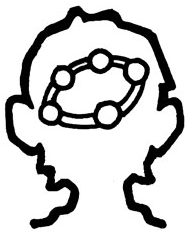


Set the Stage (10 min)



Activity (15 min)

Reflect (15 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 3 or Engineering Journal, p. 7
- ☐ *Engineering Design Process* poster
- ☐ *Catch that Toad* video
- ☐ 1 small stuffed animal
- ☐ 24 crayons or markers

Materials Store

- ☐ 1 roll of string
- ☐ 1 roll of tape
- ☐ 2 hand towels
- ☐ 2 paper cups
- ☐ 2 boxes
- ☐ 8 straws
- ☐ 10 dominoes
- ☐ 24 clothespins

For each group of 3-5 kids:

- ☐ 1 pair of scissors

For each kid:

- ☐ Engineering Journal

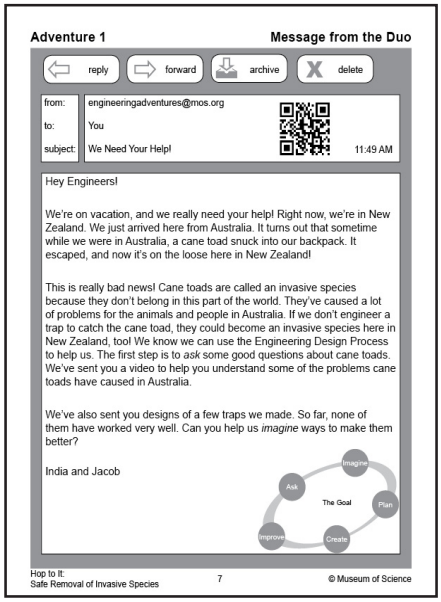
Preparation

Time Required: 10 minutes

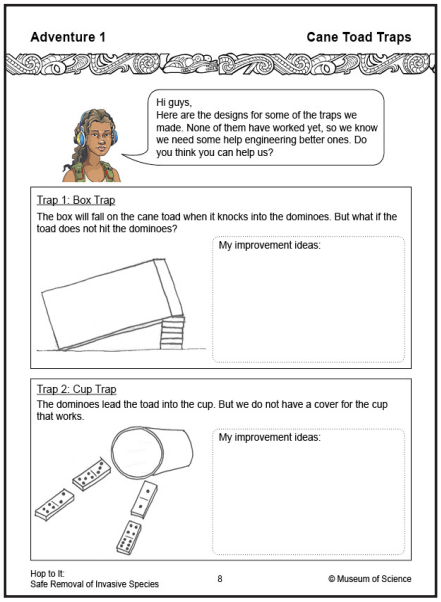
1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Watch and be prepared to play the entire video *Catch that Toad* (6:46): eie.org/hoptoit. Review the video notes on the next page.
4. Set up a Materials Store with the materials listed above.

Journal Pages for Adventure 1

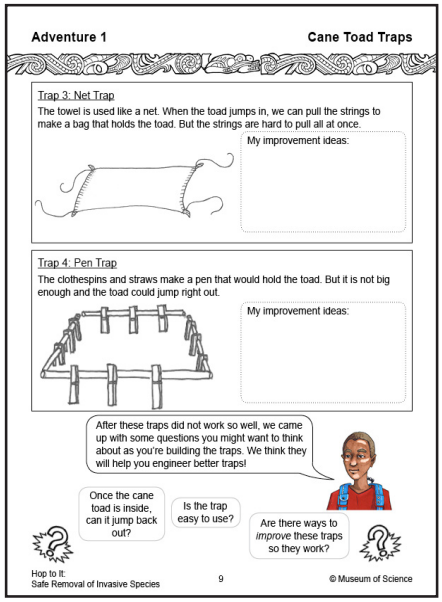
Message from the Duo, p. 7



Cane Toad Traps, p. 8



Cane Toad Traps, p. 9



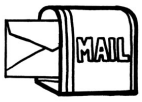
Video Notes

The *Catch that Toad* video gives kids some background information to understand the cane toad problem in Australia. Below are some notes about important ideas or facts covered in the video. Note that the entire video is just over 6 minutes long.

Minutes	Summary
50 seconds	Explains the problem the Duo has (they accidentally brought a cane toad to New Zealand)
1:55	Describes some characteristics of cane toads
2:20	Explains why cane toads were originally brought to Australia
3:35	A scientist discusses what happens when native animals try to eat cane toads
5:00	A scientist explains why it's so important to stop cane toads from entering New Zealand
5:20	Explains how the Engineering Design Process can help you catch the cane toad

Cane Toad Invasion

Kids will learn:
- Invasive cane toads cause many problems for the animals and people of Australia.
- Technologies often do not work perfectly the first time they are designed.



