Cadette
Think Like an Engineer
Journey

girl scouts
of western new york

Cadette Think Like an Engineer Journey

In this journey we will do 3 design thinking activities:

- design and build prototypes of a life vest for a dog,
- a model camp cabin inspired by nature,
- and a prosthetic leg for an elephant.

These will help us prepare for our Take Action Project at the end. Then you will plan your take action project to help others.

What kinds of work do Engineers do?

Here are some examples of how engineers help the world a better place:

- **Everyday Solutions:** Engineers solve everyday problems by inventing and building things that can be used in the real world, like bridges, buildings, planes. They create new and improved ways to make life easier and more efficient for everyone.
- **Agricultural Solutions:** Engineers work with farmers to design new machines, like improved irrigation (watering) systems, that help them to grow and harvest crops faster and more efficiently.
- **Water Solutions:** Engineers work around the world to build wells and other water systems, providing communities with access to clean water.
- **Manufacturing Solutions:** Engineers create machines that speed up the production process.
- **Energy Solutions:** Engineers create energy and light systems, like solar and wind power, to bring electricity to communities.
- **Solutions in Times of Disaster:** Engineers design structures with disaster in mind. For example, following Hurricane Sandy in New York City, engineers evaluated their current systems and designed stronger infrastructure for cities like New York to better weather against any future natural disasters.
- **Technological Solutions:** Aerospace engineers design spaceships and satellites, giving astronauts and scientists the ability to learn more about our solar system and universe.

Cadette Think Like an Engineer Journey

Engineers go through certain steps to solve a problem.

- First step is to - Define the need -
- Second Step - Brainstorm -
- Third step - Design -
- Fourth Step is a cycle of steps starting with
  - Building your design
  - Test /Evaluate
  - Redesign your project
- Fifth step is to share your solutions

Step 1
Define the need

Define The Need - This means to figure out what the problem is that you would like to fix. Example: Maybe grandma has trouble getting up the steps at your house. Here would be the problem you would need to focus on.

Step 2
Brainstorm

Brainstorm - This means to think about how we can fix the problem we have found. Maybe you design and build a ramp.

Step 3
Design

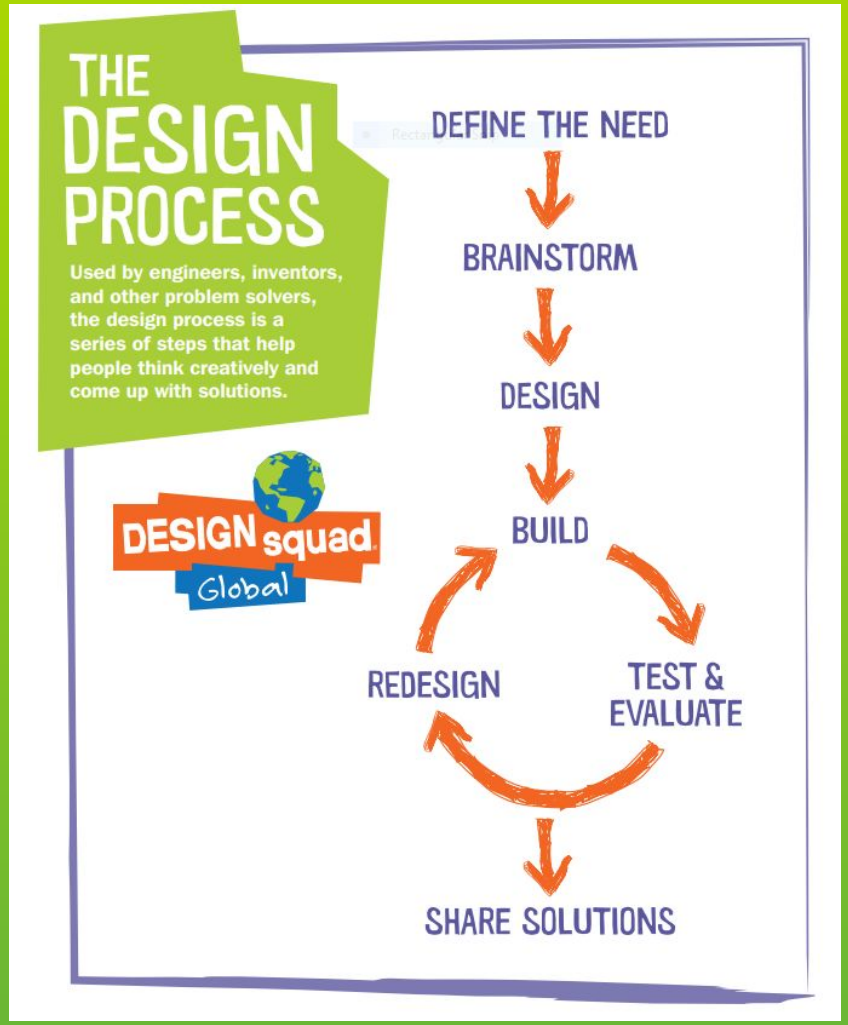
Design - This is the step where you will sketch or draw out what it will look like. So if you were designing a ramp you would sketch how it looked and start thinking about materials dimensions and any other supplies you may need.

