Brownie Robotics

Explore robotics by earning these three badges!

Badge 1:
Programming Robots

Badge 2:
Designing Robots

Badge 3:
Showcasing Robots

Welcome to the world of robots!

When you've earned these three badges, you'll know how to build a robot, program a robot, and share what you've designed with others.

Every day, a robotics engineer invents another robot that can do something new — like perform surgery, explore Pluto and, yes, even herd cattle.

What will they do in the future? If you can't wait to find out, you might want to think about becoming a robotics engineer someday so can you can invent what our future looks like!

Badge 1: Programming Robots

Robots are simple machines that are programmed to run automatically. Programmers are the engineers that create step-by-step instructions, or algorithms, that tell robots how to understand and respond to their environment. Start by engineering a simple algorithm, then learn about programming on paper, before you program a "robot" Brownie friend and on a device.

Steps

1. **Create a simple machine**
2. **Test your robot senses**
3. **Learn about programming**
4. **Try simple programming**
5. **Code a robot**

Purpose

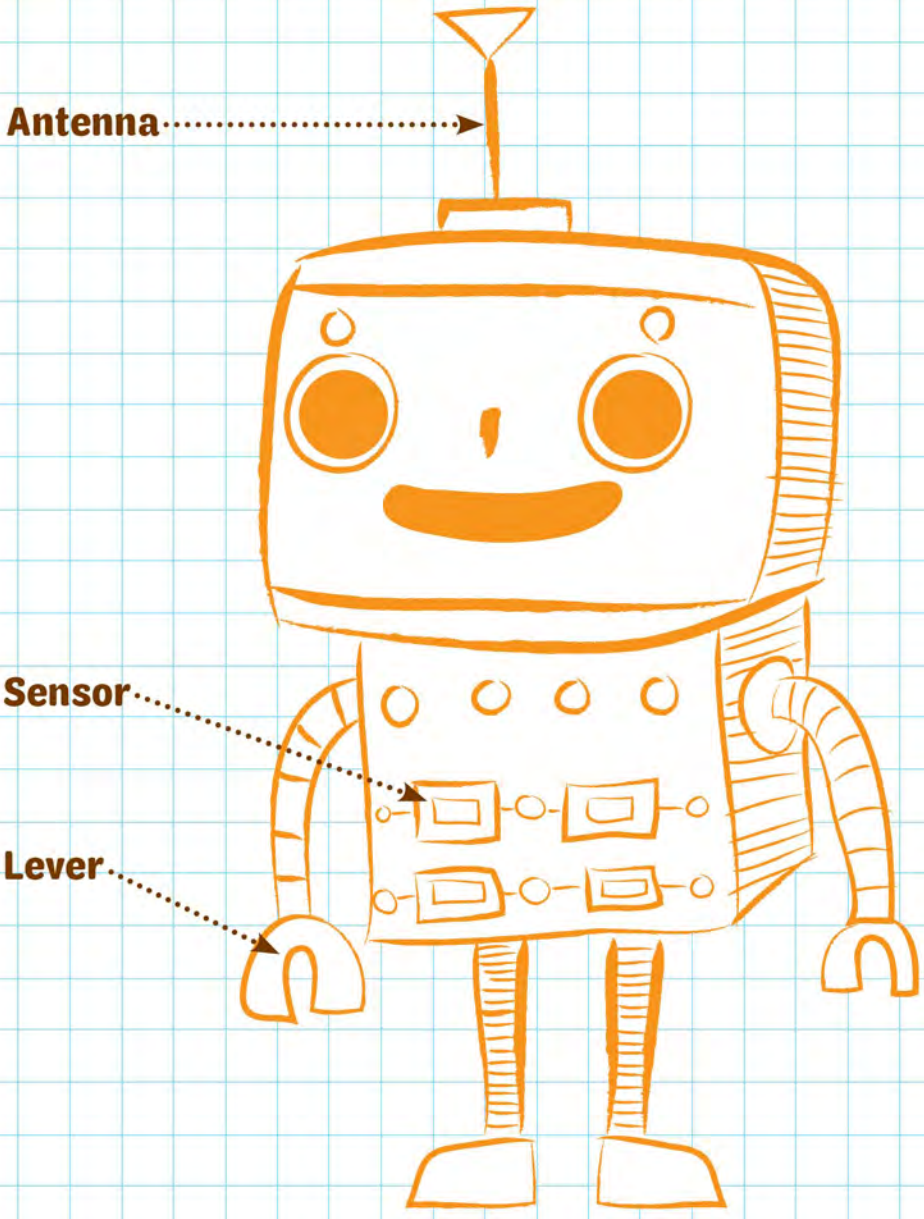
When I've earned this badge, I will know how to create a program that could be run by a robot.