Present the Message from the Duo (5 min)

1. Tell kids that they have received a very important message from India and Jacob. They are traveling and have run into a big problem. They need help engineering a solution.
2. Have kids turn to *Message from the Duo*, p. 7 in their Engineering Journals. Play track 3.
3. To check for understanding, ask:
   - **What is the problem India and Jacob need help solving?** *They accidentally let a cane toad loose in New Zealand and need help engineering a trap to catch it.*

Set the Stage: Cane Toads in Australia (10 min)

1. Tell kids that you are going to show them the video that India and Jacob sent. Explain that the video has lots of information to help them better understand the cane toad problem in Australia.
2. Once kids have watched the video, ask:
   - **What are some of the problems cane toads are causing in Australia?** *Cane toads take food from native animals, kill native animals with poison, spread quickly, etc.*
   - **Why do you think it is important for us to help India and Jacob catch the cane toad they let loose in New Zealand?** *We do not want the toads to spread in New Zealand like they did in Australia.*

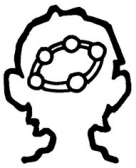
Improving Traps (15 min)

1. Tell kids that throughout the rest of this unit, they will have the chance to engineer cane toad traps to help India and Jacob catch the toad. Today, they will take a few minutes to make some of the first designs that India and Jacob tried.
2. Remind kids that India and Jacob said that these traps have not worked well so far. Their job will be to think about how to make the traps work better.
3. Have kids turn to Cane Toad Traps, pp. 8–9 in their Engineering Journals, to see the photos of the traps that India and Jacob have created.

Tip: Reinforce that technologies often do not work perfectly the first time they are engineered. That is why the *improve* step of the Engineering Design Process is so important.

4. Groups should choose one of the four traps to make. If possible, make at least one example of each trap.
5. Each group should send one member to the Materials Store to gather the materials needed for their trap.
6. Groups should follow the directions on pp. 8–9 of their Engineering Journals to create and test their trap.
7. Remind kids that they will get the chance to create their own improved traps during the next adventure, so imagining ways to improve these traps will give them a head start.

Tip: If groups finish early, they can fill out *Cane Toad Problems*, pp. 18–19 in their Engineering Journals.



Reflect (15 min)

1. Have each group share what they created. Ask:
   - **How does your group's trap work?**
   - **How do you think you could make this trap better?**
2. Show kids the *Engineering Design Process* poster. Ask:
   - **Do you think we used any steps of the Engineering Design Process today? How?** *We* asked *about why cane toads are a problem in Australia, and we* asked *and* imagined *how we could* improve *the traps that India and Jacob tried.*
3. Give kids time to record some of their improvement ideas on *Cane Toad Traps*, pp. 8–9 in their Engineering Notebooks. Recording their ideas will help them remember what they learned and apply it in the next adventure.

Extension: Invasive Species Near You?
Find out if there are any invasive species that live in your area. Have a discussion with kids about the impact that invasive species have on the local ecosystem.

Message from the Duo

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	We Need Your Help!

11:49 AM

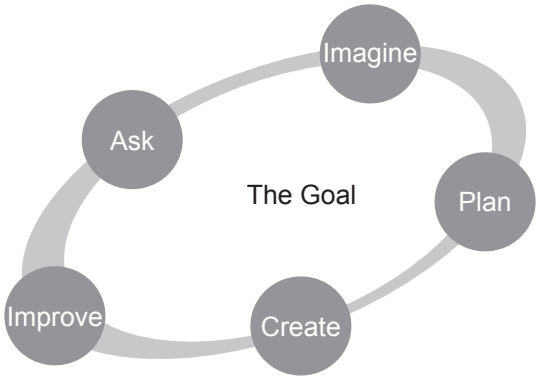
Hey Engineers!

We're on vacation, and we really need your help! Right now, we're in New Zealand. We just arrived here from Australia. It turns out that sometime while we were in Australia, a cane toad snuck into our backpack. It escaped, and now it's on the loose here in New Zealand!

This is really bad news! Cane toads are called an invasive species because they don't belong in this part of the world. They've caused a lot of problems for the animals and people in Australia. If we don't engineer a trap to catch the cane toad, they could become an invasive species here in New Zealand, too! We know we can use the Engineering Design Process to help us. The first step is to *ask* some good questions about cane toads. We've sent you a video to help you understand some of the problems cane toads have caused in Australia.

We've also sent you designs of a few traps we made. So far, none of them have worked very well. Can you help us *imagine* ways to make them better?

India and Jacob



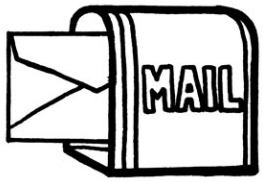
Create a Cane Toad Trap

Overview: Kids will use the steps of the Engineering Design Process to *imagine*, *plan*, *create*, and *improve* their own cane toad traps.

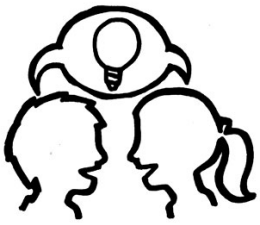
Note to Educator: Kids will either *improve* the traps they made in Adventure 1 or engineer their own new traps. Let kids know it is okay if they do not complete their designs today, as they will be able to continue working on them during the next adventure.

