ROBOTS AND SOCIETY

AT A GLANCE After visiting the *Robot Revolution* exhibit, this lesson will have students thinking like engineers and learning about societal impacts on robot development.

OBJECTIVES

Students will:

- Discover how technology and society influence each other.
- Utilize engineering design practices to develop a robot that solves a societal issue.

KEY VOCABULARY

Robot, Roboticist, Effector, End Effector, Sensor, Mechanism

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices:

- Asking questions and defining problems
- Constructing explanations and designing solutions
- Obtaining, evaluating and communicating information

PACE YOURSELF

- 60 minutes

ADVANCE PREPARATION

1. Place students in teams of three or four and be able to work at one table together.
2. Print the Robot Mechanisms Cards (one set of nine cards for each group).
3. Print the Societal Scenario Cards so each group has one scenario. There are four scenarios, so with eight groups, for example, two groups should have the same scenario.
4. Print the Roboticist Design Worksheet (one sheet for each group).
5. Print the Robot Student Worksheet (one per student).
6. At the start of class, each group should have nine Robot Mechanisms Cards per group and a Robot Student Worksheet for each student.

MATERIALS

Per group:

- 9 Robot Mechanism Cards
- 1 Societal Scenario Card
- 1 Roboticist Design Worksheet
- Sensor cards from Robot Senses lesson (optional)

Per student:

- Robot Student Worksheet

WHAT YOU NEED TO KNOW

To complete their tasks, robots have to sense, plan and act. **Robots** use different kinds of sensors to collect the information they need. Software processes this information so the robot can plan a response. Then they act to get the job done. Some robots are programmed in advance to do certain tasks, while others can actually adjust certain parameters of their own programming to respond to things that happen to them. For example, a drone can keep hovering at a given height whether it's being buffeted by wind or swatted by a person. The drone, like other robots, is in a constant loop of sense, plan and act as long as it's turned on.

Robots are made for a variety of purposes and to serve different people. One type of robot, a drone, has many applications, from delivering food, medicine and packages to surveying and keeping track of wildlife to use in warfare. Depending on your background, values and cultural upbringing you may perceive robots differently. Some robots being produced today are being designed to look like humans; others look like machines but have human characteristics, and some you may not realize are robots until you look a little closer.

ROBOTS AND SOCIETY

Roboticists use the engineering design process to design and make robots. Many times these robots are designed to suit some need within a society or used for research purposes within a university to suit a particular topic of interest. Either way their experiences shape the way they design robots.

In this lesson, students will pick **mechanisms**, or mechanical parts, for a personal robot and then use the engineering design process to make a robot that suits a particular societal want or need. The mechanisms they will be selecting from fall into three categories: end effectors, sensors and movement.

In robotics, an **effector** is a part of the robot that interacts with its environment and an **end effector** includes all the devices that can be installed at a robot's wrist. The most common end effectors are grippers (to learn more about end effectors see the Robot Bodies lesson). A **sensor** is a device that detects something; for example, your nose is the sensor you use in your sense of smell (to learn more about sensors and senses see the Robot Senses lesson).

WARM UP

Lead students through a discussion about robots and robot mechanisms they discovered in the *Robot Revolution* exhibit. Possible questions could include:

- What robot did you like the most and why?
- What features or mechanisms of the robots did you find most interesting and why?
- What are some ways in which robots can help people?

ACTIVITY

1. Have each student in the group look at the nine Robot Mechanism Cards to learn about different features their robot can have and let them pick four mechanisms for a personal robot. Each student in the group can pick whatever four mechanisms they want even if another student has picked the same ones.
2. List on their Robot Student Worksheet the four robot mechanisms they selected and explain why they chose them.
3. Ask some students to share with the class what mechanisms they picked for their own personal robot and why.
4. Ask the students if they would change any of their choices after hearing some of their classmate's choices and reasons. Explain that this is part of the engineering design process and working as a team to come up with the best possible design.
5. Give each group a Societal Scenario Card and a Roboticist Design Worksheet and have the group work together to design a robot that addresses the societal want or need on the card.
6. Explain that engineers start with a problem that can be solved through developing or designing a solution. Roboticists are engineers that work exclusively with robots.
7. Record on the Roboticist Design Worksheet what problem they were given and then discuss and write down the mechanisms the robot should have. Students can use the mechanisms cards from the first section, be given additional sensor cards from the Robot Senses lesson and/or come up with their own. There is no limit to the number of choices students can make in this section.
8. After they have made their choices as a group they will sketch out their design, making sure to add all the mechanisms they have selected.
9. All groups will present their problem and designs to the class.

