Unit 1

Design and Function

How can technology make our lives easier?

I will learn

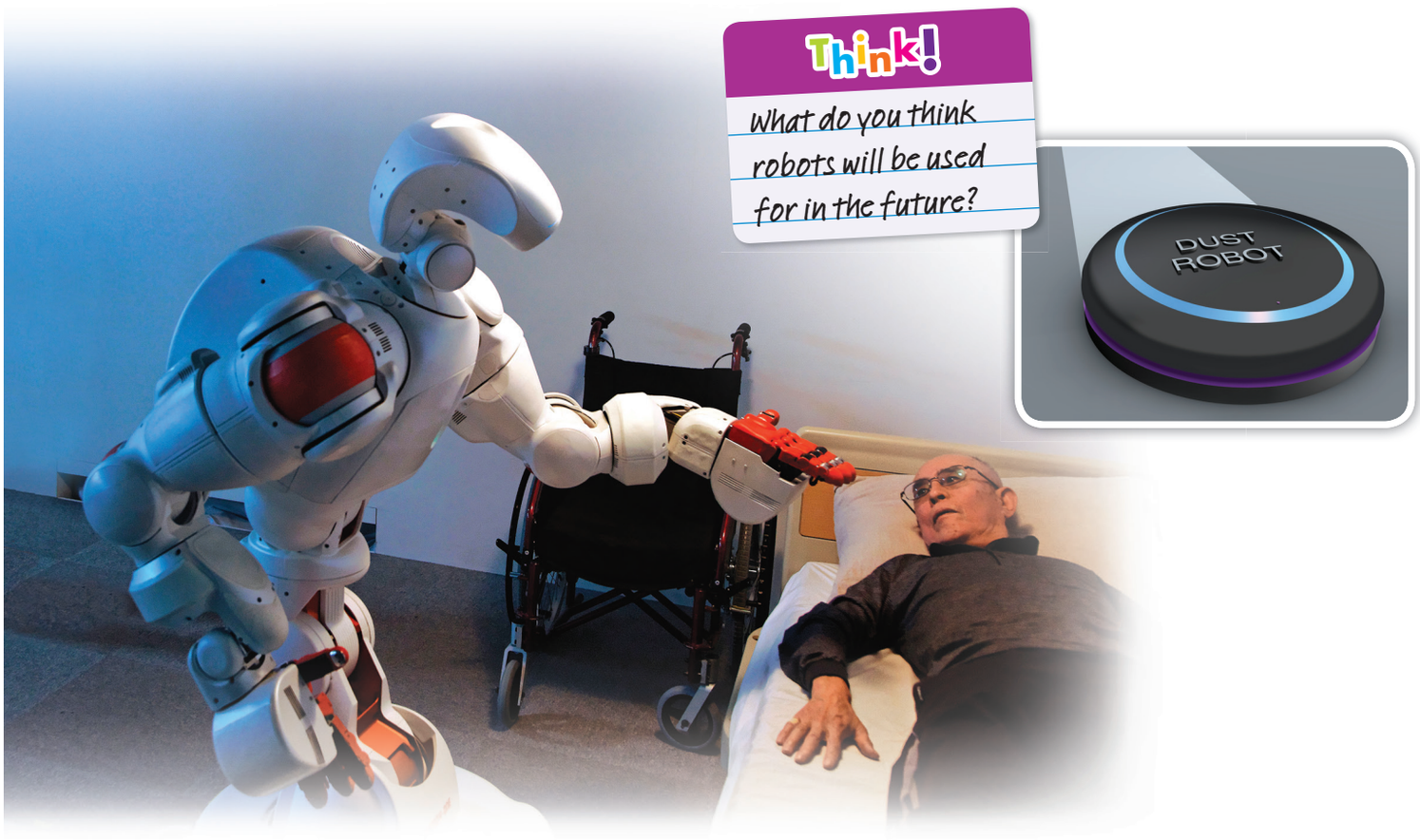
- how some technology can mimic the muscular and skeletal systems.
- how to use the design process.

1 **With a partner, make a list of recent inventions and new technology.**

2 **With a partner, number the first five steps of the design process.**

- ☐ Do research.
- ☐ Design and construct a prototype.
- ☐ Identify the problem.
- ☐ Choose one solution.
- ☐ Develop possible solutions.

