



## ***Robotics—Hands Down!***

### **LESSON DESCRIPTION**

This lesson includes a series of activities that are based on robotics applications.

### **OBJECTIVES**

Students will

- Explain how the end effectors for the robotic arms used on the space shuttle and the International Space Station work
- Design and construct a grapple fixture that will enable the end effector to pick up an object
- Describe how artificial intelligence allows robots to behave more like humans
- Provide examples of real-world applications of robotics

### **NASA SUMMER OF INNOVATION UNIT**

*Engineering—Robotics*

### **GRADE LEVELS**

7 – 9

### **CONNECTION TO CURRICULUM**

*Science and Technology*

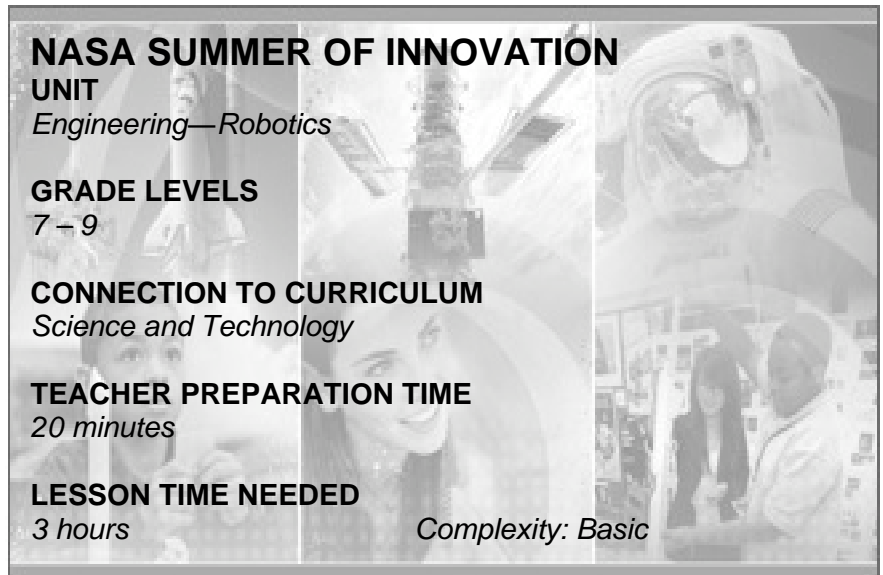
### **TEACHER PREPARATION TIME**

20 minutes

### **LESSON TIME NEEDED**

3 hours

*Complexity: Basic*



### **NATIONAL STANDARDS**

#### **National Science Education Standards (NSTA)**

##### *Science as Inquiry*

- Understanding of scientific concepts
- An appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- Dispositions to use the skills, abilities, and attitudes associated with science

##### *Science and Technology Standards*

- Abilities of technological design
- Understanding about science and technology

##### *Science in Personal and Social Perspectives*

- Personal health
- Risks and benefits
- Science and technology in society

##### *History and Nature of Science*

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

#### **ISTE NETS and Performance Indicators for Students**

##### *Creativity and Innovation*

- Apply existing knowledge to generate new ideas, products, or processes
- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

### *Communication and Collaboration*

- Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats
- Develop cultural understanding and global awareness by engaging with learners of other cultures
- Contribute to project teams to produce original works or solve problems

### *Critical Thinking, Problem Solving, and Decision Making*

- Identify and define authentic problems and significant questions for investigation
- Plan and manage activities to develop a solution or complete a project
- Collect and analyze data to identify solutions and/or make informed decisions
- Use multiple processes and diverse perspectives to explore alternative solutions

## **MANAGEMENT**

Build an “End Effector” prior to class. Model for students the way to cut the Styrofoam cup. Demonstrate how to use either a serrated knife or scissors.

## **CONTENT RESEARCH**

The following link provides additional resources for teachers and students and not necessarily a NASA resource but rather private industry, colleges, universities, and organizations that have taken an interest in one form or another in robotics, robotics competition, teaching, and design. Please review content from the following resource: <http://robotics.nasa.gov/edu/6-8.php>.

## **Shuttle and Station Robotic Arm**

Today, new exploration strategies are at work. The goal is no longer humans or robots. It is humans and robots working together. Each brings important complimentary capabilities to the exploration of space. On the space shuttle the 15-meter-long arm is mounted in the orbiter’s cargo bay. It has seven degrees of freedom (DOF). The gripping device is called an end effector. That means it is located at the end of the arm and it has an effect (such as grasping) on objects within its reach.

## **Artificial Intelligence**

Today’s robots have multiple sensors and are able to make their own decisions based on given information. Robots come in all shapes and sizes. Artificial intelligence allows robots to behave more like humans and to act independently in a changing environment.