Step 4
Building

Building your design - This is where you build what you have sketched to help solve the problem. After you build it you will Test & Evaluate which is a part of the cycle in this step. If you test it out and it does not work the way you had hoped then you go and Redesign your project again. Then once you have redesigned and think you have fixed the problem you will build again and then test again. Engineers may spend a great deal of time on this last step in order to get their project working in the best way to help people. It is ok to try and fail several times it is part of the process. Failure actually helps because an Engineer will learn more and more each time they fail and can fix the problems so that they can create the best solution to help people!

Step 5
Share solutions

The fifth step is to **share** your solutions.


THE DESIGN PROCESS
Used by engineers, inventors, and other problem solvers, the design process is a series of steps that help people think creatively and come up with solutions.
DESIGN squad Global
DEFINE THE NEED
BRAINSTORM
DESIGN
BUILD
TEST & EVALUATE
REDESIGN
SHARE SOLUTIONS

Journey Glossary

https://my.girlscouts.org/content/dam/girlscouts-vtk2019/local/aid/meetings/C18EJ01/Cadette-Think-Like-an-Engineer-Glossary.pdf

Bioinspiration – the process of being inspired by living things. Bioinspired engineering is a new and growing field. It combines knowledge of engineering and natural sciences to develop technologies that are often more sustainable than those not inspired by nature. Many technologies are bioinspired, such as Velcro strips inspired by plant burrs or aerodynamic cars shaped like boxfish.

Biomechanical engineers – people who use what they know about biology and mechanical engineering to solve problems related to health and safety. Biomechanical engineers work on projects such as designing artificial limbs, joint replacements, and safety equipment, like helmets and life jackets.

Constraints – ways that you or your design are limited. For example, you might only have a certain amount of time or materials for your prototype.

Criteria – things you or your design needs to accomplish. For example, if your Design Challenge is "You must create a tower 4 feet tall" or "You must build a structure that can withstand wind for 30 seconds," those are your criteria.

Design Thinking Process – the steps engineers use to design technologies to solve problems. Engineers begin with identifying a problem that needs to be solved and investigating what has already been done. Next, engineers imagine different solutions and plan their designs. Then, they create and test their designs and make improvements based on the test results. Finally, engineers communicate their findings to others.

Empathy – the ability to understand how someone else feels.

Engineers – people who use their creativity and knowledge of math and science to design technologies that solve problems. They create infrastructure like bridges, build clean water solutions like wells, design energy solutions like solar and wind power, build rockets that take aeronauts into space, and so much more.

Empathy – the ability to understand how someone else feels.

Engineers – people who use their creativity and knowledge of math and science to design technologies that solve problems. They create infrastructure like bridges, build clean water solutions like wells, design energy solutions like solar and wind power, build rockets that take aeronauts into space, and so much more.

Form and function – the concept that the form (shape and size) of an object determines how well that object functions (does its job). For example, adding a rudder to a boat helps it to move in specific directions.

Materials engineering – the field of engineering focused on designing materials with desired properties. Materials engineers use their understanding of the properties of different materials (such as metals, plastics, or woods) to design and improve technologies. In particular, materials engineers explore the properties of different materials to help them choose which material will work best to solve the problem.

Model – a representation that helps us to understand an object or concept. Biomechanical engineers sometimes use models of their subjects to help them engineer prototypes before they are ready to test their designs in the real world.

Prosthesis – an artificial device that takes the place of a missing body part.