3 **What problems were these robots invented to solve? Discuss with a partner.**



Lesson 1 · How does technology mimic living things?

Key Words

- sensor system
- prosthetic limb
- nanotechnology
- atom
- nanobot

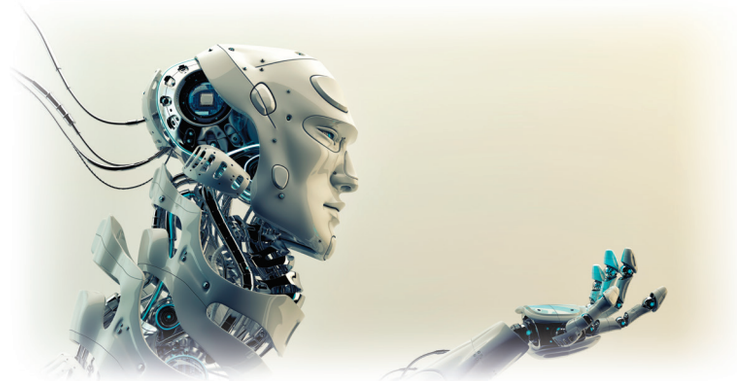
1 **How can this device help someone communicate? Discuss as a class.**

Flash Lab

With a partner, make a list of all the technology you use and discuss how each kind helps you.

2 **Read and circle *T* (true) or *F* (false).**

Technology and the Human Body



The human body is an amazing structure. Engineers sometimes use scientific knowledge of how the body works to develop technologies. Some of the technologies help people whose bodies do not function as they should. Some technologies do tasks that are too dangerous for people. Technologies that have moving parts can be like the human body. A robot is one of these technologies. Robots can have a body structure and movable joints that are similar to the human skeletal and muscular systems. Robots use an electrical energy source to help them move. The human body uses energy from food to help it move. Robots have a **sensor system** and a computer to control movement. In the human body, the brain and nervous system help to control movement.

1. Technology can benefit people with disabilities. **T / F**
2. Robots can mimic parts of the human body. **T / F**
3. Robots have nervous systems to control movement. **T / F**
4. Robots can use a variety of energy sources to operate. **T / F**

3 **In what ways do you think a robot is like you? Discuss with a partner.**

4 **How is the runner's prosthetic leg similar to the legs of the other runners? Discuss as a class.**

5 **Read and, with a partner, discuss the questions below.**

Prosthetic Limbs

Robotic technology can also be used to make a prosthetic limb move. A **prosthetic limb** is an artificial arm, hand, leg, or foot that replaces a missing one. Modern prosthetic limbs can be controlled by electrical signals from the brain.

In the past, prosthetic hands had few fingers and could not do many things. Today, they have a thumb and four fingers that are controlled individually. These prosthetic hands can turn a key, pick up small objects, and hold a glass.

Current prosthetic legs and feet allow their users to walk and even run. As technology advances, prosthetic legs and feet work more like real legs and feet. The latest prosthetic limbs also look more like real limbs.

1. How do prosthetic limbs help people?
2. How are prosthetic hands different today compared with those of the past?

6 **What does this man's prosthetic hand enable him to do? Look and discuss with a partner.**

7 **Read. With a partner, list the characteristics of each machine or robot that mimics the real animal.**

Animals and Technology

Some technologies mimic the muscular and skeletal systems of animals. These systems help animals to move in different ways. The wings and tails of birds help them fly. Fish have muscular and skeletal systems that help them swim.

Airplanes have parts that mimic the wings and tails of birds. Like the wings and tails of birds, airplane wings and tails can be adjusted to control how the airplane moves.

Some robots can also fly. The robotic bat flaps its wings and flies like a bat. It can search collapsed buildings and other areas people cannot get to. Some robots that are used to explore the ocean have parts that mimic the muscular and skeletal systems of fish.