## **LESSON ACTIVITIES**

### **End Effector**

Students will learn how the end effectors works in the robotic arms used onboard the space shuttle and the International Space Station. Students will design and construct a grapple fixture that will enable the end effector to pick up object.

<http://virtualastronaut.tietronix.com/teacherportal/pdfs/humans.and.robotics.pdf>

## **MATERIALS**

- Narrow rubberbands
- Drinking straws
- Cardboard
- Scissors
- Nylon cord
- Centimeter ruler
- Pencils
- Drawing compass
- Tape
- Glue
- Markers
- Crayons
- Colored pencils
- Pen
- Styrofoam coffee cups (2 each) 6 ounces
- 12-cm pieces string (1 each)
- Cellophane tape
- Plastic picnic knives (serrated)

## I Want To Hold Your Hand

To construct a robotic, human-like hand and demonstrate how grasping occurs go to

[I Want To Hold Your Hand](#)

## ADDITIONAL RESOURCES

**Station Robotic Arm:** Canada contributed an essential component of the International Space Station, the Mobile Servicing System. This robotic system plays a key role in space station assembly and maintenance: moving equipment and supplies around the station, supporting astronauts working in space, and servicing instruments and other payloads attached to the space station. Astronauts receive robotics training to enable them to perform these functions with the arm.

[http://www.nasa.gov/mission\\_pages/station/structure/elements/mss.html](http://www.nasa.gov/mission_pages/station/structure/elements/mss.html)

**Robonaut 2:** Latest generation of the Robonaut astronaut helpers, launched to the space station aboard Space Shuttle Discovery on the STS–133 mission in 2011. It is the first humanoid robot in space, and although its primary job for now is teaching engineers how dexterous robots behave in space, the hope is that through upgrades and advancements, it could one day venture outside the station to help spacewalkers make repairs or additions to the station or perform scientific work.

[http://www.nasa.gov/mission\\_pages/station/main/robonaut.html](http://www.nasa.gov/mission_pages/station/main/robonaut.html)

**Mars Science Laboratory:** Unmanned robotic rover designed to land on Mars and assess whether Mars ever was, or is still today, an environment able to support microbial life to determine the planet's habitability. The rover, named Curiosity, is about the size of a small sport-utility vehicle. It will carry an advanced suite of instruments to study Martian terrain and soil.

<http://sse.jpl.nasa.gov/missions/profile.cfm?MCode=MarsSciLab>

**Curiosity Robot cam:** Curiosity Cam takes you inside the clean room at NASA's Jet Propulsion Laboratory in Pasadena, California, so you can watch the next Mars rover being built. The camera may be turned off periodically for maintenance. The rover may occasionally be out of view as it is moved around the clean room. When Curiosity Cam is off air, you will see a slideshow of Mars and rover images.

[http://www.nasa.gov/mission\\_pages/msl/building\\_curiosity.html](http://www.nasa.gov/mission_pages/msl/building_curiosity.html).

**NASA Robotics:** Find out how NASA plans to create a human, technical, and programmatic resource of robotics capabilities to enable the implementation of future robotic space exploration missions.

<http://robotics.nasa.gov/>

**eClips:** Real World: Robotic Arm; Real World: TriATHLETE—The Engineering Design Process in Action; NASA 360 Mind Body Connection.

<http://www.nasa.gov/audience/foreducators/nasaclips/search.html?terms=robotics>

## DISCUSSION QUESTIONS

- Make a Venn diagram to compare your hand to the robotic hand you made. *If it the humanoid Robonaut then the grasp is similar to humans, but if it is with the shuttle or station end effector then grasping is different*
- Write why you think some things cannot be picked up with your robotic hand. *Not enough strength; with end effector the cup must fit over the object otherwise it will not pick it up.*
- What items can you pick up with your robotic hand? *Simple, lightweight items such as empty soda bottles, erasers, or pencils.*
- What would happen if you added more fingers? *You would have a better grasp but it may be harder to control.*
- What would happen if you added a thumb? *You will have two point of opposition for better grasping if controlled correctly.*

## **ASSESSMENT ACTIVITIES**

Review the tables or charts created by your students. Pay special attention to the ideas students have for improving their grapple fixtures.

## **ENRICHMENT**

- Students can enter First LEGO Robotics Competitions:  
[http://robotics.arc.nasa.gov/events/2011\\_sponsorship.php](http://robotics.arc.nasa.gov/events/2011_sponsorship.php)
- NASA Robotics: <http://robotics.nasa.gov/students/sumo.php>
- Robotics Summer Camps: [http://robotics.nasa.gov/students/summer\\_camps.php](http://robotics.nasa.gov/students/summer_camps.php)
- NASA-KSC Luna-Botics:  
<http://www.nasa.gov/offices/education/centers/kennedy/technology/lunabotics.html>