10. As students are presenting, act as the client for each scenario. Ask questions about why they chose certain mechanisms and help them really think about their choices by asking questions like “Have you considered……?” or “What if ……. happens?” etc.
11. Allow students to make changes to their initial design based on feedback given and their own thoughts as they watched the other groups present.
12. Have them answer the remaining questions on page two of the Robot Student Worksheet.

CHECK FOR UNDERSTANDING:

- Why were your personal choices different than the choices you made for your societal problem?
- How might who we are or where we live influence what robots are made in the future?
- Do you think engineers usually work in teams to design solutions? Why or why not?

WHAT’S HAPPENING?

In having students compare their personal choices to choices they would make given a particular societal issue they need to solve, they can make the connection about how technology and society are intertwined.

Using creativity and teamwork to design and redesign a robot allows students to practice the skills of an engineer. Presenting their designs allows them to practice communication skills.

DIFFERENTIATED INSTRUCTION

Depending on the level of the class or students, you can make the engineering design process more or less challenging. Give every group the same societal problem to work on instead of different problems. To make it more challenging, have the groups come up with their own societal problem to address.

EXTENSIONS

This lesson can be incorporated into a longer engineering design curriculum. Students can go through every step of the engineering design process by starting with the problem, designing a robot to solve the problem, building a prototype and/or testing some of their ideas, then redesigning, rebuilding and testing again.

This lesson also can be combined with history or social studies by having students research different cultures or historical problems and incorporate their findings into their robot design.

DIGITAL RESOURCES

Videos and articles about robotics, including their impact on society.
http://www.ted.com/topics/robots

List of robots that have been or are being developed
http://robot-kingdom.com/

Lesson plans on nanoscience, which is related to robots
http://www.nisenet.org/search/product_category/k-lesson-plans-15

This lesson was inspired by
www.nisenet.org/catalog/programs/exploring_nano_society_-_you_decide

IN THE EXHIBIT

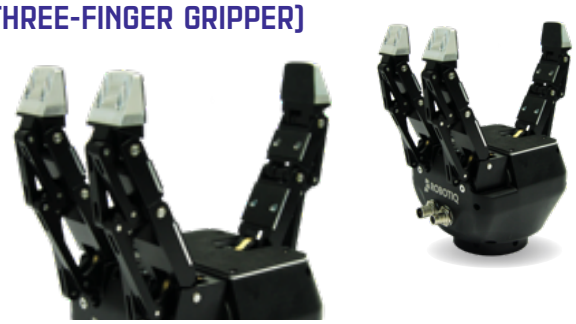
- VERSABALL® Gripper
- Robotiq 3-Finger Adaptive Robot Gripper
- PARO Therapeutic Robot
- ROBOTIS OP
- Drone
- Double Telepresence Robot

VACUUM END EFFECTOR

Vacuum end effectors like the one above have a granular material like coffee grounds or sand inside and use a vacuum to wrap around an object and then pick it up. They can pick up delicate objects like an egg without breaking them. However, they cannot pick up really large objects or very tiny objects and are limited in how much they can move the object around once it is picked up.

MECHANICAL END EFFECTOR

(THREE-FINGER GRIPPER)

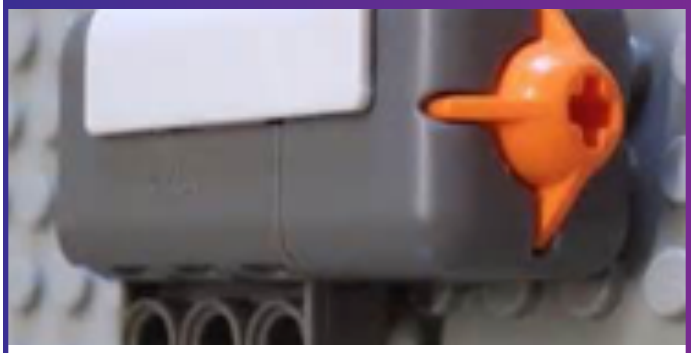


Mechanical end effectors, like this three-finger gripper, grip objects similar to how a person would. This allows for more movement of the object once it is picked up. However, they are not able to pick up objects of every shape and will likely crush very delicate objects like an egg.