Scientists use robotic animals to study the behavior of real animals. A robotic squirrel makes noise and moves its tail like a real squirrel. It can be placed in an area where real squirrels live. A real squirrel may wiggle its tail and make noises at the robotic squirrel. Scientists can use this information to learn how squirrels communicate with one another.

airplane/bird	robotic bat/bat	robotic squirrel/squirrel

8 **As a class, discuss how animal robots can be used.**

real squirrel

robotic fish

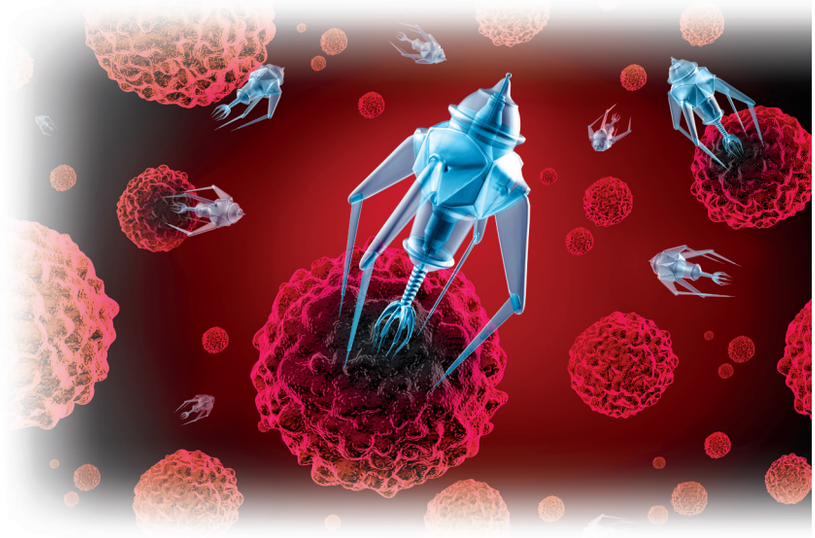
At-Home Lab

Walk around your neighborhood with an adult. Observe any ways in which technology mimics living things. Record these observations in your Science Notebook.

9 **Read and circle *T* (true) or *F* (false).**

Nanobots

How can you build a robot that is only a few billionths of a meter long? Scientists hope to be able to build these tiny robots using **nanotechnology**. Scientists have found ways to move one **atom** at a time. They hope to be able to use this technology to build tiny robots, or **nanobots**, that can perform all kinds of tasks.



Scientists hope that nanobots will be able to kill cancer cells or treat other human disease.

One idea is to use nanobots inside the human body. Nanobots may be able to deliver medications better than current methods. Scientists are also researching how to make a nanobot that can remove cholesterol from the walls of arteries.

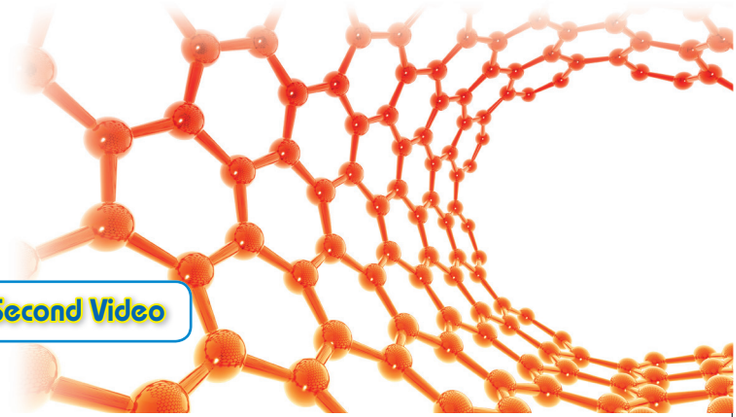
1. Tiny robots called nanobots already exist. **T / F**
2. Scientists believe nanobots will not be used inside human bodies. **T / F**
3. Nanobots may be able to help sick people more effectively than current methods. **T / F**

10 **Invent a technology that could help a blind person. Draw your prototype and present your idea to the class.**

Think!

In what other ways do you think nanotechnology might be useful?

This nanotube's walls are only one atom thick!



Lesson 2 · What is the design process?