Be sure to keep the traps groups build today for use in Adventures 3 and 4.

Duo Update (5 min)

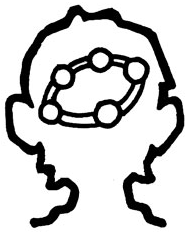


Set the Stage (5 min)



Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 4 or Engineering Journal, p. 10
- ☐ *Engineering Design Process* poster
- ☐ 2 wind-up toad toys

Materials Store

- ☐ 1 roll of aluminum foil
- ☐ 4 rolls of string
- ☐ 8 empty boxes
- ☐ 8 hand towels or small pieces of fabric
- ☐ 8 pairs of scissors
- ☐ 8 rolls of masking tape
- ☐ 8 rulers or meter sticks
- ☐ 10 dowels, ¼" diameter
- ☐ 16 paper/cardboard sheets
- ☐ 24 table tennis balls
- ☐ 30 clothespins
- ☐ 30 paper cups
- ☐ 30 paper towel tubes
- ☐ 30 rubber bands
- ☐ 55 dominoes
- ☐ 60 craft sticks
- ☐ 60 paper clips
- ☐ 60 straws
- ☐ 100 pipe cleaners

For each kid:

- ☐ Engineering Journal

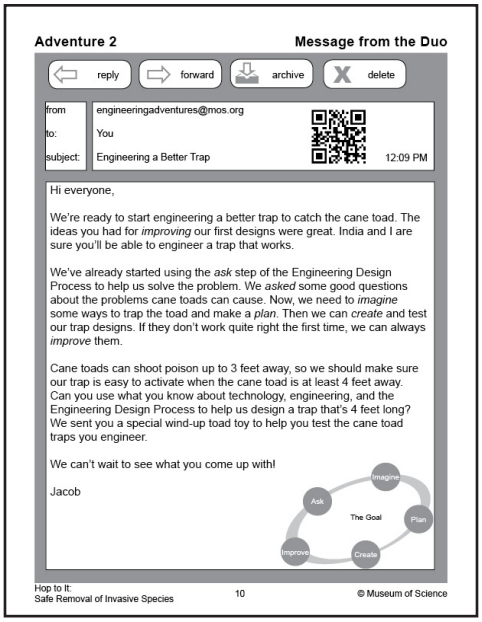
Preparation

Time Required: 10 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Set up a Materials Store with all the materials kids will have available for designing their traps.

Journal Pages for Adventure 2

Message from the Duo, p. 10



Adventure 2 **Message from the Duo**

reply | forward | archive | delete

from: engineeringadventures@mos.org
to: You
subject: Engineering a Better Trap
12:09 PM

Hi everyone,

We're ready to start engineering a better trap to catch the cane toad. The ideas you had for *improving* our first designs were great. India and I are sure you'll be able to engineer a trap that works.

We've already started using the *ask* step of the Engineering Design Process to help us solve the problem. We *asked* some good questions about the problems cane toads can cause. Now, we need to *imagine* some ways to trap the toad and make a *plan*. Then we can *create* and test our trap designs. If they don't work quite right the first time, we can always *improve* them.

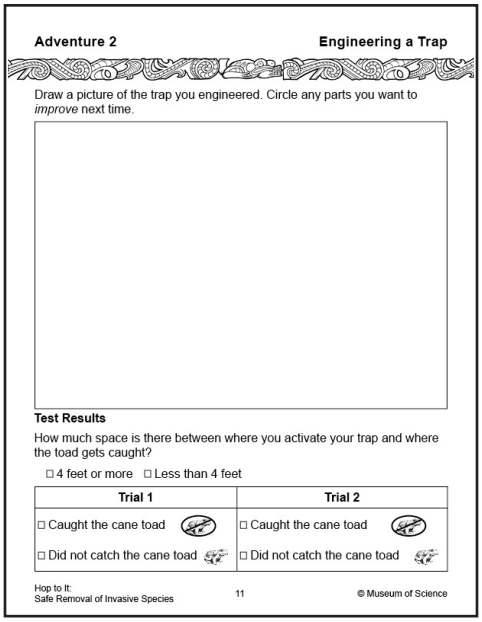
Cane toads can shoot poison up to 3 feet away, so we should make sure our trap is easy to activate when the cane toad is at least 4 feet away. Can you use what you know about technology, engineering, and the Engineering Design Process to help us design a trap that's 4 feet long? We sent you a special wind-up toad toy to help you test the cane toad traps you engineer.

We can't wait to see what you come up with!

Jacob

Hop to It:
Safe Removal of Invasive Species 10 © Museum of Science

Engineering a Trap, p. 11



Adventure 2 **Engineering a Trap**

Draw a picture of the trap you engineered. Circle any parts you want to *improve* next time.