STEP
1 Create a simple machine

A robot is a machine that does a task or a number of tasks automatically. Without a program, robots are just simple machines, made of many different parts, each with its own important job to help the robot to work. Some of these create the body, like its wheels, and others, like wires and sensors, help robots to understand their worlds. Explore the different parts that are used in a robot, and see what simple machines you can create!

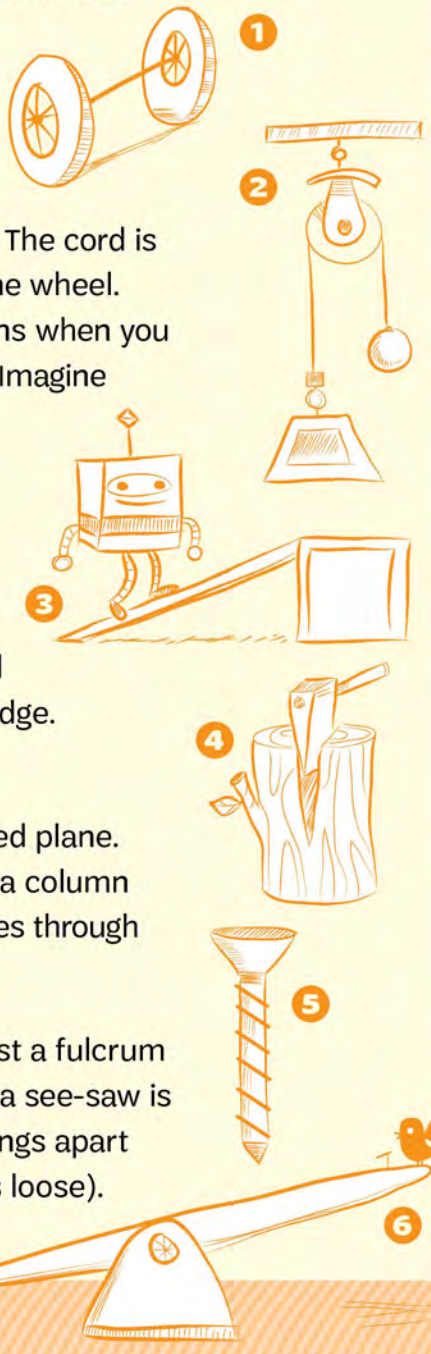
What Do Robots Do?

A robot is any machine that can follow instructions to do jobs that are too boring, dangerous or impossible for people to do. Robots can do anything from cleaning gutters on your house, to operating on people, to exploring Mars!



HOW DO ROBOTS MOVE?

All robots move by using simple machines. Knowing what simple machines are — and how they help robots move — will help you design and build your own robots. Here are examples of simple machines:



1. Wheel & Axle: The wheel turns with the axle, causing movement. On a wagon, for example, an open box is fastened over the axles.

2. Pulley: A pulley is a cord that wraps around a wheel. The cord is used to raise and lower objects. The simplest pulley uses one wheel. Using a wheel reverses the direction of force. That just means when you pull down on a rope in a pulley it pulls up on the other side. Imagine a flagpole. You pull down on the rope and the flag rises up.

3. Inclined Plane: A flat, slanted surface can help move objects across distances and up. A common inclined plane is a ramp.

4. Wedge: You can use the pointed edges of an inclined plane to push things apart. When you use it this way, it's a wedge. For example, an ax blade is a wedge.

5. Screw: A screw is actually just another kind of inclined plane. Imagine a very skinny inclined plane that's wrapped around a column — that's a screw! A screw can easily be turned so that it moves through a solid object, such as a block of wood.

