



Daisy Mechanical Engineering

Explore mechanical engineering by earning these three badges!

Badge 1:

Board Game Design Challenge

Badge 2:

Roller Coaster Design Challenge

Badge 3:

Model Car Design Challenge



This Mechanical Engineering badge booklet for girls provides the badge requirements, information, and fun facts about engineering for all three (LEVEL) mechanical engineering badges. It does not include all the information needed to complete the badges. Volunteers may access full meeting plans—including detailed activity instructions—on the Volunteer Toolkit (VTK) or by contacting their local council.

Welcome to the world of mechanical engineering!

When you've earned these three badges, you'll know what engineers do.

You'll know how to brainstorm and design things.

You'll know how to build a model, test it, and make it better.

You'll also know about the kinds of things engineers make and how scientific ideas like force and friction help engineers build better machines.



Badge 1: Board Game Design Challenge

People have been playing games for thousands of years. Some are active, like hide-and-seek and soccer. Others, such as tic-tac-toe and Monopoly, are board games. Anyone can use their imagination and what they have on hand to make a game, just like an engineer. Engineers create things that solve problems, using simple steps to come up with ideas, make samples, test them out, and then improve their ideas. You'll use the same steps to create your own board game.

Steps

1. Come up with an idea for your board game
2. Design a spinner for your game
3. Test your game and make it better

Purpose

When I've earned this badge, I will know how to create my own board game and understand what inventors and engineers do.

Oldies, but Goodies: Board Games in History

- Senet, a game from ancient Egypt, is the oldest known board game. It's been found in tombs from 3500 to 3100 BCE!
- Mancala most likely started in Egypt and Eritrea between 500 and 700 CE. It was soon played by people across Africa and the Middle East.
- Backgammon comes from ancient Persia and Mesopotamia (or present-day Iran and Iraq).
- Most people think chess started in India before the 7th century.



STEP

1 Come up with an idea for your board game

What is your favorite board game? If you asked a lot of people, you'd get a lot of different answers. Board games can be about anything. Some are about solving mysteries, or being a doctor, or trying to get from one place to another. The one thing they all have in common, besides being fun, is that they started with an idea.

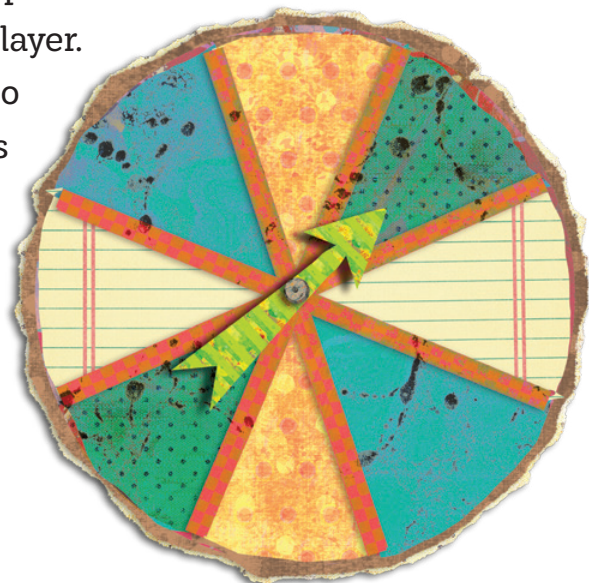
If you could design a board game about anything, what would it be? What is the goal? How do the players move around the board? How does someone win?

STEP

2 Design a spinner for your game

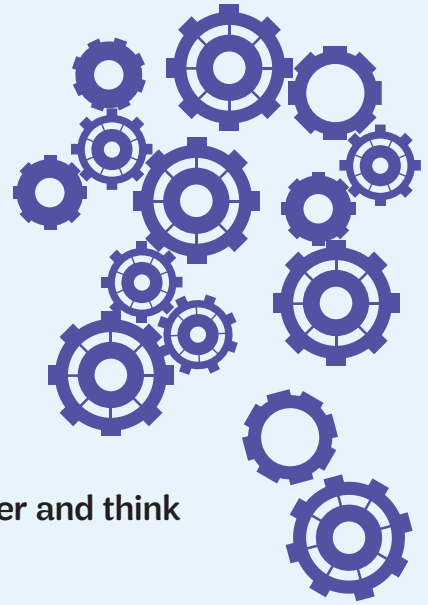
In most games, players take turns. Sometimes they roll dice, sometimes they pick a card, and sometimes they use a spinner to find out what to do on their turn. A spinner could have instructions other than just how many spaces to move forward—maybe you have to skip a turn, go twice, or trade places on the board with another player.