Prosthetic – a replacement body part (e.g. A prosthetic device such as an artificial leg).

Prototype – a quick way to show your idea to others or to try it out. It can be as simple as a drawing or it can be made with everyday materials like cardboard, paper, string, rubber bands, etc.

Sustainability – coming up with a solution that lasts and continues to address the problem over time.

Sustainable solution – a solution that lasts. Sustainable solutions often address the root causes of an issue. Sustainable solutions create a difference for those impacted by a problem over the long-term.

Technology – anything created by people to help solve a problem or meet a need. Technology can be things that require electricity, such as computers and phones, or non-electric products, such as pencils, paper, and water bottles.

User-centered design – When engineers practice user-centered design, they involve their users at every stage of the Design Thinking Process. By incorporating the user's needs, concerns, and feedback into their design, engineers are better able to create a product that solves their user's problem and takes into account what's most important to them.

This resource is available on-line by clicking the link above.

Dog Model Template

https://my.girlscouts.org/content/dam/girlscouts-vtk2019/local/aid/meetings/C18EJ01/Dog-Model-Template.pdf

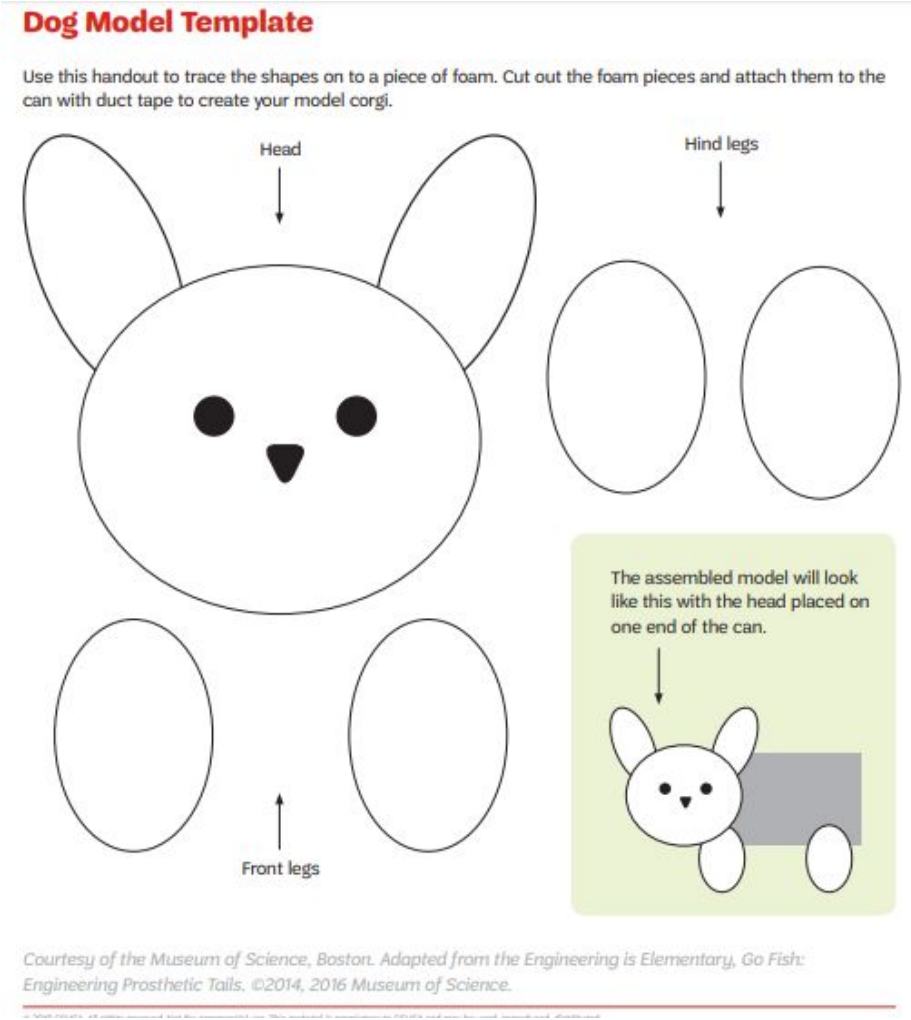
This resource is available on-line by clicking the link above.

You will need to make this model dog model to help with Activity #1

Suggested materials:

- Fun foam
- Scissors
- Duct tape
- Unopened can

(Substitute other materials if needed.)