6. Lever: A lever is an arm that "pivots" (or turns) against a fulcrum (the point or support on which a lever pivots). For example, a see-saw is a lever. Levers can lift objects (think of a see-saw) or pry things apart (think of the claw end of a hammer that you use to pry nails loose).

STEP 2 Test your robot senses

Robots, just like us, have to use their senses to understand their surroundings. Robots need to see and sense what is around them to move and complete their tasks. For some robots, being able to understand their environment is crucial to doing their job. Test your "robot" senses to determine what snack is in your bag, and explore how robots use sensors to collect information about the world around them.

STEP 3 Learn about programming

Computer engineers, or programmers, create algorithms, sets of step-by-step instructions, which are coded into the robot so they can move and act automatically. Create a program on paper to help a fellow Brownie, your "robot," color in an image without looking at it, and learn about algorithms and computer programming.

How Do Robots Know What to Do?

People create programs to tell a robot what to do. The language they use is called coding. A program is like a step-by-step recipe. Not only is each step important, but the steps have to be in the right order. When the programmer writes a code that gives the robot the right steps in the right order, the robot moves and acts the way the programmer wants.

PROGRAMMING

WORDS TO KNOW

Prototype - A prototype is a hand-built model of an idea. The word prototype comes from two Latin words: *proto* (which means first) and *typus* (which means model). Once you get an idea for a new robot or a new invention, you can build a prototype to see how your idea might look, feel and work in real life. You can also test your prototype and see what is working and what isn't. A prototype can be a model that's made from common objects, like cardboard and wire. It can also be a simple sketch of your idea that you can show to people to see what they think about your design.

Algorithm - This is a set of step-by-step instructions for how to do something. A recipe is an algorithm. It tells you the steps you need to take to bake a cake or cook some food. When your friend gives you directions to her house, the directions are an algorithm, too. She's telling you what you need to do to get to where she lives.

Program - This is an algorithm that has been coded into something that can be run by a machine.

Debugging - Sometimes a programmer writes code for a robot — but the robot doesn't do what it's supposed to. That means there's something wrong with the code. Programmers say that there's a "bug" in the program. When they find and fix the problem, they call it "debugging."

What is a Robotics Engineer?

Behind every robot is a robotics engineer. Robotics engineers figure out what job a robot needs to do. The engineers identify a problem to solve. Then they invent, design or create robots to solve those problems. They often work in teams to plan and put together the perfect piece of equipment.

STEP 4 Try simple programming

Programmers create algorithms that instruct robots on how to move and react. Do you think you could create a program to navigate a "robot" friend through a course? Create a step-by-step algorithm for your robot to navigate the course. Your robot will encounter obstacles to sense and react to along the way, so make sure to include special instructions that tell your robot how to react.

STEP 5 Code a robot

Engineers program their robots to move, act, and understand. Now is your chance to code on a device, like a tablet or computer, and complete an Hour of Code. Choose a game from the site and program your robot or character to complete the tasks. Remember, no matter what game you play, you could give the same instructions to a robot, just like you are giving instructions to the game's characters. Your algorithms could be programmed into a robot to bring them to life!

NOTES

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

- Creating algorithms to teach others how to do something.
- Sharing with others what I have learned about computer programming.
- Encouraging others to learn to code.

I'm inspired to:

Badge 2: Designing Robots

Robots are made of many different parts, each with its own important job to help the robot. Sometimes, engineers design robots that are inspired by humans, animals, and nature. Team up with your fellow Brownies to design a robot inspired by a bumblebee and engineer a robotic arm. After, plan, build, and share your own robot prototype that helps other people or animals!

Steps

1. **Explore how robots imitate nature**
2. **Learn about the parts of a robot**
3. **Plan your robot**
4. **Create a prototype**
5. **Get feedback on your robot**