As the designer, you get to decide! Use the materials you have and your imagination to build a spinner that can twirl and point for your game.



WORDS TO KNOW

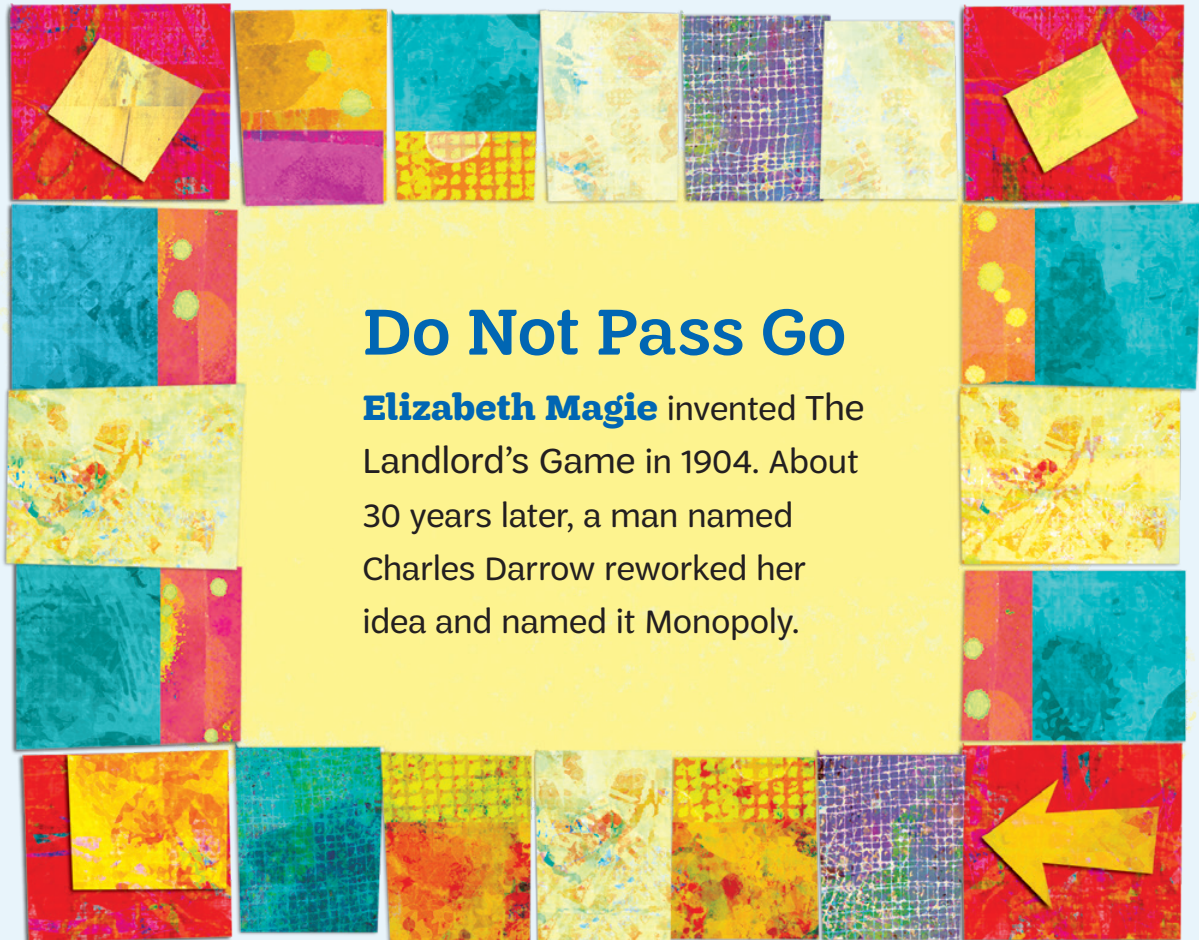
- ▶ **Inventors**—People who think of and build new products.
- ▶ **Engineers**—People who like to know how things work. They design and build things people use every day like computers, phones, roads, bridges, and cars.
- ▶ **Brainstorming**—When people come together and think of new ideas and solutions.
- ▶ **Features**—Parts of a product that are designed to make them more useful. For example, windshield wipers or automatic door locks are features of a car.
- ▶ **Force**—The strength or energy that creates movement. Push and pull are examples of force.
- ▶ **Friction**—A force that slows down movement. Friction happens when two surfaces move across each other.





