Drexel-SDP GK-12 ACTIVITY

Activity: Space Station Remote Manipulator Arm

Subject Area(s) **Earth and Space**

Associated Unit **Astronomy, module 2**

Associated Lesson: Space Station Remote Manipulator Arm

Activity Title Fabrication Activity: Space Station Remote Manipulator Arm

Header

Grade Level 6 (3-7)

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Activity Dependency None

Time Required 15-20 minutes

Group Size 1

Expendable Cost per Group **$0.20**

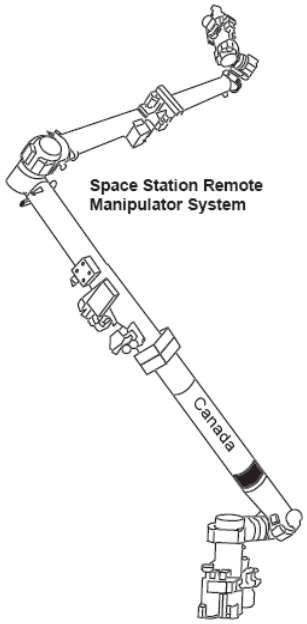

Image 1

ADA Description: Picture shows robotic manipulator arm

Caption: Robotic manipulator arm

Image file name: img1.pdf

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Summary

In the associated lesson, students briefly learned about the role of a remote manipulator arm in space research missions. The objective of this activity is to expose students to some of the mechanical devices designed by engineers to assist scientists and astronomers with space exploration and space research. In this activity, students will follow a design plan to fabricate a robotic end effector (a gripper) attached to a remote manipulator arm (a robotic arm).

Engineering Connection

The role of robotics for astronauts working on the International Space Station (ISS): Astronauts working on the ISS often must manipulate small objects, which can be very hard to do in cumbersome space suits! To compensate for the limited use of their hands, astronauts use robotic arms with a specialized end effector (a gripper) attached at the end to pick up or place objects of varying size. Theses devices are designed and fabricated by teams of engineers who work in the mechanical and electrical fields.

Keywords

Astronomy, electrical engineer, international space station, mechanical engineer, robotics

Educational Standards (PA)

- Science: Technological Devices - Instruments 3.7.B, Physical Science, Chemistry and Physics - Astronomy 3.4.D, Science, Technology and Human Endeavors - Meeting Human Needs - 3.8.B
- Math: Measurement and Estimation 2.3, Geometry 2.9:

Pre-Requisite Knowledge

Familiarity with the degrees of an angle and circle.

Learning Objectives

After this activity, students should be able to:

- **Explain what an electrical engineer does**
- **Explain what a mechanical engineer does**
- **Explain what the ISS is and how it is used for space research**
- **Explain how mechanical and electrical engineers are involved in the design of components to assist astronauts on the International Space Station (ISS)**

Materials List

Each individual needs:

- Three styrofoam cups,
- Three pieces of string – about 6 in. each
- Six 1 in. pieces of tape

To share with the entire class:

- Gram weights on a hook to test the strength of the manipulator arm
- (or) Arbitrary objects (such as quarters or pennies) to lift, and a
- Balance to weigh the weights

Introduction / Motivation

In constructing robotic arms for the International Space Station, engineers must make careful measurement specifications in their design. Why do you think it's important to make careful measurements? How could a bad measurement affect an astronaut's mission in space? In this activity, we will practice making a prototype, or a test sample, of a robotic manipulator arm similar to the one an astronaut might use in space.

(This activity will be conducted after some discussion about the role of robotics in assisting astronauts who work on the International Space Station (ISS), plus some discussion on mechanical engineers and electrical engineers.)

Vocabulary / Definitions

Word	Definition
Remote manipulator arm	A mechanical device for grasping. May or may not be electronically controller.
End effector	A mechanical device for gripping
International Space Station (ISS)	An in-space research laboratory that orbits the Earth
Mechanical engineering	The study and design of systems having moving parts or involving motion
Electrical engineering	The study and design of systems and components that utilize or generate electrical power
Prototype	A full-scale working model of a new or existing device

Procedure

Before the Activity

- Present the Fabrication Lesson: Space Station Remote Manipulator Arm

With the Students

1. Step 1: Each student gets two paper cups, a plastic knife, and a few pieces of string.

2. Step 2: The student will use the plastic knife to saw out the bottoms of each of the cups, as depicted in the figure below. Then, place one cup inside the other.

3. Step 3: The student will attach three strings placed 120 degrees apart. One end of the string is taped to the outside of the outer cup. The other end of the string is taped to the outside of the inner cup, as depicted in the figure below.