MAGNETIC END EFFECTOR

Magnetic end effectors use a powerful magnet or magnets to pick up or move objects. They can pick up an object of almost any size or shape, but the object they want to pick up needs to be magnetic for it to work.

TOUCH SENSOR



Touch sensors detect pressure. When the sensor is pushed or bumps into something, the robot can programmed to respond in many ways. For example, the PARO robot in *Robot Revolution* has many touch sensors under its fur. PARO is programmed to respond with noises and movement depending on how soft or hard it is touched. Touch sensors are often used on grippers so the gripper knows when to squeeze and when to release.

VISUAL SENSOR

There are many types of visual sensors from ones that just detect light and dark to ones that detect UV or infrared light to specialized cameras. A visual sensor can be used in combination with programming for security, allowing the robot to respond to lights going on and off; for designing a robot that can follow a path; for giving a robot the ability to learn faces and respond to different people; for taking pictures or video automatically; or for reacting to any type of visual signal.

SOUND SENSOR

There are many types of sound sensors. Some detect how loud or soft a sound is, while others can recognize details of people's voices. In combination with programming, sound sensors can be used to type or write what you are saying; to understand speech and respond to you; to react to music or any other sound.

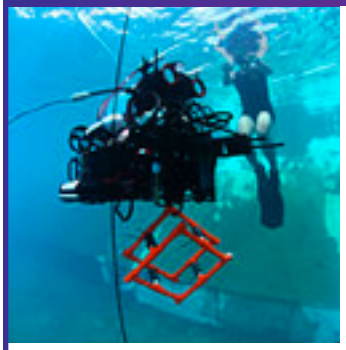
WHEELS

Wheels allow a robot to move around quickly and in all directions. They are easier to make and program, but are limited to use on mostly flat surfaces.

LEGS

Two, four, six or more legs give a robot movement similar to humans or animals. Legs are hard to make and complicated to program. Currently most robots with legs move slowly and fall down easily. Some can climb stairs and some can go over obstacles, but most only work on flat surfaces.

PROPELLERS



Propellers allow a robot to zip through the water or fly through the air. They can be damaged by running into an obstacle.

SOCIETAL SCENARIO CARDS

A large corporation sells and ships items all over the world. They sell items as small as a ring to as big as a car. They can get many items to their customers in as quickly as 24 hours, but would like have packages delivered in less than 12 hours. These packages sometimes need to get across oceans or mountains and must be delivered directly to people's homes or businesses.

A small country is constantly threatened by earthquakes. Recently a 7.8 magnitude earthquake hit the country, killing hundreds of people and destroying many homes and businesses. The country's leaders would like a robot or robots that can search through rubble to find survivors, help with the clean up and rebuild structures to get the country back on its feet.

Farms all over the world are attacked by bugs, small mammals and birds that feed on the crops. Many farmers don't want to kill these animals, but would prefer if they found their food somewhere else. They would like a robot or robots to help; these robots can be any size, but cannot interfere with the farmers when they are harvesting their crops.

SOCIETAL SCENARIO CARDS

An elderly woman with no children is starting to have trouble getting around her house. She is starting to forget to take her medicine and needs help preparing her meals. She wants to be able to stay living at home, but is going to need help. The robot needs to be able to easily move around her house, help with everyday chores and give her reminders.

ROBOTICIST DESIGN WORKSHEET

NAME: _____ **DATE:** _____

Write the problem you are trying to solve from your group's Societal Scenario Card.

_____

_____

_____

Work together to describe the size of your robot or robots:

_____

_____

Work together to describe how you will power your robot or robots:

_____

_____

_____

List mechanisms the robot or robots will have (there are no limits to the number of mechanisms):

_____

_____

Draw your robot in the box below and label all the mechanisms.

STUDENT WORKSHEET

NAME: _____ **DATE:** _____

List four mechanisms you would want in a robot for yourself and explain why you chose them.

MECHANISM 1:	**WHY:**
MECHANISM 2:	**WHY:**
MECHANISM 3:	**WHY:**
MECHANISM 4:	**WHY:**

Do you think your choices are the same as your classmates? Why or why not?

_____

_____

_____

_____

_____

STUDENT WORKSHEET

NAME: _____ **DATE:** _____

What changes did you make to your design after your presentation?

Do you think it was good to make changes? Why or why not?

How might a robot designed in another country be different than a robot designed in the United States?

List three other problems you think a robot might be able to help solve and explain how.

1) _____

_____

_____

_____

2) _____

_____

_____

_____

3) _____

_____

_____

_____