POPULAR GAMES INVENTED BY WOMEN

Have you ever played Quirkle? Monopoly? Sleeping Queens? Jenga?
All of these games were invented by women.



Do Not Pass Go

Elizabeth Magie invented The Landlord's Game in 1904. About 30 years later, a man named Charles Darrow reworked her idea and named it Monopoly.

Tower Power

In 1983, **Leslie Scott** created Jenga, which means “to build” in Swahili. She modeled the tower game after one she played using wooden blocks with her family. Thirty-five years later, over 4.3 billion Jenga blocks have been sold all over the world!

The Royal Treatment

Sleeping Queens is a card game invented in 2003 by a six-year-old girl! **Miranda Evarts** thought up the game when she couldn't fall asleep one night. Her family helped her develop the game and find a publisher, and three years later, it won an award from the Canadian Toy Testing Council.



Pattern Maker

Qwirkle is a pattern game invented by **Susan McKinley Ross** in 2006. Mindware, the company that produces it, says it is their most award-winning game.

STEP

3 Test your game and make it better

Failure is a good thing! Scientists, engineers, and inventors know that—they can learn a lot when their ideas don't work. Engineers test their inventions to find out what works and what doesn't. By thinking about how their invention failed, they can figure out how to make it better. Now that you've made your game, try it out to see how it works.

CHANGES

**Now that I've earned this badge,
I can give service by:**

Making a new game for my friends and family to play.

I'm inspired to:



Badge 2: Roller Coaster Design Challenge

Roller coasters are machines that move people very fast in surprising directions. It's all about the thrill of speed, turns, climbs, and drops. Some people love to ride on them and others do not, but we can all agree that building one will be fun! To build a great roller coaster, you need to understand motion, speed, and how to think like an engineer.

Steps

1. Make a simple roller coaster car
2. Build a model of a roller coaster
3. Test your roller coaster

Purpose

When I've earned this badge, I will know how roller coasters work and understand motion and speed.

STEP

1 Make a simple roller coaster car

To ride on a roller coaster, you need a car. Engineers make models when they are creating something new. Those models are called “prototypes.” *Proto* is Greek for “first.” Prototypes are a first try at making something new.

By making a model of a car that can roll down a ramp, you’ll be able to test an important part of your roller coaster to learn how it works.



Designed to Thrill

When she was a teenager, Robbin Finnerty discovered that she loved to build things. She worked in a machine shop and a junkyard and did construction work. Then she went to college to study engineering.

Now she works for Great Coasters International, Incorporated (GCII) where she comes up with ideas for new roller coasters. She works with structural engineers and construction crews to design and build roller coasters that are fun and safe.

Some of the roller coasters made by GCII are Thunderhead at Dollywood in Tennessee, Lightning Racer at Hershey Park in Pennsylvania, and Roar at Six Flags in Maryland.

STEP

2 Make a model of a roller coaster

Wood Versus Steel: Choose Your Track!

The first roller coasters were built out of wood with flat metal tracks, like a train.

Steel roller coasters, with tracks made of metal tubes, have a smoother ride than wooden roller coasters. Because the tube-shaped tracks can be bent in loops and corkscrews, steel roller coasters can take you upside down or looping sideways in ways that wooden roller coasters can't.

Some people still like the bumpier ride of wooden roller coasters better than the smooth ride of the steel versions.

Zooming down the track of a roller coaster is

exciting. As you drop down a steep hill, every part of you is moving faster and faster, making you feel like you are floating!

Roller coasters are made out of different kinds of materials and have different shapes. Once you've created a ramp for your car to roll down, you can use the ramp and your roller coaster car to make a model roller coaster. Try making ramps with different materials and see how well your car rolls.

