Western Engineering

Outreach

Musical Masterpieces

Grade 6-8

Meet Today's ENG HERO!

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Corey Baron is an Assistant Professor of Medical Biophysics and a Robarts Scientist. Dr. Baron has a Ph.D. in Biomedical Engineering from the University of Alberta. His expertise includes high field diffusion MRI, MRI physics and image reconstruction, and his lab develops and applies ultra-high field quantitative MRI to uncover new imaging biomarkers for and obtain a greater understanding of the brain and neurological conditions. To learn more about Dr. Baron visit: https://cfmm.uwo.ca/people/core_scientists/Corey%20Baron.html

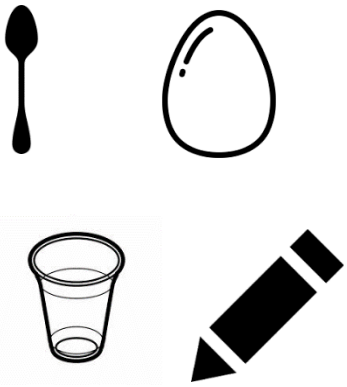
Learning Goal:

- Describe the basic concept of a hearing-aid and how sound can be amplified.
- Describe the need for the modern-day hearing aid and how engineers have improved the device with new materials and technologies.
- Curriculum Connections: Grade 6- Electricity and Electrical Devices, Grade 7- Form and Function, Grade 8- Systems in Action

Materials Needed:

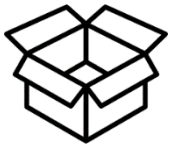
Maracas:

- 1 plastic egg or small plastic container
- 2 spoons
- Filling: Beans, Rice, popcorn seed or anything you have available at home
- Masking Tape
- Markers



Ear Trumpets (You do not need all of those materials since this is a design challenge)

- Scissors
- Masking tape
- Elastics
- Cotton Balls
- Construction paper
- Plastic soda bottle with the bottoms cut off (360 ml or 12 Oz size)
- Plastic cups
- Cardboard
- 6-8 cardboard tubes from paper towel or toilet paper rolls
- (optional) 4 funnels of various sizes; plastic works best



Engineering and Science Connections

What is the Engineering Design Process?

The engineering cycle or engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times, the solution involves designing a product (like a machine or computer code) that meets certain criteria and/or accomplishes a certain task.

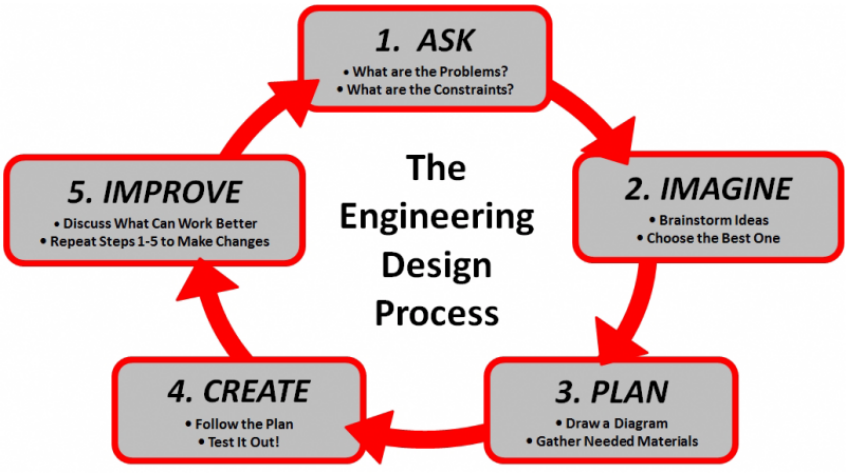
What is the difference between the Engineering Design Process and the scientific method?

The engineering design process is different from the Scientific Method, which you may be more familiar with. If your project involves making observations and doing experiments, you should probably follow the Scientific Method. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process. For today's activity, we will be using the engineering design process.

What are the steps to the engineering design process?

The steps of the engineering design process are to:

- Define the Problem
- Do Background Research
- Specify Requirements
- Brainstorm Solutions
- Choose the Best Solution
- Do Development Work
- Build a Prototype
- Test and Redesign (ITERATE)



Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change your design. This way of working is called iteration, and your process will likely do the same!

