

Pre Lesson: Teacher's Guide

Engineers and the Engineering Design Process

The pre-visit lesson consists of a power point presentation explaining engineering and the design process.

- 1** *Ask students:*
- What do you think an engineer is or what is engineering?
 - What do you think of when you hear the word engineering?

Answer:

Engineering is not usually considered a science. Science is about discovering the natural. Engineering is creating the artificial.

Engineers apply the principles of science and mathematics to develop solutions to problems.

Math and science classes are both basic to engineering. Engineers use math and science to invent, design, and build things. They are team players with independent minds who ask, "How can we develop a better recycling system to protect the environment, design a school that can withstand an earthquake, or create cutting-edge special effects for the movies?" By dreaming up creative and practical solutions, engineers are changing the world all the time.

- 2** *Show your class the picture of the picnic scene. Break them into small groups and have them come up with 5-10 items that have been engineered in the picture. Challenge your students to think beyond the typical.*

Or as a class, make a list of the items that have been engineered.



Give the groups about 10 minutes to come up with their answers. Then have each group in turn list all the items they came up with.

Some examples: (bold are commonly missed)

- Playground, building, fence, bike, helmet, cell phone, cooler, pop can, **pop**, water bottles, **apples**, sunglasses, football, chair, sandals, watch, **clothes**.
- Almost everything in the picture has been engineered.

Teacher note: An argument could be made that everything pictured could be engineered, including dirt, rocks and even animals. However, many natural items in a student's world will not have been engineered.

Engineering has been called the "invisible" or "stealth" profession. Everything around you and that you use every day has been engineered in some way, yet you rarely hear about the work of engineers.

3 There are many types of engineering. (The italicized sentences are teacher information.)

The four main branches are:

- Chemical
- Civil
- Electrical
- Mechanical

Other branches of engineering include aerospace, biomedical, environmental, and manufacturing.

Chemical engineers

- Chemical engineers discover and manufacture:
 - plastics
 - paints
 - fuels
 - fibers
 - medicines
 - fertilizers
 - paper
- Chemical engineers also play an important role in protecting the environment by inventing cleaner technologies.

Civil engineers

- Civil engineers oversee the construction of the buildings and other structures that make up our world:
 - highways
 - skyscrapers
 - railways
 - bridges
 - water reservoirs

Civil engineers are known to say it's architects who put designs on paper, but engineers who actually get things built.

Electrical engineers

- This is the largest field of engineering
 - Encompasses the macro (huge power grids that light up cities) as well as the micro (devices smaller than a millimeter that tell a car's airbags when to inflate).*
- Electrical engineers develop components for
 - the most fun things in our lives
 - MP3 players, digital cameras, or roller coasters
 - as well as the most essential
 - medical tests or communications systems

Mechanical engineers

- Mechanical engineers work in nearly every area of technology.
- If an object or system has a moving part, it has benefited from the influence of a mechanical engineer.
 - Mechanical engineers often have to work with all other branches of engineering.*
- Mechanical engineers might develop:
 - a bike lock
 - an aircraft carrier
 - a child's toy
 - a hybrid car engine
 - a wheelchair
 - a sailboat

4 Engineering Design Process

- Engineers use a design process.
 - Not all engineers use all the steps of the design process but many use some of the steps.*
- It helps them stay focused and on track when developing a product or a solution to a problem.



- The main steps are
 - **Identify the Problem**
Describe the challenge to be solved, including limits and constraints.
 - **Explore**
Research what others have done. Discover what materials are available.
 - **Design**
Use your knowledge and creativity to come up with many solutions. Choose one idea and draw or make a model of it.
 - **Create**
Make your solution.
 - **Try It Out**
Test your solution.
 - **Make It Better**
Evaluate how the solution worked and think of how to improve your design.

Example Design Process

Identify the Problem: Make a new running shoe.

- Constraint: Made only of recycled materials

Explore: Find out what other companies are doing to use recycled parts. What materials are they using, how are they finding the materials, and what part of the shoe are they using them for.

- *Example: KEDS is making a shoe with recycled rubber from tires, organic cotton and shoelaces made from recycled water bottles.*

Design: Sketch and model various solutions, describing what each part is made of and how it will be transformed into a part of the shoe.

Create: Make the best solution from your models

Try It Out: Do tests with target audience (*e.g. runners and athletes*) and get their feedback.

Make It Better: Evaluate the feedback and make changes.

We look forward to having your class visit The Works where they will put the engineering design process into action.

Please read the emailed confirmation and review the schedule and your expectations with your students.