Purpose

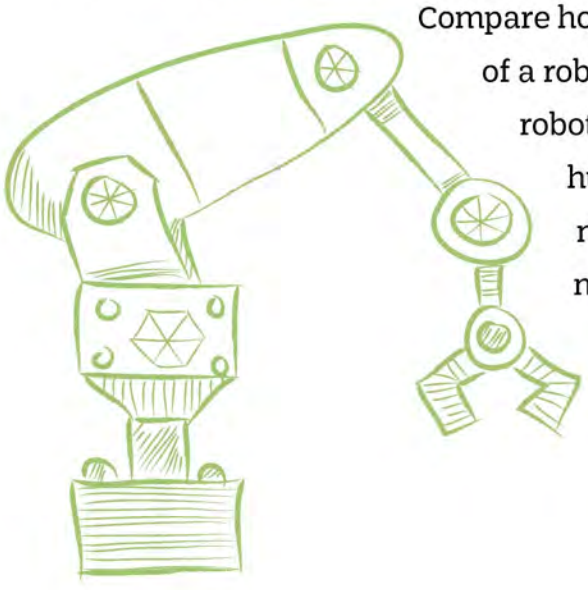
When I've earned this badge, I will know how to design a robot that helps other people or animals.

STEP
1 Explore how robots imitate nature

A lot of the time, we think of robots as shiny metal figures that kind of look like us, with heads, bodies, arms, and legs. Biomimicry is when an engineer makes a machine that looks and acts like a human, animal, or plant. Engineers study how humans and animals look and act to brainstorm creative ways to design their robots. Explore how engineers use biomimicry to design robots, and work in teams with your fellow Brownies to design a robot inspired by a bumblebee.

STEP
2 Learn about the parts of a robot

Just like us, robots have different parts of their bodies that help them to move, sense, and react. Compare how your body moves to that of a robot as you explore how a robot's parts can be inspired by humans. After, create a simple machine out of common materials that mimics a robotic arm to help extend your arm's reach!



Faster than a Speeding Robot

The Cheetah robot is fast! It can run up to 29 miles an hour. The fastest person in the world, an Olympic Gold-medal winner, can only run 23 miles per hour. When developing this robot, scientists studied how real cheetahs move. The Cheetah robot has a bendy back that moves back and forth on each step. This allows the robot to have larger strides and faster speeds, much like the real animal has.

Anyone for Sushi?

Sushi rolls are delicious bites of fish and vegetables, surrounded by rice and seaweed. Chefs who create sushi rolls are considered artists. Although robots may not be able to beat a sushi chef in a cooking contest, they can really whip out the rolls.

Here's how they do it: A human being puts sushi ingredients into the robot. Twelve seconds later, the robot spits out an entire sushi roll. In Japan, robots make large quantities of sushi for supermarkets and all-you-can-eat buffets.

STEP 3 Plan your robot

Engineers look for needs in our world and build robots that solve problems both big and small. If you could build a robot that solves a problem for other people or animals, what would your robot do? What would it look like? What parts would it need? Brainstorm and sketch your ideas for robots that can help others. Share your designs with other Brownies, and choose one to build a prototype of in Step Four.

STEP 4 Create a prototype

Engineers create prototypes, a quick way to show an idea to others or to try it out. It can be as simple as a drawing or created with common materials, such as cardboard, paper, and string. Now is your chance to build a prototype of your robot. Remember, you're creating a robot, not a simple machine, so you'll also need to create a step-by-step program for your robot prototype to "run".

STEP 5 Get feedback on your robot

Once engineers create a prototype, they test it to find ways to improve and redesign their new products. Work with a fellow Brownie to test your robot prototype. Tell your partner how to move the prototype according to your program so you can "debug" or fix problems before you share your prototype with your Troop. After you share, gather feedback and ideas, like an engineer, on how to improve your robot's design and make it even better!

11 ROBOT SENSORS

Like our own senses, sensors help robots get information about what's around them: Is the air hot or cold? What kind of sounds can you hear? When you go from one place to another, how far have you traveled?

Hundreds of different sensors can be programmed to collect data. Here are examples of the kind of information robots gather — and the sensors that help them do it:

1. Light – Like eyes, cameras gather light in through lenses and form images.

2. Sound – Like ears, these sensors gather sound.

3. Temperature – These sensors can tell the temperature of the air, water, soil or atmosphere around them.

4. Contact – This sensor identifies when a robot bumps into something in order to avoid obstacles. When the robot hits something, the sensor triggers the robot to reverse or turn in a different direction.

5. Distance – These sensors send out high-pitched sounds or light beams which hit objects and bounce back—like an echo. By analyzing the time it takes to bounce back, the sensors can tell how far away something is.

6. Pressure – These sensors are sensitive to touch and pressure. They are often used in robotic hands and help the robot know how hard to hold or grasp an object.