Test Results

How much space is there between where you activate your trap and where the toad gets caught?

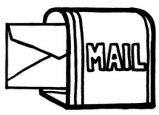
☐ 4 feet or more ☐ Less than 4 feet

Trial 1	Trial 2
☐ Caught the cane toad	☐ Caught the cane toad
☐ Did not catch the cane toad	☐ Did not catch the cane toad

Hop to It:
Safe Removal of Invasive Species 11 © Museum of Science

Create a Cane Toad Trap

Kids will learn:
- The Engineering Design Process is a tool they can use to help engineer solutions to problems.
- to think like engineers as they design a trap to catch the cane toad.



Present the Message from the Duo (5 min)

1. Tell kids that today they will begin engineering their cane toad traps. Jacob sent them a message with more details.
2. Have kids turn to *Message from the Duo*, p. 10 in their Engineering Journals. Play track 4.
3. To check for understanding, ask:
   - **What is the technology that Jacob is asking you to help engineer?** *A trap to catch the cane toad.*
   - **How far away does the starting point need to be from the part of the trap that catches the toad? Why?** *At least 4 feet because the cane toads can shoot poison from up to 3 feet away.*
   - **Which steps of the Engineering Design Process do you think will help you the most?**

Set the Stage (5 min)

1. Show kids the model cane toad (the wind-up toy) that India and Jacob sent so they can understand how it will interact with their trap. Wind up the toy and let it go so they can see how it moves.
2. Ask a volunteer to help you test the toad. Prop up a piece of cardboard or paper using a domino. Have the volunteer test whether the toad can go up the ramp, or whether or not it can turn corners. Encourage kids to think about how these factors might affect their designs!
3. Show kids the materials they will have available for designing their traps. Tell them that the rules are:
   - They need to be able to activate their trap 4 feet away from where the cane toad will be caught.
   - They need to try their trap at least twice and record whether it works each time.

Let the Building Begin! (25 min)

1. Explain that kids will work in groups of 3-5 to build a trap to catch the cane toad. They might choose to *improve* some of the traps that India and Jacob started with, or they might engineer something completely different. Once a group has agreed upon a design, they may get materials from the Materials Store and begin to build.
2. As groups are engineering, encourage them to think creatively and to move back and forth between the steps of the Engineering Design Process. Use

the poster to guide conversations and encourage groups to use the names of the steps of the Engineering Design Process to describe what they are doing.

3. As groups *create*, ask questions like:
   - **How will your trap work?**
   - **What steps of the Engineering Design Process have you used so far?**
4. When a group is ready to test their trap, have them measure the distance between the starting point of the trap and where the toad will be caught. Make sure the distance is at least 4 feet. Then, allow them to test twice with the wind-up toad and record their results in their Engineering Journals.
5. As groups test, ask questions like:
   - **What works well in your trap?**
   - **What does not work well in your trap?**
   - **How could you *improve* your trap?**

Tip: Some groups may not be ready to test today. They will have more time to test during Adventure 3.

Reflect (10 min)

1. Remind kids that they will get more time to work on their traps during the next adventure.
2. If some groups would like, let them share their traps with the whole group. Before groups activate their traps, have them review the *Engineering Design Process* poster. Ask:
   - **Which step of the Engineering Design Process helped you the most today? Why?**
   - **How will you *improve* your trap next time?**
3. Be sure to save the traps teams build today for use in Adventures 3 and 4.
4. Give kids time to record their thoughts in *Engineering a Trap*, p. 11 in their Engineering Journals. Recording the results of their testing and their ideas for improvements will help kids remember what they learned and prepare them for the next adventure.

Message from the Duo

reply | forward | archive | delete

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

12:09 PM

Hi everyone,

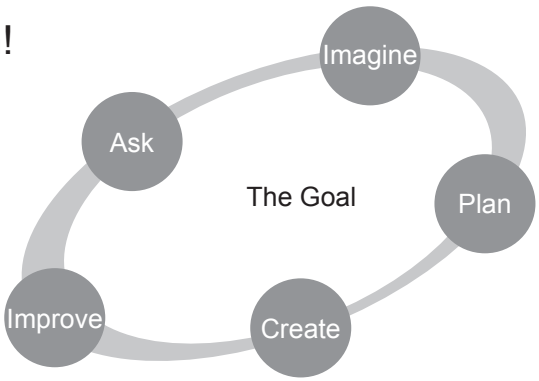
We're ready to start engineering a better trap to catch the cane toad. The ideas you had for *improving* our first designs were great. India and I are sure you'll be able to engineer a trap that works.

We've already started using the *ask* step of the Engineering Design Process to help us solve the problem. We *asked* some good questions about the problems cane toads can cause. Now, we need to *imagine* some ways to trap the toad and make a *plan*. Then we can *create* and test our trap designs. If they don't work quite right the first time, we can always *improve* them.