Key Words

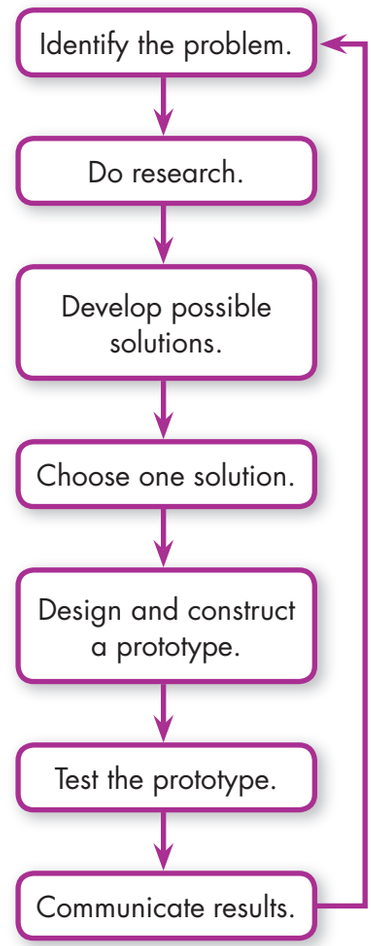
- design process
- bristle
- prototype
- plaque
- document
- robotic

1 **Read and underline the word for a person who designs technology.**

Design Process

Technology helps to solve many of the problems we have. We use technology in our homes, schools, and offices. There are technologies for constructing buildings, communicating with others, transporting people and products, and so much more.

Who makes all this technology? People all over the world develop technologies. You may be surprised to know that even students your age develop new technologies. An engineer is a person who designs new technologies. People work in many different fields to apply scientific knowledge to everyday life. People use the **design process** to develop new technologies. The design process is a set of steps for developing products and processes that solve problems.



2 **Why do you think it is important to follow the design process when designing new technologies? Discuss with a partner.**

3 **Look at the steps of the design process. In your notebook, write what you think each step involves.**

4 **Read and write the heading for each stage of the design process.**

Identify the Problem Develop Possible Solutions Do Research

_____

In order to make or improve existing technology, scientists need to know what technology already exists. Scientific journals, magazines, the Internet, informational books, and encyclopedias can be helpful for solving design problems. Interviewing an expert may be the best way to find out information.

Engineers designing a new toothbrush might investigate how the shape of the handle affects how people brush their teeth. Engineers should also know how different **bristle** materials affect teeth.

_____

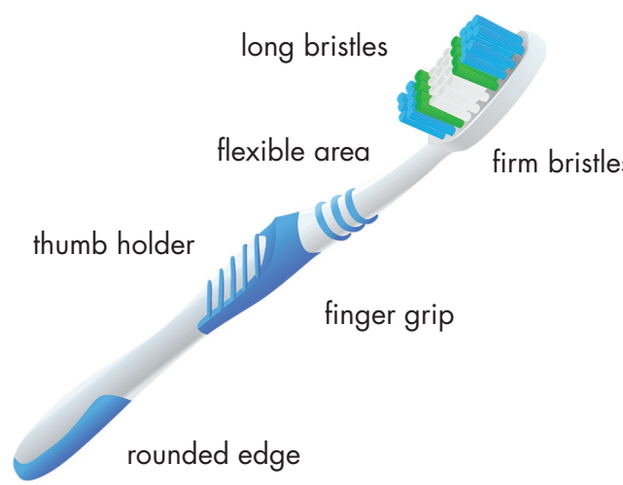
In this step of the design process, it is necessary to identify a need or problem. All technology comes from the need for a solution to a problem. It is important in this step to determine who would be helped by the solution. For example, a toothbrush that cleans teeth with less effort could potentially help everyone reduce cavities and gum problems.

_____

Using what they learned, scientists and engineers think of ways to improve an existing technology. Charts and diagrams can be useful to communicate their design solutions.

5 **Underline the sources you would use to find out what other scientists are working on. Then circle how scientists can communicate their design solutions.**

6 **Look and, with a partner, explain what you can learn from the drawing and what step of the design process it corresponds to.**



7 Read and answer the questions below.

Choose one solution.

It is important to choose wisely the one solution you will build. Making many solutions may take too much time. The cost of making the solution can also affect your decision. For example, even if the toothbrush works very well, people may not buy it if it is very expensive.

Design and construct a prototype.