7. Tilt – This sensor measures how an object is leaning. Robots that are roaming use this sensor — and the information it gathers — to keep from falling over.

8. Acceleration – This sensor tells you how fast or slow the robot is moving.

9. Magnetic field – These sensors measure the strength of a magnetic field. That can be helpful with navigation as well as determining the makeup of a planet's crust.

10. Gas – These sensors help robots that detect gas leaks. They can measure the amount of a specific gas in the air.

11. Navigating/positioning – GPS (Global Positioning Software) is a sensor that can help a robot figure out where it's located.

5 ROBOTS BASED ON REAL ANIMALS

If you're trying to solve a problem, you may find a clue in nature — if you look closely enough.

Want to fly? Study how birds, bats and butterflies take to the air. Want to make buildings that stay cool? Take a look at how termites build their homes.

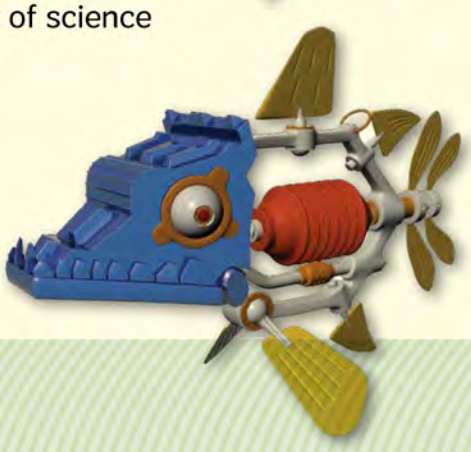
Robotics engineers have studied animals to come up with ideas about how their robots could move. Here are a few examples:

1. JellyBots: These robots move like jellyfish and blink light codes to each other. Because of the robots' natural movement, they can get close to real animals in the wild and help scientists study them.

2. Robotic Roach: This collapsible robot can squish down and crawl into tiny crevices to look for damage in buildings or find people trapped in tight spaces.

3. RoboBee: This tiny robot is modelled after flying insects like bees and flies. It was designed to zoom and hover over disaster sites and find people who need to be rescued.

4. Sticky Bot: This robot is based on a gecko, a small lizard that is an amazing climber. Using the same sort of science that allows a real gecko to climb slippery surfaces, this robot can climb walls.



5. Robofish: These robots look like fish and move with fins. They're built to track patches of ocean pollution or hard-to-find fish.

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

- Sharing how robots work with younger girls.
- Sharing with someone else how to make a prototype.
- Using the engineering design thinking process to solve community problems.

I'm inspired to:

Badge 3: Showcasing Robots

After engineers build their robots, they show them to others and enter them into challenges and competitions. Now that you have built your robot prototype, it's time to create a presentation and share your design with others. After, learn about robotics teams and competitions and see a robot in action!

Steps

1. **Create a presentation to share how you designed your robot**
2. **Tell others how you designed your robot**
3. **Learn about robotics competitions**
4. **Learn about robotics teams**
5. **See robots in action**

Purpose

When I've earned this badge, I will know how to share my robot with others.

STEP

1 Create a presentation to share how you designed your robot

After an engineer creates a prototype, she shares it with others. This is important because it gives her a chance to share her work, get feedback, and teach others how to build their prototype. Choose a way to share your prototype and explain how you designed it.

OPTION 1: Create a media presentation (video, photo collage, etc.)

One way to share your prototype is with photos, videos, and other media. Work in your prototype design teams to create a presentation using craft materials or technology. You might need help from others to film, edit, or gather materials for your presentation.

OPTION 2: Create a show-and-tell presentation

You can also share your prototype using your words, just like a show-and-tell. Prepare and practice a short presentation with your prototype design team. Make sure to explain the process you went through to design and build your prototype, including any problems you encountered along the way. Include a demonstration of your robot acting out its program to show others how you coded your robot.

So You Think You Can Dance?

Not all robots build cars, fly to outer space or dive to the bottom of the ocean. Some take on other challenges — like tangos, mambos and cha-cha-chas. A Japanese engineer created ballroom dancing robots that look like people. They even wear fancy dresses! The robots' sensors can follow the moves that their dancing partners make. And since the robots have wheels instead of feet, no one has to worry about stepping on the robots' toes!