Dog Model Template

Use this handout to trace the shapes on to a piece of foam. Cut out the foam pieces and attach them to the can with duct tape to create your model corgi.

Courtesy of the Museum of Science, Boston. Adapted from the Engineering is Elementary, Go Fish: Engineering Prosthetic Tails. ©2014, 2016 Museum of Science.

Activity 1

DESIGN CHALLENGE:

Corgi Life Vest Challenge

Suggested materials

- Large plastic tub with water and towels for testing clean-up
- Model Corgi
- 2 sheets of foam (roughly 9 x 12 in. each)
- 2 plastic bags (strong sandwich bags)
- 3 large rubber bands
- Measuring tape
- Scissors
- Duct tape

Throughout this Journey, you'll be challenged to design things that make the lives of animals and humans better. Today, you've been hired by a family who has a corgi named Champ. Corgis have a hard time swimming because of their short legs. In preparation for an upcoming trip, the family would like a life vest made for Champ that would allow him to play with the children in the lake., use your imagination to create a reason why your animal might need to be able to float.

You'll use your group's model to test the prototype of your life vests.

A ***prototype*** is a quick way to show an idea to others or to try it out. It can be as simple as a drawing or it can be made with everyday materials like cardboard, paper, string, rubber bands, etc.

Engineering Notes

BRAINSTORM SOLUTIONS, PLAN, & BUILD A PROTOTYPE

What is the design plan for your life vest? Write down ideas or draw plans for your design.

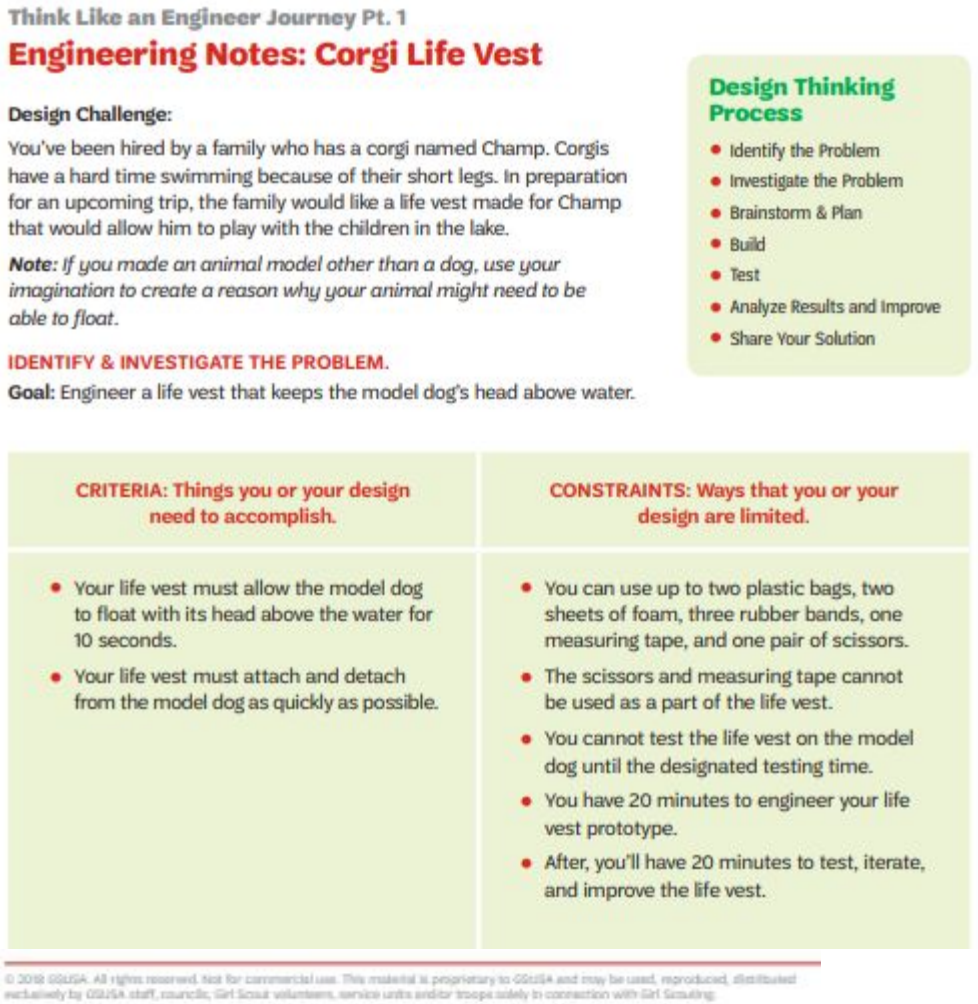
TEST, EVALUATE, AND REDESIGN

What materials or methods worked best for keeping Champ afloat?