Cane toads can shoot poison up to 3 feet away, so we should make sure our trap is easy to activate when the cane toad is at least 4 feet away. Can you use what you know about technology, engineering, and the Engineering Design Process to help us design a trap that's 4 feet long? We sent you a special wind-up toad toy to help you test the cane toad traps you engineer.

We can't wait to see what you come up with!

Jacob



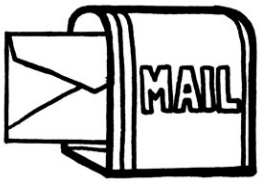
Improve a Cane Toad Trap

Overview: Kids will continue using the steps of the Engineering Design Process as they *create* their cane toad traps, test them, and *improve* their designs.

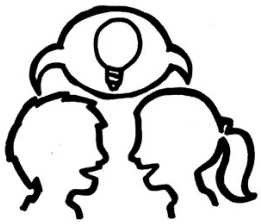
Note to Educator: Allow groups to move through the *improve* step at their own pace and continue this activity on another day if necessary.

Be sure to keep the traps groups build today for use in Adventure 4.

Duo Update (5 min)

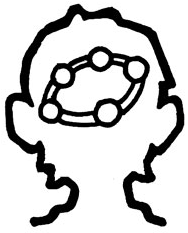


Set the Stage (5 min)



Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 5 or Engineering Journal, p. 12
- ☐ *Engineering Design Process* poster
- ☐ 2 wind-up toad toys

Materials Store (remaining materials from Adv. 2):

- ☐ 1 roll of aluminum foil
- ☐ 4 rolls of string
- ☐ 8 boxes
- ☐ 8 hand towels or small pieces of fabric
- ☐ 8 pairs of scissors
- ☐ 8 rolls of masking tape
- ☐ 8 rulers
- ☐ 10 dowels, ¼" diameter
- ☐ 16 paper/cardboard sheets
- ☐ 24 table tennis balls
- ☐ 30 clothespins
- ☐ 30 paper cups
- ☐ 30 paper towel tubes
- ☐ 30 rubber bands
- ☐ 55 dominoes
- ☐ 60 craft sticks
- ☐ 60 paper clips
- ☐ 60 straws
- ☐ 100 pipe cleaners

For each kid:

- ☐ Engineering Journal

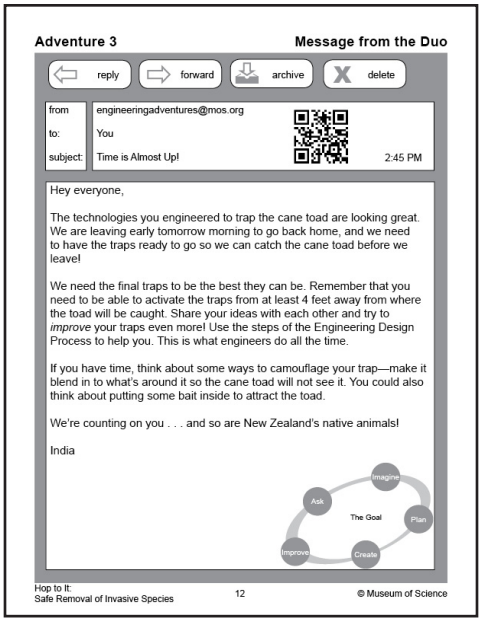
Preparation

Time Required: 10 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Set up a Materials Store with all of the leftover materials from Adventure 2.

Journal Pages for Adventure 3

Message from the Duo, p. 12



Adventure 3 **Message from the Duo**

reply | forward | archive | delete

from	engineeringadventures@mos.org
to:	You
subject:	Time is Almost Up! 2:45 PM

Hey everyone,

The technologies you engineered to trap the cane toad are looking great. We are leaving early tomorrow morning to go back home, and we need to have the traps ready to go so we can catch the cane toad before we leave!

We need the final traps to be the best they can be. Remember that you need to be able to activate the traps from at least 4 feet away from where the toad will be caught. Share your ideas with each other and try to *improve* your traps even more! Use the steps of the Engineering Design Process to help you. This is what engineers do all the time.

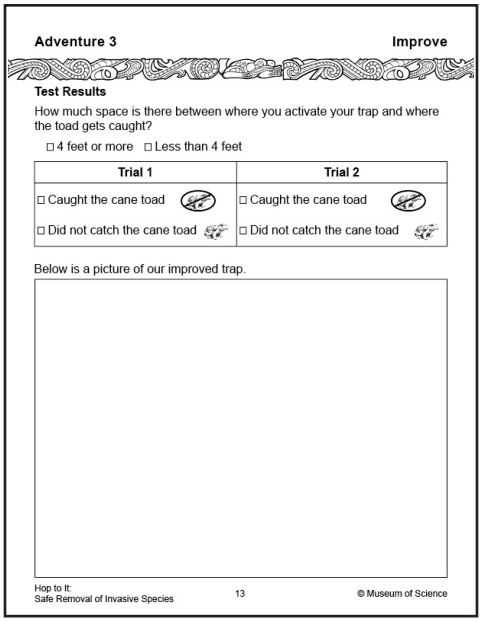
If you have time, think about some ways to camouflage your trap—make it blend in to what's around it so the cane toad will not see it. You could also think about putting some bait inside to attract the toad.