IDEAS

ROLLER COASTER SCIENCE

Roller coasters are all about having fun with energy, force, and gravity. **Force** is the energy that moves something. When a roller coaster car climbs up that first steep hill, it stores up **potential energy** that it turns into **kinetic**, or moving, **energy** as it rushes down the hill. **Gravity** is the force that pulls the car down the hill.



Bungee jumping also uses gravity and potential and kinetic energy to make a thrilling and bouncy ride. When people go bungee jumping, they jump off a platform. Then the force of gravity pulls them down, stretching out the big rubber band that is a bungee cord. By stretching, the bungee cord stores potential energy. When the bungee cord snaps back, pulling the jumper up, it turns the potential energy stored in the cord into kinetic energy that moves them up.

STEP

3 Test your roller coaster

When engineers built the first rocket or robot, do you think it worked perfectly?

Probably not.

Some inventors spend years trying to get their ideas to work. They keep making it better by testing it over and over. Test your roller coaster to see how it works, just like an engineer would. How fast does your car go? What kind of ramp makes the car go faster?

That Special Something ...

Features are parts of an invention that make it more useful or interesting. An upside-down loop, a splash down in water, or special safety harnesses in the cars are features of roller coasters.

What kind of features would you put in your roller coaster?



HOW TO IMPROVE MY ROLLER COASTER

**Now that I've earned this badge,
I can give service by:**

Teaching someone else what I've learned about engineering.

I'm inspired to:



Badge 3: Model Car Design Challenge

People can get from place to place in a lot of ways. Some walk or ride a bike or skateboard. Sometimes people take a plane, train, or boat, and sometimes they go by car. Engineers have been creating cars for hundreds of years, and now it's your turn! Learn how engineers brainstorm, build models, and test their ideas as you create a car.

Steps

1. Design and build model cars
2. Use model cars to test the friction of different surfaces
3. Race your cars

Purpose

When I've earned this badge, I'll know how to build and test model cars and understand how friction and gravity affect speed.

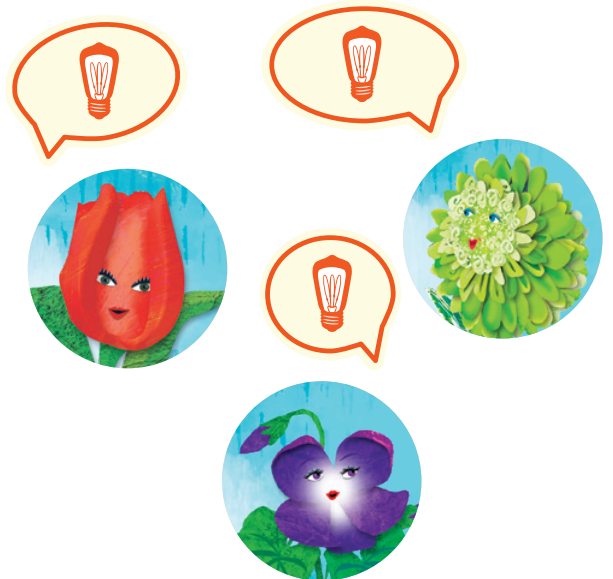
STEP

1 Design and build model cars

Before an engineer builds something, she thinks about the best way to do it. A group of engineers will brainstorm ideas about how to build their invention with the materials they have.

“Brainstorm” means they talk about the problem as a group and tell each other every idea they think of. No idea is too wacky!

Your challenge is to build a car that you can test on different surfaces to explore how friction impacts your car’s speed. What are some different ways you can use your materials to make a car?



STEP

2 Use model cars to test the friction of different surfaces

Engineers always test their inventions to understand how they work in different situations.

Sometimes they even make predictions about what will happen in a test. Now that you’ve built your car, it’s time to test how it works on different surfaces. Make a guess about whether your car will go farther on a smooth surface or a rough one. Then do a test to find out.

CREATIVE CARS

1 Henry Ford created the first car that would be produced in a factory so that lots of people could have one. It was called the **Model T**.



2 There were many **electric cars** in the 1800s. Then gasoline got cheaper and people started buying cars that used gas for fuel instead of electricity. Now that people are worried about the pollution gas-powered cars can cause, electric cars are becoming popular again.