What materials or methods worked best for quickly attaching and detaching the life vest to and from Champ?

https://my.girlscouts.org/content/dam/girlscouts-vtk2019/local/aid/meetings/C18EJ01/Cadette-Engineering-Notes-Corgi-Life-Vest.pdf

This resource is available on-line by clicking the link above.



Think Like an Engineer Journey Pt. 1

Engineering Notes: Corgi Life Vest

Design Challenge:

You've been hired by a family who has a corgi named Champ. Corgis have a hard time swimming because of their short legs. In preparation for an upcoming trip, the family would like a life vest made for Champ that would allow him to play with the children in the lake.

Note: *If you made an animal model other than a dog, use your imagination to create a reason why your animal might need to be able to float.*

IDENTIFY & INVESTIGATE THE PROBLEM.

Goal: Engineer a life vest that keeps the model dog's head above water.

Design Thinking Process

- Identify the Problem
- Investigate the Problem
- Brainstorm & Plan
- Build
- Test
- Analyze Results and Improve
- Share Your Solution

CRITERIA: Things you or your design need to accomplish.	CONSTRAINTS: Ways that you or your design are limited.
• Your life vest must allow the model dog to float with its head above the water for 10 seconds. • Your life vest must attach and detach from the model dog as quickly as possible.	• You can use up to two plastic bags, two sheets of foam, three rubber bands, one measuring tape, and one pair of scissors. • The scissors and measuring tape cannot be used as a part of the life vest. • You cannot test the life vest on the model dog until the designated testing time. • You have 20 minutes to engineer your life vest prototype. • After, you'll have 20 minutes to test, iterate, and improve the life vest.

Take Action Pause

Let's take a minute to brainstorm who is in our community. In the circles you will get a little idea of what your communities look like. Each circle represents a different community, starting with you in the center and working your way out to each community. They are all a part of a larger scale community which your are a part of , but each has its own area in your life.

Take a few minutes and draw your communities and then add problem areas in each community you may like to fix or help with.

Now that you brainstormed different issues in each community, narrow down which community you would like to focus on.

Congratulations you have a huge start to your Take Action Project!!

Use this **Take Action Guide** if you need more help planning your Take Action Project :
https://my.girlscouts.org/content/dam/girlscouts-vtk2019/local/aid/meetings/C18EJ01/Engineering-Take-Action-Guide.pdf

Activity 2

DESIGN CHALLENGE:

Camp Cabin

A summer camp would like you to design their new cabins. They would like the cabins based upon, or inspired by, shelters created by animals.

“Animal shelters” refer to the natural homes animals create and live in. It does not mean a place where stray animals are housed.

Goal for Design challenge: Engineer a model camp cabin inspired by a shelter created by an animal.

Examples of animal shelters: Birds nest, beaver lodge, end, burrow, etc

Use your Design process to complete challenge

Materials needed:

- Ball of string
- Electric fan
- Roll of aluminum foil
- Spray bottle
- Construction paper
- Stop watch
- Masking tape
- Packaging tape
- Sheet of cardboard 8x8
- 2 plastic cups 1-2 oz
- 2 sheets construction paper
- Measuring tape
- Scissors
- Examples of animal shelters you found

Animal Shelter Examples

BIRD'S NEST

A bird's nest is where a bird keeps its eggs and raises its young. The structure is usually made of intertwined and woven twigs and leave. Often, birds use mud to seal the woven pieces together.

BEAVER LODGE

These are structures built by beavers to keep out predators, like coyotes and bears. Beavers make their lodges out of mud, stones, leaves, sticks, and bark to make a large and very strong structure.

TERMITE MOUND

Termites live in a nest at the base of a mound that has many chambers and tunnels. Termites create a mixture of earth materials and saliva that makes a concrete-like, water-resistant material that surrounds their mound.