We're counting on you . . . and so are New Zealand's native animals!

India

Hop to It:
Safe Removal of Invasive Species 12 © Museum of Science

Improve, p. 13



Adventure 3 **Improve**

Test Results

How much space is there between where you activate your trap and where the toad gets caught?

☐ 4 feet or more ☐ Less than 4 feet

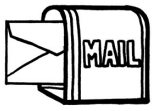
Trial 1	Trial 2
☐ Caught the cane toad	☐ Caught the cane toad
☐ Did not catch the cane toad	☐ Did not catch the cane toad

Below is a picture of our improved trap.

Hop to It:
Safe Removal of Invasive Species 13 © Museum of Science

Improve a Cane Toad Trap

Kids will learn:
- The *improve* step of the Engineering Design Process is important for perfecting a design.



Present the Message from the Duo (5 min)

1. Tell kids that today they will *improve* their cane toad traps so they are the best they can be. India has sent them a message with more details.
2. Have kids turn to *Message from the Duo*, p. 12 in their Engineering Journals. Play track 5.
3. To check for understanding, ask:
   - **What kind of technology are we engineering?** *A cane toad trap.*
   - **Do you remember how far away the starting point of your trap needs to be from where the toad is caught? Why?** *The trap needs to be activated from a spot at least 4 feet away from where the toad will be caught because the cane toad can shoot poison up to 3 feet!*

Set the Stage (5 min)

1. Explain that kids can all learn from each other's first trap designs and testing. Have some groups share what they have done so far. Ask:
   - **What worked well in your first design? What did not work well?**
2. Encourage groups to learn from what worked well and what did not work well in other groups' designs. Explain that engineers learn from each other all of the time!

Let the Creativity Begin! (25 min)

1. Give groups time to *improve* their traps. They may need to gather new materials from the Materials Store.
2. Have groups measure the length of their designs, and then test their designs at least twice using the wind-up toad.
3. As groups build and test, ask questions like:
   - **Did your group successfully trap the cane toad?**
   - **How have you *improved* your trap?**
   - **Which parts of your new design work well?**
4. If kids get frustrated working on their traps, remind them that engineers often come up with many designs that do not work before they are able to engineer a design that works.

Tip: If groups are stuck, encourage them to talk to other groups and ask if they have ideas about how to solve certain design problems.

Tip: If groups finish early, they can use markers and paper to camouflage their traps. For fun, you might also encourage them to perfect the way they will "hide" from the cane toad when activating their trap.

Reflect (10 min)

1. Show kids the *Engineering Design Process* poster. Ask:
   - **Which steps did you use most today?**
   - **Which step was the most fun for your group? Why do you think engineers use this step?**
   - **If you could *improve* your trap again, which parts would you change?**
2. Tell kids that during the next adventure, they will get the chance to show off the great engineering they have been doing. If you would like kids to invite their families or friends, let them know.
3. Give kids time to record their thoughts on *Improve*, p. 13 in their Engineering Journals. Recording the results of their testing will help kids remember what they have learned and prepare them for the next adventure, when they will share the traps they engineered.

Tip: If groups finish early, they can fill out *Cane Toad Problems*, pp. 18–19 in their Engineering Journals.

Improve a Cane Toad Trap

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Time is Almost Up!

2:45 PM

Hey everyone,

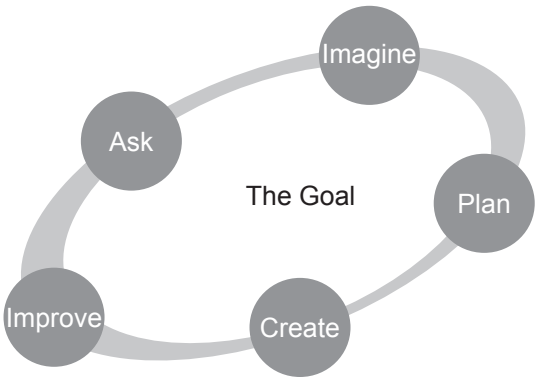
The technologies you engineered to trap the cane toad are looking great. We are leaving early tomorrow morning to go back home, and we need to have the traps ready to go so we can catch the cane toad before we leave!

We need the final traps to be the best they can be. Remember that you need to be able to activate the traps from at least 4 feet away from where the toad will be caught. Share your ideas with each other and try to *improve* your traps even more! Use the steps of the Engineering Design Process to help you. This is what engineers do all the time.

If you have time, think about some ways to camouflage your trap—make it blend in to what's around it so the cane toad will not see it. You could also think about putting some bait inside to attract the toad.