4 COOL THINGS YOU CAN DO IF YOU'RE A ROBOTICS ENGINEER

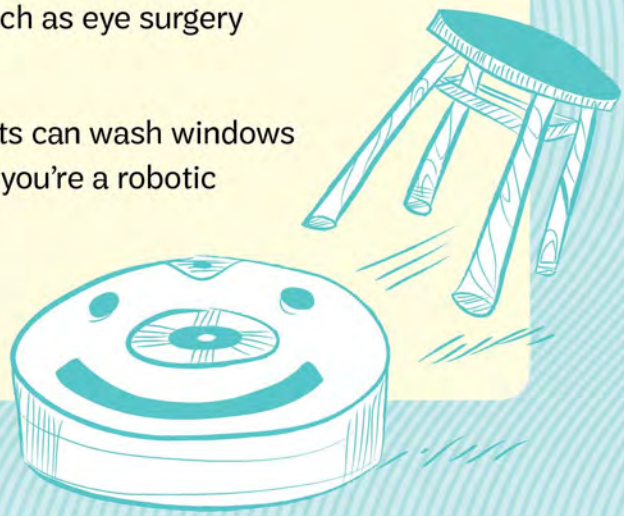
Want to have a really cool job someday? Think about becoming a robotics engineer. Here are the kinds of projects you might work on:

1. You could build animatronics. Animatronics are robots designed to look like living people or animals. Robotic dinosaurs in movies or amusement parks are animatronics.

2. You could design robots that explore planets and outer space. Already, robots have explored the surface of Mars and robot arms have released satellites from the space shuttle.

3. You could invent robots that perform surgery. Doctors use robots for operations that need small, precise movements, such as eye surgery and hip replacements.

4. You could design robots to do your chores. Robots can wash windows and vacuum floors. What's your least favorite chore? If you're a robotic engineer, you can design a robot to do it for you!



Robots, like the Roomba, help to make cleaning the house a breeze!

STEP

2 Tell others how you designed your robot

Once you've created your presentation, it's time to share what you've made with an audience.

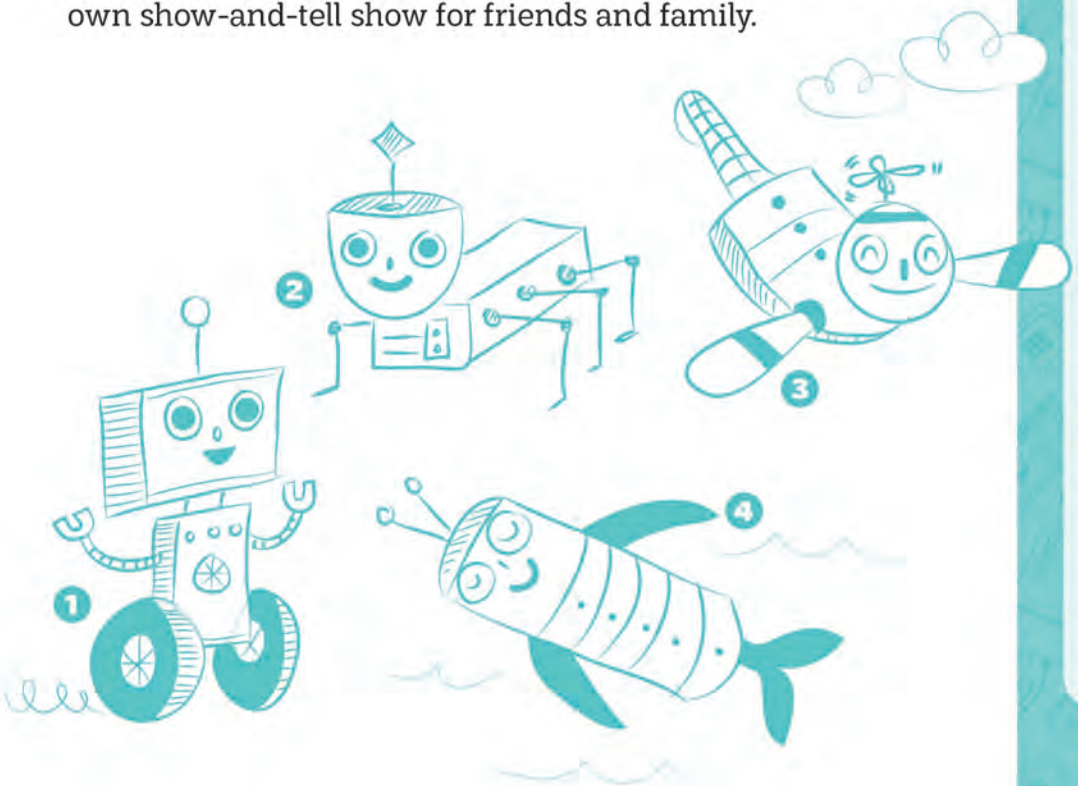
Whether you've made a media presentation or prepared for a show-and-tell, demonstrate your robot prototype and explain how you designed it. Sharing your work is an important part of being an engineer. It's your chance to teach, inspire, and get feedback to improve your robot.