WASP NEST

Wasps are able to chew up and soften wood fibers in order to make a paper pulp they can use to construct a nest. The mixture of paper fiber and saliva they use creates a water-resistant building material.

Click here to find a printable version of these:

Engineering Notes: Camp Cabin

https://my.girlscouts.org/content/dam/girlscouts-vtk/meeting-aids/Cadette-Engineering-Notes-Camp-Cabin.pdf

Think Like an Engineer Journey Pt. 2

Engineering Notes: Camp Cabin

Design Challenge:

You've been contacted by a local engineering firm. The firm has a client who owns a local summer camp and would like you to design their new cabins. She would like the cabins to be based upon, or inspired by, shelters created by animals.

Design Thinking Process

- Identify the Problem
- Investigate the Problem
- Brainstorm & Plan
- Build
- Test
- Analyze Results and Improve
- Share Your Solution

IDENTIFY & INVESTIGATE THE PROBLEM.

Goal: Engineer a model cabin inspired by a shelter created by an animal.

CRITERIA	CONSTRAINTS
• Your model cabin must be inspired by at least one of the example animal shelters. • Your model cabin must be water and wind resistant. • Your model cabin must contain an entrance. The entrance should allow for a ¼ sheet of construction paper to easily be placed inside and taken out. • Your model cabin must be at least 5 inches tall and 5 inches wide.	• You have 10 minutes to brainstorm and plan. After, you have 20 minutes to engineer. • You may use up to one sheet of cardboard, two sheets of construction paper, two plastic cups, 12 inches each of masking and packaging tape, and any amount of aluminum foil and string. • A measuring tape and scissors may be used as tools.

BRAINSTORM SOLUTIONS, PLAN AND BUILD A PROTOTYPE.

Which animal shelter(s) will you draw inspiration from?

- ☐ Bird's Nest
- ☐ Beaver Lodge
- ☐ Termite Mound
- ☐ Wasp Nest
- ☐ Other: .....

What's the design plan for your model cabin? Write ideas or draw plans for your design here. Use extra paper if you need to!

TEST, EVALUATE, AND REDESIGN.

- **Is the cabin wind resistant?** Place your cabin in front of the fan for 15 seconds. Start the fan on the lowest setting. If you cabin isn't moved by the wind, turn the fan to a higher setting.
- **Is the cabin water resistant?** Put a small sheet of construction paper inside of your cabin. Spray the top of the cabin with water 15 times, and check if the construction paper was able to stay dry.

What happened during testing?

In the wind, my cabin:

- ☐ It slid.
- ☐ It tipped or fell.
- ☐ The wind pushed it.
- ☐ No movement.

This much water dripped on the paper in my model cabin:

- ☐ None
- ☐ Spots of < ½ inch
- ☐ Spots of ½–1 inch
- ☐ Spots >1 inch

Take Action Pause

You have narrowed down the community you would like to focus on now let's look at the problems you found in that community.

Write each problem you found and identify a root cause of that problem. Use note cards to help separate the problems out and their root cause.

Take and spread them out and begin your process of deciding on which one you would like to focus on.

Look closely at each and narrow down what you feel you could be most effective and helpful with. If possible think about sustainability this will help you when you begin to think about your Silver Award.

Do not worry about brainstorming a project yet. You just want to get those ideas flowing.

To Help Narrow Down Your Problem List:

- Which of these problems happens the most in your community?
- Which of these problems impacts the most people in your community?
- Which of these problems most interests you?
- Which of these problems do you know the most about?
- Which of these problems are you in the best position to address?
- For which of these problems do you think you could create a sustainable solution?
- Which of these problems do you think could be solved with an engineering and/or technological solution?

Activity 3

DESIGN CHALLENGE:

Elephant Prosthetic

You are a Biomechanical engineer and have been asked to create a prosthetic device for an Elephant! Use supplies to create a model leg and then test it on yourself. Use design process - design - build - test - as many times as you need.

Biomechanical engineers use knowledge of biology and mechanical engineering to solve problems related to health and safety.

A prosthetic device is something used to replace the function of a body part.