The next step is to build a model of the solution, called a **prototype**. It is used to test the solution. It is important to identify the kinds of materials you use to build your prototype. The properties of the materials you use affect the function of your prototype. You will need a strong, flexible material for parts that bend. If you do not want the part to bend, you should use a rigid material. You will also need to identify the tools you use to build your prototype.

toothbrush prototype

Test the prototype.

The prototype needs to be tested to see if it meets the requirements to solve the problem. Engineers make careful measurements as they test their prototypes. When testing a toothbrush, engineers might measure how much **plaque** is left on the teeth after brushing for one minute. These measurements help the engineers evaluate how well the prototype works.

1. What are two things to consider when building a prototype?

   a) _____ b) _____

2. Why do engineers build prototypes of their design solutions? Circle.

   a) To test it to ensure that it works.
   b) To present it to others as a final solution.
   c) To test the most expensive model.

3. Read and fill in the blank.

   When testing a prototype, engineers must take careful _____ to ensure they are evaluating it accurately.

8 **Read and underline two reasons it is important to communicate your results to others. Then, in pairs, fill in the chart.**

Communicate Results

Throughout the design process it is important to document your work. **Document** means to record what you learn. Documentation helps you communicate with others. If you are working in a company, you will need to communicate your process and design to managers, salespeople, and many others. Often others will need to repeat your tests to verify the results. They will need to know your test procedures and the specifics of your design. The people you share your design with may be able to offer advice on how to improve your idea.

Your design solution can be communicated in many ways. Labeled diagrams can show the size and shape of the parts of your product. Graphic organizers can show how the parts are put together. You will also need a list of materials and tools used to make each part. Tables, charts, and graphs can help you communicate test results.

Ways to Communicate Your Design Solution	
1. _____	4. _____
2. _____	5. _____
3. _____	6. _____

9 **Read and look. Then, in pairs, make a list of three ways the redesigned prototype is better than the original.**

Evaluate and Redesign

Using the results of your tests and feedback from others, you can evaluate how well your design solved the problem. This information can help you redesign your product to make it work better. You may need to make minor adjustments or choose a completely new solution.

Think!

What might happen if you fail to document your design?

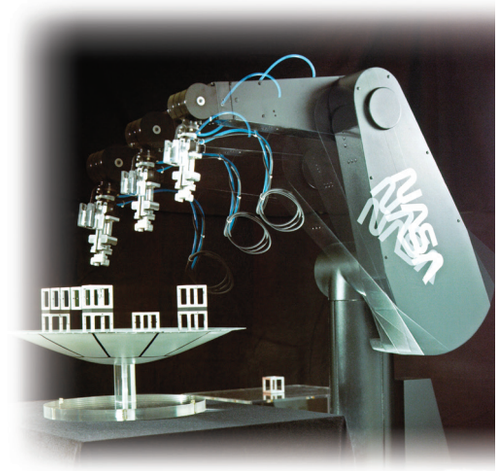
10 **Read and complete the answers. Then match the answers with their questions.**

Designing Robotic Arms

Engineers use the design process to develop robotic arms. **Robotic** arms are designed and built to mimic the movement of human arms.

The first robotic arm used in a factory was developed by George Devol. The robotic arm picked up and stacked metal parts that were too hot for workers to handle. George Devol and his partner, Joseph Engelberger, called the robotic arm the *Unimate*.

The *Unimate* had a "shoulder" but no "elbow." Devol and Engelberger continued to redesign the robotic arm. They developed a new robotic arm with an "elbow" that allowed it to perform more tasks. Today's robotic arms can move in many different directions.



PUMA, an industrial programmable robot, was introduced in 1980.

1. Who designed the first robotic arm?

The *Unimate* didn't have an _____.