3 Like the Model T, the **VW Beetle** was invented to be an inexpensive car that a large number of people could afford. Its round shape reminded the designers of a bug, so they nicknamed it “The Beetle.” (*Want to meet a Beetle that will make you laugh? The Love Bug is a funny movie about a VW Beetle named Herbie, who seems to have a mind of its own.*)



4 Designers created **Smart Cars** for folks in cities who needed to get around, but didn’t need a big car. They make one- and two-seat “microcars” that can travel far with just a little bit of fuel and don’t need much space to park.

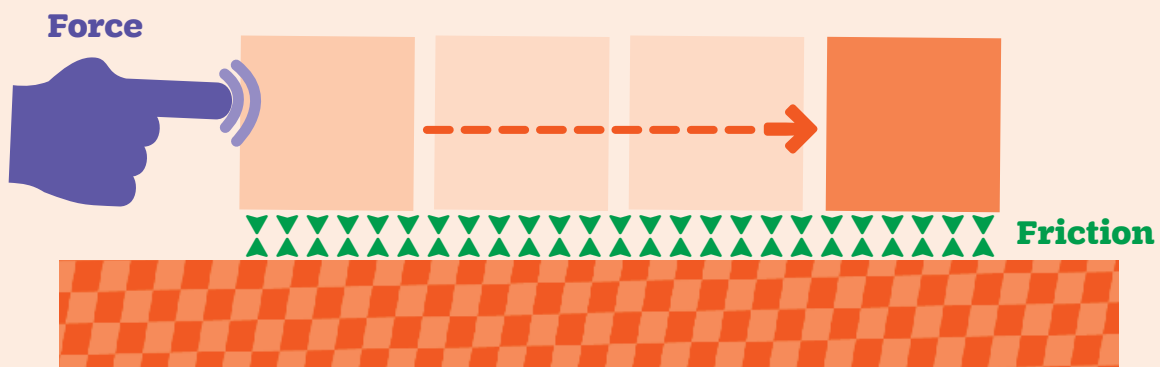


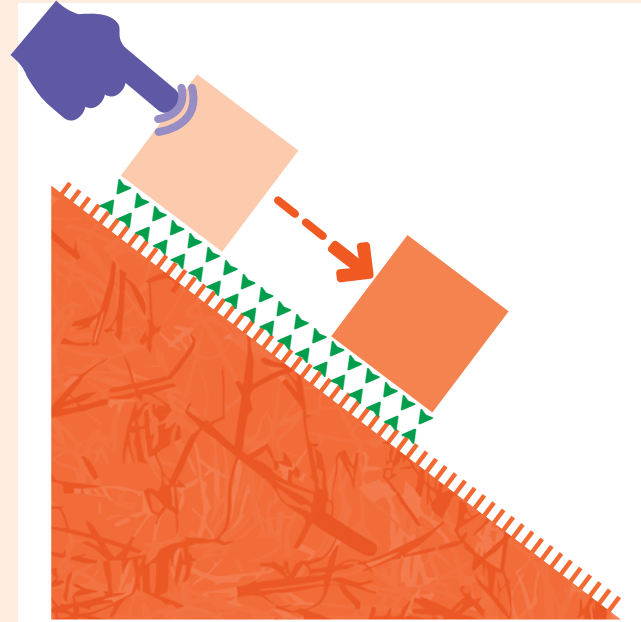
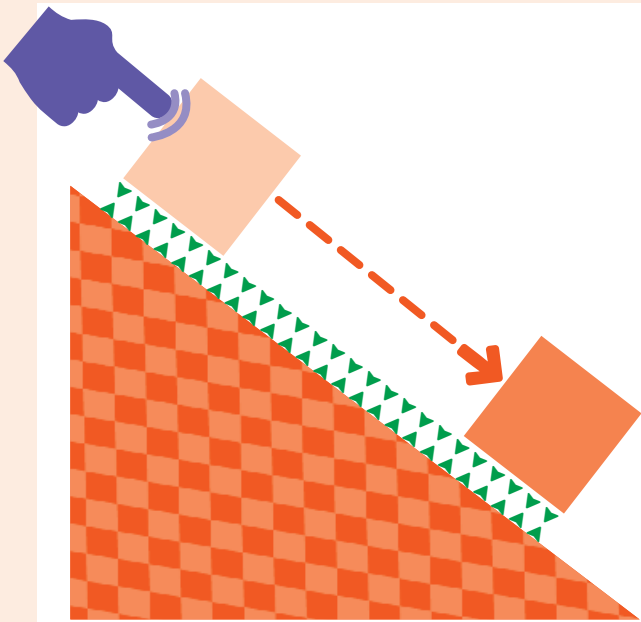
Force is the energy that moves something.