- Goal: Engineer a model prosthetic elephant leg
- Criteria: The model leg must
  1. Support their weight
  2. Attach to the models actual leg at the knee
  3. Stay together when used
  4. Be comfortable

Supplies:

- 1 roll of string
- 1 roll of packaging tape
- 1 ruler
- 2 plastic bags
- 2 sheets of felt
- 5 cardboard tubes 9”x1.5”
- 5 rubber bands
- 1 measuring tape
- 1 pair of scissors
- Duct tape
- Extra blank paper for planning
- Pens or pencils

Think Like an Engineer Journey Pt. 3

Engineering Notes: Elephant Prosthetic

Design Challenge: You've been hired as a biomechanical engineer to create a prosthetic device for a large land animal—an elephant!

- Biomechanical engineers use what they know about biology and mechanical engineering to solve problems related to health and safety.
- A prosthetic device is a technology that is designed to replace the function of a body part. Prosthetic devices have been made by humans for centuries, and now engineers are beginning to create prosthetic devices for animals, too.

Design Thinking Process

- Identify the Problem
- Investigate the Problem
- Brainstorm & Plan
- Build
- Test
- Analyze Results and Improve
- Share Your Solution

IDENTIFY THE PROBLEM.

Goal: Engineer a model prosthetic elephant leg.

CRITERIA:

The model prosthetic elephant leg must:

- Support their weight
- Attach to the model's actual leg at the knee
- Stay together when used
- Be comfortable to wear

INVESTIGATE THE PROBLEM: Chhouk's Prosthetic Leg

In 2007, a young elephant in need of help was discovered in a remote region of northeastern Cambodia. The elephant was alone and having trouble moving around because the bottom portion of his right front leg had been lost. The injury was likely caused by a hunter's snare trap.

Human volunteers cared for the elephant and nursed him back to health. They named him "Chhouk," which means "Lotus Flower," and arranged for him to be transported to a wildlife rescue center where veterinarians and animal specialists could help him.

It soon became clear that Chhouk needed a prosthetic device to keep him healthy and restore his ability to walk. A team of biomechanical engineers created a prosthetic leg that was designed to function just like his original one. They chose materials that were strong enough to support his massive weight and durable enough to last. They also used soft padding and straps to ensure that the device was comfortable to wear and easy to attach.

The design was a success! Upon receiving his new prosthetic device, Chhouk's medical issues and spirit improved rapidly. Even so, the engineers have continued to improve upon their original design, creating several new versions of the device that match Chhouk's growing size and boundless energy!

Article adapted from: Wildlife Alliance, Chhouk, the Elephant with a Prosthetic Foot

TESTING THE PROSTHETIC LEG

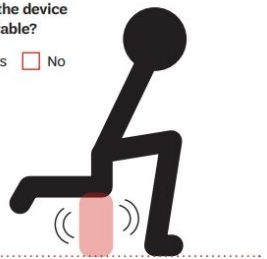
Carefully place your knee onto the top of your model prosthetic elephant leg and secure any attachments you have designed. Hold onto a friend or a steady piece of furniture to prevent yourself from losing your balance. Follow the testing procedures below.

Function

Place your weight on the prosthetic leg.

Does the device feel stable?

☐ Yes ☐ No

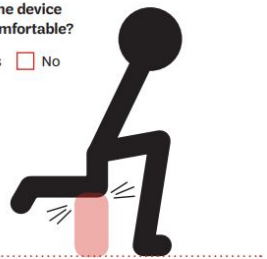


Comfort

Place your weight on the prosthetic leg.

Does the device feel comfortable?

☐ Yes ☐ No

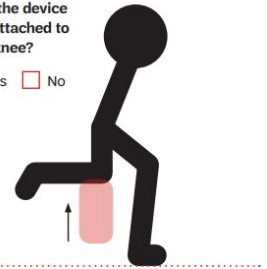


Attachment

Lift your leg off the ground.

Does the device stay attached to your knee?

☐ Yes ☐ No

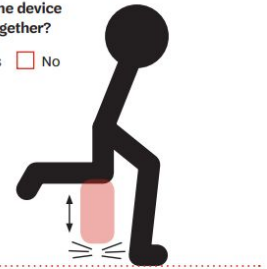


Durability

Walk in place for five steps.

Does the device stay together?

☐ Yes ☐ No



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https://my.girlscouts.org/content/dam/girlscouts-vtk/meeting-aids/Cadette-Engineering-Elephant-Prosthetic.pdf

You have earned your

Cadette Think Like an Engineer Badge!

The Cadette Think Like an Engineer badge and the Take Action badge can be purchased through our GSWNY Council Shop.

Questions?
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