OPTION 1: Share your video or presentation at a troop celebration for friends and family

Premiere your video or share your media presentation at a troop celebration for friends and family.

OPTION 2: Give a show-and-tell presentation at a school or community event

Share your prototype and what you have learned while designing it with others from your school or community. You can present to your class or community group, or create your own show-and-tell show for friends and family.



Four Ways Robots Can Move

1. **ROLL:** Some robots have two wheels, some have four, and some have even more. Different numbers and sizes of wheels can be used to increase range of motion and allow the robot to get over or around obstacles.
2. **HOP, WALK OR RUN:** Two-legged robots can walk like people or hop like kangaroos. Four-legged robots can walk and run. Many-legged robots can move like crabs, spiders or insects.
3. **FLY:** Robots can hover, glide, flap, fall or rise, depending on the mechanism. Scientists design wings based on birds or insects, as well as planes and helicopters.
4. **SWIM:** Some robots need to move through water. They can have fins like fish or even flexible bodies like jellyfish or squids.

Snowball Robot

A group of filmmakers wanted to make a film about polar bears. Getting close to a polar bear isn't easy, or safe! When they got close enough to film, the bears chased them.

So the team made snowball robots. The robots had camera sensors to take pictures. The filmmakers stood a safe distance away and rolled the snowball robots over to the bears. The polar bears were curious (wouldn't you be?). The snowball robots got amazing close-up images (except for a few that got chewed up by the bears).

STEP 3 Learn about robotics competitions

There are a lot of places where you can meet other people who design robots. At robotics competitions, teams of engineers build robots that can navigate mazes, lift heavy objects, and solve other problems. Teams are posed with challenges, then design prototypes to solve the problem using robotics kits. Competitions like these are held around the world! Girls like you can sign up to join robotics teams to engineer and design robots. Choose a way to learn more about robotics competitions.

OPTION 1: Go to a competition or science fair

Engineering teams present their robots at competitions and science fairs. Take a trip to a robotics competition or science fair to see how robots are being showcased. If you can, talk to other girls about why they are there and why they love being on a robotics team.

OPTION 2: Talk to someone who competed

Talk to an older girl, a robotics team coach, a GS volunteer, or anyone else who has attended or competed in a robotics competition to learn more. Prepare by brainstorming questions you'd like to ask ahead of time.

OPTION 3: Learn about competitions online

Watch videos to see what happens at robotics competitions. Take note of what you see robots doing in the competitions and how you see teams working together.

STEP

4 Learn about robotics teams

Robotics teams are made up of dedicated members, each with their own talent or expertise to bring to the robot, from programming to driving to marketing the robot. Robotics teams work together, listen to each other, and make sure to be safe when creating their robots. Now that you've seen what teams do at robotics competitions, consider if you'd you like to join a robotics team.

OPTION 1: Join or create a robotics team in your area

After all you've learned about robotics, you might want to join a team. See if any of your fellow Brownies would like to join with you or even create a brand new team. Research your options for robotics competitions and challenges to figure out next steps.

OPTION 2: Talk to someone who has been part of a team

Talk to an older girl, a robotics team coach, a GS volunteer, or anyone else who has been part of a robotics team about their experience. Brainstorm what you'd like to ask.