We're counting on you . . . and so are New Zealand's native animals!

India



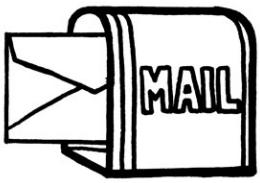
Engineering Showcase: Hop to It

Overview: Kids present their cane toad traps and knowledge of the Engineering Design Process by creating a Public Service Announcement (PSA) that tells others about the dangers of cane toads.

Note to Educator: It may take some groups extra time to prepare their PSAs. Consider spreading this adventure over the course of two sessions.

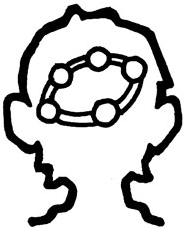
You may want to invite guests; such as other kids from your program, parents, friends, or even professional mechanical engineers; to come see the Showcase! During the Showcase, encourage kids to take ownership of their designs, feel proud of the work they have done, and show off their new skills and knowledge.

Duo Update (5 min)



Activity (35 min)

Reflect (5 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 6 or Engineering Journal, p. 14
- ☐ *Engineering Design Process* poster
- ☐ wind-up cane toad
- ☐ optional: camera or video camera

For each group of 3-5 kids:

- ☐ markers or crayons
- ☐ paper
- ☐ traps from Adventure 3

For each kid:

- ☐ Engineering Journal

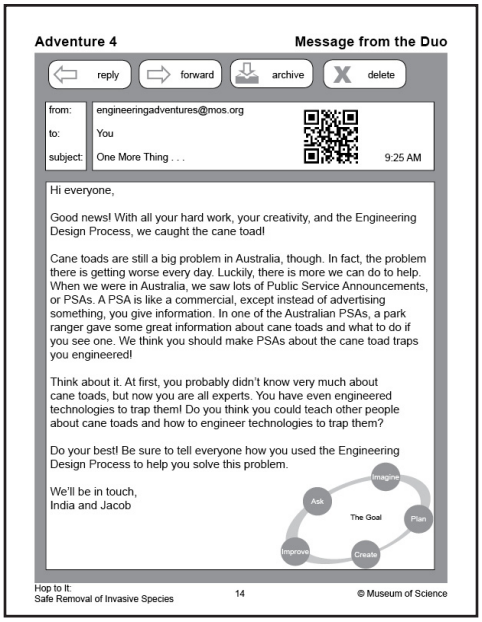
Preparation

Time Required: 10 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. If possible, plan to record or take pictures of this adventure!

Journal Pages for Adventure 4

Message from the Duo, p. 14



Adventure 4 **Message from the Duo**

reply | forward | archive | delete

from: engineeringadventures@mos.org
to: You
subject: One More Thing . . . 9:25 AM

Hi everyone,

Good news! With all your hard work, your creativity, and the Engineering Design Process, we caught the cane toad!

Cane toads are still a big problem in Australia, though. In fact, the problem there is getting worse every day. Luckily, there is more we can do to help. When we were in Australia, we saw lots of Public Service Announcements, or PSAs. A PSA is like a commercial, except instead of advertising something, you give information. In one of the Australian PSAs, a park ranger gave some great information about cane toads and what to do if you see one. We think you should make PSAs about the cane toad traps you engineered!

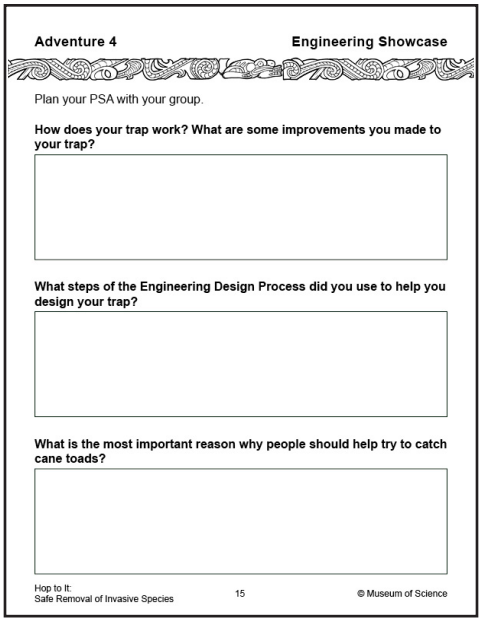
Think about it. At first, you probably didn't know very much about cane toads, but now you are all experts. You have even engineered technologies to trap them! Do you think you could teach other people about cane toads and how to engineer technologies to trap them?

Do your best! Be sure to tell everyone how you used the Engineering Design Process to help you solve this problem.

We'll be in touch,
India and Jacob

Hop to It:
Safe Removal of Invasive Species 14 © Museum of Science

Engineering Showcase, p. 15



Adventure 4 **Engineering Showcase**

Plan your PSA with your group.

