Science Screen Report FOR KIDS

VOLUME 25, EPISODE 4 - 11 minutes

ENGINEERING: *The Science of Prosthetics*

SYNOPSIS

Prosthetics are commonly called artificial limbs and are used to replace limbs amputated or missing due to traumatic injury, disease, or birth defect. Many people who have lost limbs or who were born without them have benefited from the use of prosthetics and orthotics, also known as braces. New advances in prosthetics have given people more maneuverability, dexterity, and control than ever before. Scientists and engineers are increasingly finding ways to mimic real limbs. One major advancement is the presence of newer materials, such as advanced plastics and carbon-fiber composites. These materials can make a prosthetics limb lighter, stronger and more realistic. For example, with the use of myoelectric prosthetics, engineers have found ways to utiliize the electrical impulses from muscle tissue. They can amplify the signals and use them to drive prosthetic limbs. Electronic technologies make today's advanced prosthetics more controllable, even capable of automatically adapting their function during certain tasks, such as gripping or walking. Great strides are being made each day in the field of prosthetics, and while great technological challenges remain, artificial limbs are becoming increasingly similar to real limbs. The technology that drives the industry continues to advance and helps to continue to improve people’s lives.

CURRICULUM UNITS

- ANATOMY
- ENGINEERING

CAREER POSSIBILITIES

- PROSTHETIST
- BIOMEDICAL ENGINEER

NEXT GENERATION SCIENCE STANDARDS & NATIONAL SCIENCE EDUCATION STANDARDS

NEXT GENERATION SCIENCE STANDARDS: www.nextgenscience.org

3-5-ETS1-1. Engineering Design.
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Grades 3 - 5

Engineering Design
Defining and Delimiting
Engineering Problems

CRITICAL THINKING EXERCISES

1. Research the topic of prosthetics and report on major developments in its history.
2. Give several examples of the ways that orthothic devices have improved over the years.
3. Describe some of the ways technology can be used in designing prosthetics.
4. Compare and contrast the uses of orthotics vs. prosthetics.

ABET
Accreditation Board for Engineering and Technology
www.abet.org

NMOE
National Museum of Education
www.nmoe.org

BACKGROUND

In the event that a person loses a limb to disease or injury, or if they were born without one, orthotics and prosthetics can be invaluable. The loss of a hand or an arm can alter how a job is performed and how one goes about daily tasks. The loss of a foot or leg has obvious implications regarding walking and running. Designing and creating prosthetic devices is highly personalized because it directly affects a person's life. Despite that prosthetic devices are not quite capable of the same tasks as a patient's original biological limbs, today's scientists and engineers strive to mimic the anatomy and physiology of missing limbs to give patients a realistic experience. They hope to get as close to the real thing as possible because people often struggle with emotional aspects of losing limbs as well as the physical absence.

Organizations such as Hanger Incorporated create ground-breaking prosthetic innovations with the help of microprocessors, carbon fiber, accelerometers, robotics, and advanced socket materials. As one of the largest rehabilitative product and service organizations in the world, Hanger makes high end products such as the bebionic hand, which utilizes individual actuators to drive each finger. Each digit moves and grips in a natural and coordinated manner, providing compliant and conformable grips around complex shapes. Hanger has also developed the élan microprocessor-controlled hydraulic foot. Using patented microprocessor-controlled technology, the foot provides real time, simultaneous adjustments as the user walks, allowing for smoother gait.

ADVANCED ORGANIZERS

Prior to viewing the video students should have some understanding of the following Science Benchmarks from AAAS, Project 2061. This is a longterm initiative focused on improving science education so that all Americans can become literate in science, mathematics, and technology.

Benchmark 3. The Nature of Technology.
Section B. Design and Systems, Grades 3-5
By the end of the 5th grade, students should know that

- There is no perfect design. Designs that are best in one respect (safety or ease of use, for example) may be inferior in other ways (cost or appearance). Usually some features must be sacrificed to get others. 3B/E1

SUGGESTED REFERENCES

- *AAAS, Project 2061:* ***http://www.aaas.org/program/project2061***
- *American Academy of Orthotists and Prosthetists:* ***http://www.oandp.org/***
- *Orthotics and prosthetics Career information:* ***http://www.opcareers.org/***
- *Hanger homepage:* ***http://www.hanger.com***
- *The International Society for Prosthetics and Orthotics:* ***http://www.ispoint.org/***
- *History of Prosthetics and Orthodics:* ***http://www.ap.gatech.edu/mspo/old/about.htm***
- *Advancements in Prosthetics and Orthodics:* ***http://www.nextstepbionicsandprosthetics.com/expertise-inmotion/ bionics-and-prosthetics/products-and-technology.aspx***
- *Prosthetics with Mind Control:* ***http://science.howstuffworks.com/prosthetic-limb4.htm***
- *Robot Game for Kids:* ***http://www.coolmath-games.com/0-go-robots***

VOCABULARY

Actuator: A servomechanism that supplies and transmits a measured amount of energy for the operation of another mechanism or system.
Hydraulic: Operated by pressure transmitted through a pipe by a liquid, such as water or oil.
Myoelectric: Of or relating to the electrical properties of muscle tissue from which impulses may be amplified, used especially in the control or operation of prosthetic devices.
Orthotics: The science that deals with the use of specialized mechanical devices to support or to supplement weakened or abnormal joints or limbs.
Prosthetics: The branch of medicine or surgery that deals with the production and application of artificial body parts.

Vocabulary Learning Tool: Make a Jeopardy Game. **http://www.superteachertools.us/jeopardyx/brandnewgame.php**

INQUIRY ACTIVITIES

Grades 3-5: Robotic Arm Design Challenge

Overview: In this activity, students work in teams to design and build a working robotic arm from a set of everyday items. Each arm should be able to pick up a Styrofoam cup. Participating teams of three or four students are provided with a bag including the materials listed below. Each team must use the materials to design and build a working robot arm. The robot arm must be at least 18 inches in length and be able to pick up an empty Styrofoam cup. Teams of students must agree on a design for the robot arm and identify what materials will be used. Students will draw a sketch of their agreed upon design prior to construction. Resulting robot arms are then tested to pick up the cup.

Materials: hole punch, 2 large paper clips, marker, 1 medium brass fastener (1 in. [2.5 cm]), paper cup, smooth string (39 in. [100 cm]) (for example, fishing line), 1 straw (cut into 1-in. [2.5-cm] lengths) , 1 strip of corrugated cardboard (about 2 x 4 in. [5 x 10 cm]) (corrugated cardboard has grooves in the middle, like a cardboard shipping box), 1 strip of corrugated cardboard (about 2 x 8 in. [5 x 20 cm]) , tape

Procedure: The goal of this activity is to design and build a robotic arm that can pick-up a Styrofoam cup. Explain that teamwork, trial, and error are part of the design process. There is no "right" answer to the problem – each team's creativity will likely generate an arm that is unique from the others designed in your class.

1. Divide your class into teams of about four students.
2. They are then instructed to examine the materials and to work as a team to design and build a robot arm.
3. The robot arm must be at least 18 inches in length and be able to pick up an empty Styrofoam cup.
4. Teams of students must agree on a design for the robot arm and identify what materials will be used.
5. Students draw a sketch of their design before construction.
6. When finished, the teams of students can test their robotic arms to see if the Styrofoam cup can be lifted.
7. If time permits, robotic arms can be tested to see if they can pick-up a cup loaded with different amounts of giant paper clips.