OPTION 3: Learn about robotics teams online

Watch videos to see how robotics teams work. Think about how you see teams working together and what sort of responsibilities different team members have.

Bear Hug Robot

When people are in the hospital, they sometimes need help moving around, so robotics engineers designed a robot shaped like a giant bear. This robot is strong, soft and gentle. It can lift patients in and out of bed, put someone into a wheelchair, and help patients to stand up.

Dr. Robot

Doctors already use robots to help operate on people. The robot is positioned next to the patient. The doctor uses the robot's camera sensors to see what needs to be done. She uses a computer to control the robot's movements with a computer.

In the future, doctors may be able to do this remotely, so that robots could perform surgery on people miles away from a hospital.

Some scientists are working on microscopic robots that can move the way bacteria do and could be injected into a patient. Once they're inside the patient's body, the sensors could get information about what's making the patient sick. Someday, the tiny robots might even be able to do surgery from inside a patient!

STEP 5 See robots in action

Robots exist all around our everyday world. See a robot in action and reflect on everything you've learned. What does the robot do? What sort of parts do you see in the robot? Discover how engineers bring robots to life.

OPTION 1: Go on a field trip to see a real robot

Find a robotics team with a robot, perhaps at the high school or local college, and visit their workspace. You can also visit a local business and learn how they use technology and/or robotics in their work. Explore the lab or watch the robot to see how a robot looks in action. Ask the engineers or business how the robot works.

OPTION 2: Talk to someone who has been in a lab or used a robot

Talk to an older girl, a robotics team coach, a GS volunteer, or anyone else who has been in a robotics lab or used a robot. Before they arrive, brainstorm questions to ask them about their experience.

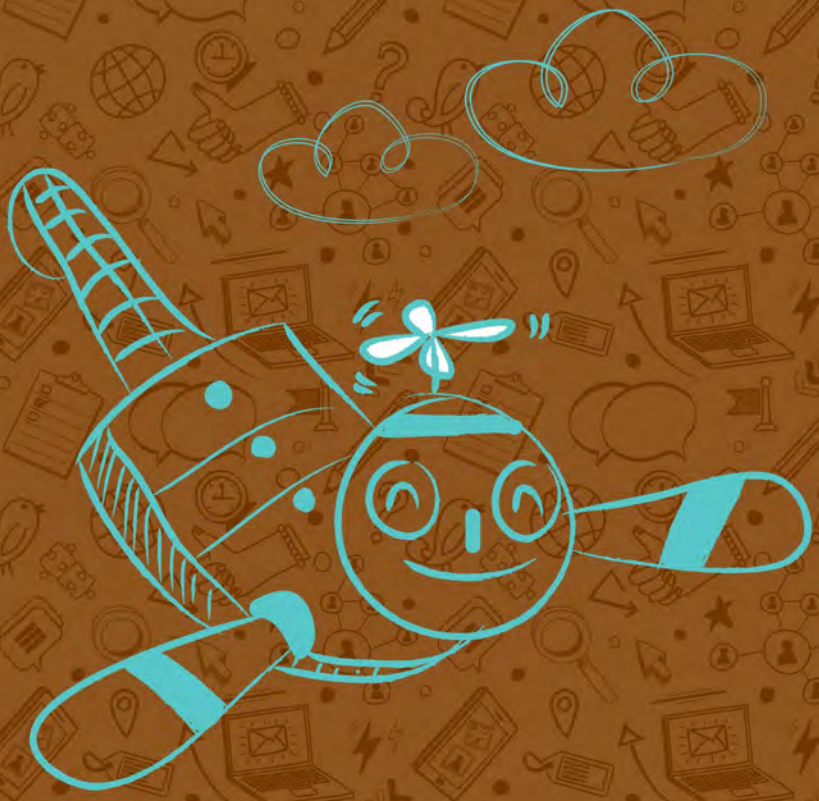
OPTION 3: See a robotics lab online

With help from your parents or Leader, search online for "Robotics Lab Virtual Tours" to find videos and virtual tours of robotics labs around the world. As you look around, point out what robotics team members are working on and any robot parts you see.

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

- Telling others about robotics teams and competitions.
- Sharing my robot presentation with others.
- Joining a robotics team to continue creating robots that solve problems for others.

I'm inspired to:



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