2. What could the first robotic arm do?

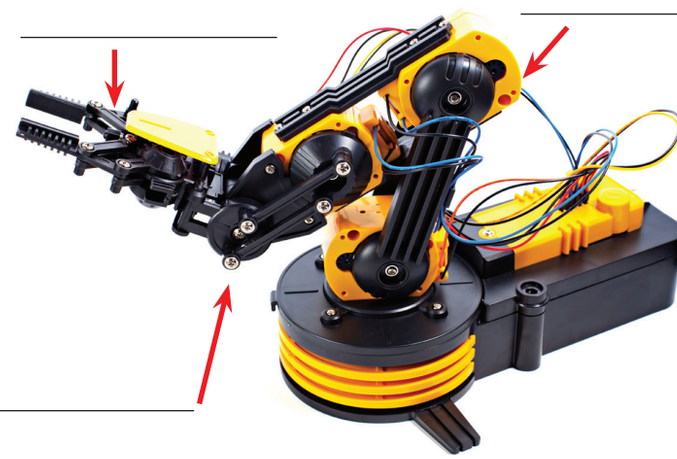
_____ developed the first robotic arm.

3. What did the *Unimate* not have?

The first robotic arm was able to _____ _____.

11 **Look and label the parts of this modern robotic arm that are like a human arm.**

shoulder wrist elbow



12 **With a partner, discuss why the modern robotic arm might be better than *PUMA*.**

Materials


hole punch


metric ruler


3 poster board strips


3 fasteners


large paper clip


clay ball with paper clip


dowel with eye hook

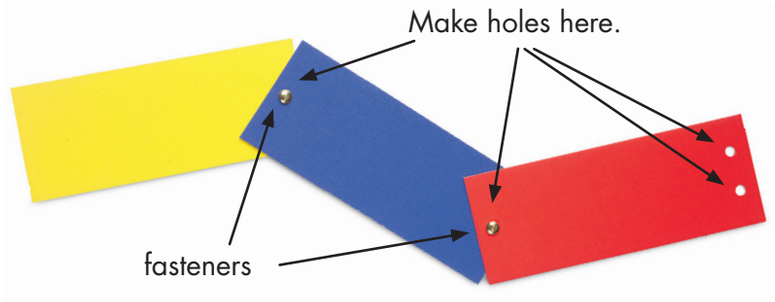

rubber band

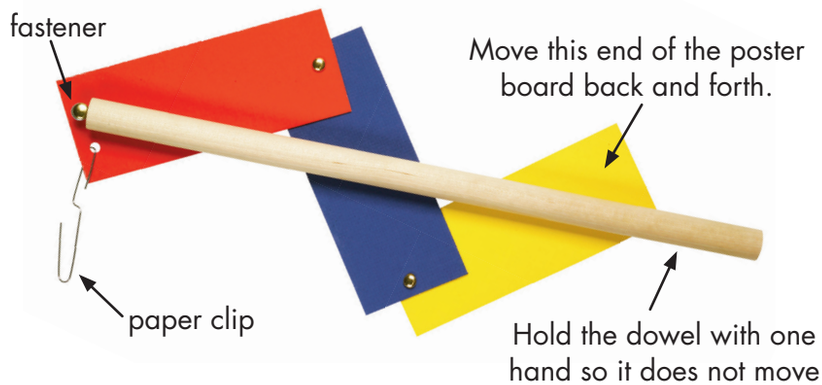

string

Let's Investigate!

How can you make and redesign a model of a robotic arm?

1. Use a hole punch to make holes in three poster board strips as shown. Use two fasteners to join the strips together.





2. Use a fastener. Attach the eye hook on the dowel to one of the two holes on the red strip.
3. Bend a large paper clip into an S shape and put the top of the S through the other hole in the red strip.
4. Use the robotic arm. Try to pick up the objects listed in the chart. Record the number of tries you need. Use up to 5 tries for each object.
5. Redesign your model of a robotic arm. Repeat step 4.

Objects Chart		
Object	**Number of Tries**	
Clay ball with paper clip		
Paper clip		
Rubber band		
String		

Unit 1
Review

REVIEW THE BIG ?

How can technology make our lives easier?

Lesson 1

How does technology mimic living things?

1 **Circle the correct answer.**

An artificial arm that mimics the real human muscular and skeletal system is called a _____ arm.

a) synthetic
b) prosthetic
c) limb
d) mechanical

2 **Imagine a robot that explores the bottom of the ocean. What two features of a fish might the robot mimic?**

1. _____
2. _____

Lesson 2

What is the design process?

3 **Circle the goal of the design process.**

a) To redesign a prototype.
b) To communicate ideas to others.
c) To find a solution to a problem.

4 _____ **means to record what you've learned throughout the design process.**