FORCE VERSUS FRICTION

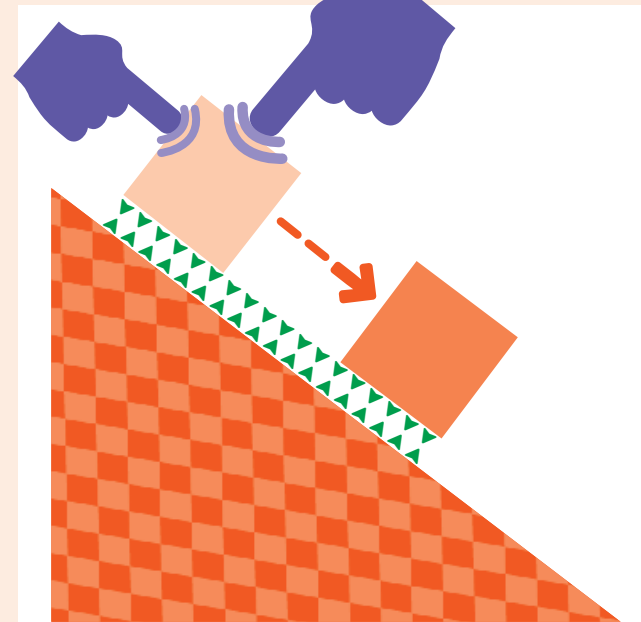
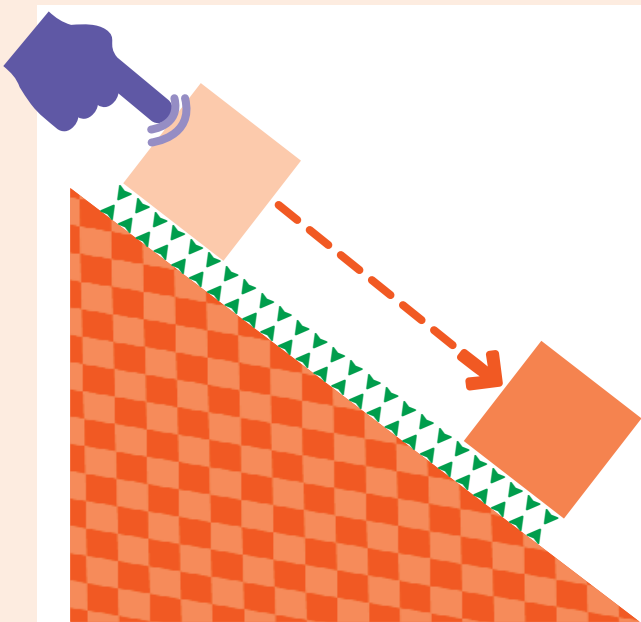
Friction is a force that slows down movement. Friction happens when two surfaces move across each other.

How much friction is created depends on the texture of the surfaces—whether they are smooth or rough—and how much one surface is pressing on the other surface.





If both blocks are pushed with the same force, the block on the tile floor (left) will go faster and farther than the block on the carpet (right).



If you have two blocks and one is being pressed harder against the floor (right), it will experience more friction and move more slowly than the other block (left).

STEP

3 Race your cars!

Daisies, start your engines! Almost as soon as the car was invented, people started racing them. In the 1890s, the first races with gasoline-powered cars got lots of people excited about the new invention.

Now is your chance to race your car against your Girl Scout sisters. Watch to see which car goes the farthest on the rough surface. Why do you think some cars go farther than others?

Fair Tests

Engineers always test their inventions to find ways to make them better. Sometimes they do different kinds of tests on the same invention to learn more about it.

It's important to only test one thing at a time and test all the inventions the same way to be sure the test is fair. Testing different cars on the same track and testing the same car on different tracks are examples of fair tests.



**Now that I've earned this badge,
I can give service by:**

Telling other people with I learned about force, friction, and fair tests.

I'm inspired to:



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