Be creative as an engineer!

Since engineers often need to get creative in the solutions they find to everyday problems, a great way to explore this line of thinking is actually through art. Every great engineering innovation started with an idea that no one had ever tried before, so the more creative you are, the better you can be as an engineer!

What is sound?

Sound is a type of energy made by vibrations. When any object vibrates, it causes movement in nearby air particles. These particles bump into the particles close to them, which makes them vibrate too, causing them to bump into more air particles. This movement, called sound waves, keeps going until they run out of energy. If your ear is within range of the vibrations, you hear the sound.

Sound Waves

Sound waves travel into the ear canal until they reach the eardrum. The eardrum passes the vibrations through the middle ear bones or ossicles into the inner ear. The inner ear is shaped like a snail and is called the cochlea. Inside the cochlea, there are thousands of tiny hair cells. Hair cells change the vibrations into electrical signals that are sent to the brain through the hearing nerve. The brain tells you that you are hearing a sound and what that sound is.

Biomedical Engineers

Some biomedical engineers study the function of the ear and develop systems that solve hearing problems, whether they are conductive or sensorineural. They can help develop the tiny circuits that control the microphones and amplifiers that work together to convert sound waves to electrical impulses. Once they have created the device, they need to ensure the design is made of durable, flexible plastic and shaped to fit comfortably in the ear or ear canal.

Hearing Aids: In our modern times, we have the technology to help us electronically amplify these sound waves to help someone with poor hearing be able to better identify sounds. The earliest versions of hearing aids were acoustic, meaning they had to mechanically amplify sounds without the aid of any technology. In historic times, ear trumpets (also known as ear horns) were made from hollowed-out horns from cows, rams or other animals. In later centuries, engineers experimented with different materials such as silver, brass, ocean shells, and more recently, plastic. To aid in his deafness, composer and

pianist Ludwig van Beethoven used many of these devices, which in the 1700s and 1800s, were considered a fashion accessory. Today, the ear horn has been replaced with the modern hearing aid, typically worn in the outer ear.

Highest Quality of Sound

To achieve the highest quality of amplified sound, engineers experimented with different materials and shapes for ear trumpets over the years. Amplitude measures how much energy a particular wave carries. For humans, the amplitude is interpreted as loudness or intensity. A material's ability to transmit sound depends on its properties. For example, stiff plastics and rubber tubing transmit sound energy well, while cloth and porous foam absorb sound energy. Also, the more layers through which sound waves must travel, the more energy that is absorbed and the quieter the sound seem.

Activity

In today's activity, you will design an ear trumpet to amplify the sounds made by different types of maracas that you will build.

To get started let's build the maraca first!

Step 1: The Filling

- Place the filling in the egg, you only need about a tablespoon.

Step 2:

- Close the eggs and squeeze them in between the two spoons. Secure with tape around the spoons. You can decorate the tape of the maracas if you want.

Now let's design your ear trumpets using the engineering design process! Ready for the Design Challenge?

Step 1: *Imagine*

- Using the available materials think of ideas and designs.

Step 2: *Plan*

- Using a paper draw your design and label the materials used for each component of the design.

Step 3: *Create*

- Start building what you have planned on the paper.

Step 4: *Test*

- Evaluate your by ranking how well the devices aided in hearing differently pitched sounds and voices, and how big of an "ocean-effect" the devices caused, which is considered a design flaw and should be minimized. Try to hear the maracas

Step 5: *Improve*

- Make modifications to your original design. Retest the second design, following steps 4-6 again, recording results on a paper.

What did you learn?

- What is sound?
- The Engineering Design Process
- Designing your trumpet design
- Hearing aids and engineers

Future Learning

- You can turn this design challenge into a fun game to play with friends, siblings, family members, guardians or anyone at home! Have one person in the center of the room blindfolded with a cotton ball in their ear and have another person stand around the room. Have one person at a time shake their maraca and see if the blindfolded students can identify which corner of the room the sound is coming from. Repeat the activity with the ear horns and see if the listening partner does a better job of identifying which direction the sound is coming from

Share your creations!

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