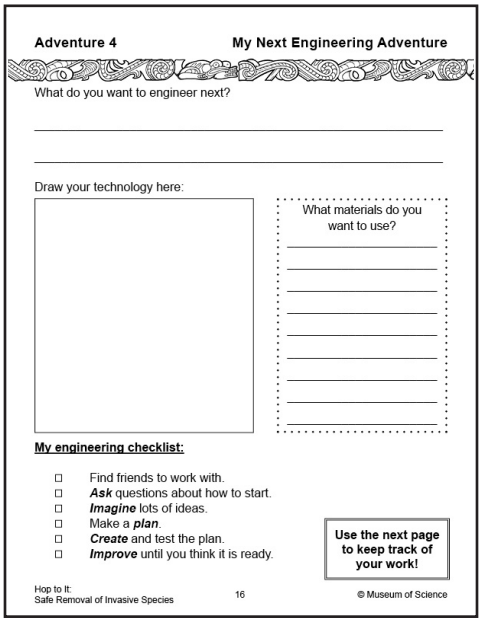
How does your trap work? What are some improvements you made to your trap?

What steps of the Engineering Design Process did you use to help you design your trap?

What is the most important reason why people should help try to catch cane toads?

Hop to It:
Safe Removal of Invasive Species 15 © Museum of Science

My Next Engineering Adventure, p. 16



Adventure 4 **My Next Engineering Adventure**

What do you want to engineer next?

Draw your technology here:

What materials do you want to use?

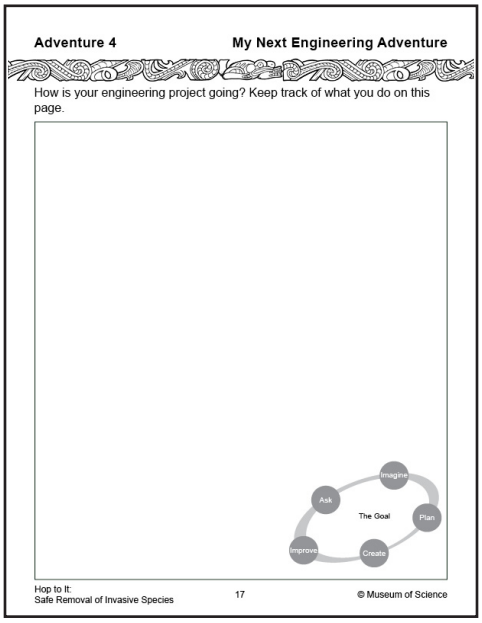
My engineering checklist:

- ☐ 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!

Hop to It:
Safe Removal of Invasive Species 16 © Museum of Science

My Next Engineering Adventure, p. 17



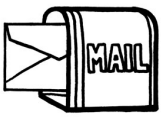
Adventure 4 **My Next Engineering Adventure**

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

Hop to It:
Safe Removal of Invasive Species 17 © Museum of Science

Engineering Showcase: Hop to It

Kids will learn:
- They can share how they used the steps of the Engineering Design Process to help them *ask*, *imagine*, *plan*, *create*, and *improve* their cane toad trap technologies.



Present the Message from the Duo (5 min)

1. Tell kids that today they will get the chance to share all of their great engineering work with others. The Duo sent them a message with some details.
2. Have kids turn to *Message from the Duo*, p. 14 in their Engineering Journals. Play track 6.
3. To check for understanding, ask:
   - **What do India and Jacob want us to do?** *They want us to make a PSA to tell people about why cane toads are dangerous and how we engineered our traps.*
   - **Why do they want us to do this?** *If we teach people about what we did to help solve the cane toad problem, maybe other people will try to solve the problem, too.*

Let the Creativity Begin! (15 min)

1. Have groups think about how they will present their PSA. They may want to record ideas in *Engineering Showcase*, p. 15 of their Engineering Journals. Encourage groups to think about how they used the Engineering Design Process throughout all of the adventures.
2. Remind kids that they will share their presentations with the entire group when they are done.

Tip: If you have time, show kids a few PSAs from the Internet. Talk about what each is trying to say and what makes it effective.

Share (20 min)

1. Have each group present their PSA to everyone. Have the wind-up toad toy available so groups can show how their traps work. If possible, record the PSAs or take pictures.
2. After groups present, ask:
   - **Which parts of your trap work the best?**
   - **Which parts of your trap would you still like to *improve*?**
   - **Which step of the Engineering Design Process helped you the most in engineering your trap?**

Reflect (5 min)

1. Gather kids together to wrap up their engineering experience. Ask:
   - **What would you say to someone who is about to bring an invasive species to an area?**
   - **Do you think engineers can help take care of the environment? Why?**
2. Give kids time to record their thoughts in *My Next Engineering Adventure*, p. 16–17 in their Engineering Journals. Having kids record their ideas will help them to remember and consolidate what they learned throughout the unit and to apply their new skills in their daily lives. Encourage kids to continue engineering!

Message from the Duo

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	One More Thing . . .

9:25 AM

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