4. Step 4: Students will perform stress testing to determine the mass (using a balance) of the heaviest object their end effector is capable of picking up.

5. Step 5: Open a discussion as to how well the manipulator arm worked, and ask the students to suggest ways to improve the lifting ability of their arm.

Image

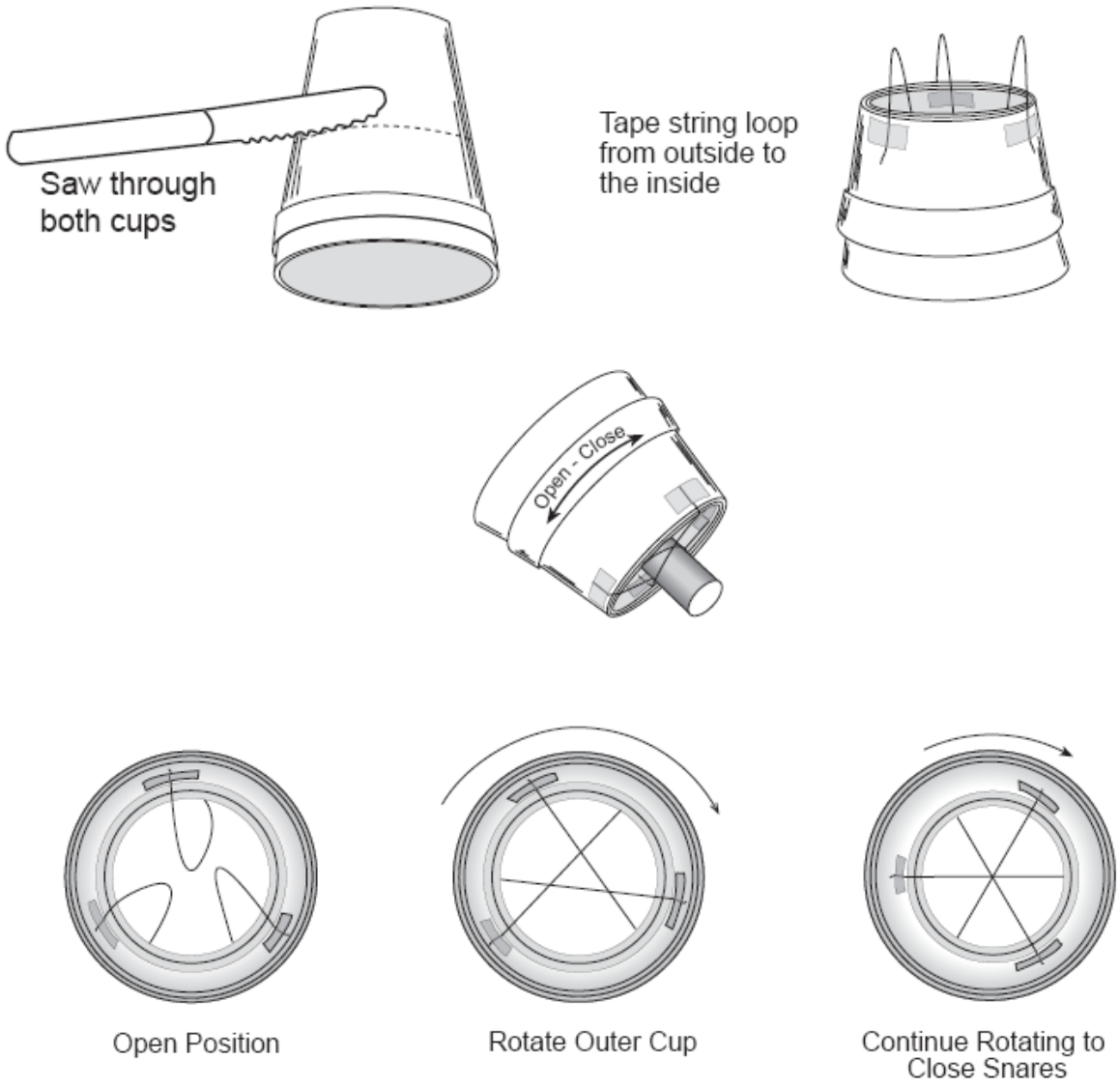

Image 2

ADA Description: Picture shows the steps for how to fabricate a robotic manipulator arm

Caption: The steps for how to fabricate a robotic manipulator arm

Image file name: img2.pdf

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Attachments

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Safety Issues

- Supervise students for proper use of plastic knives

Troubleshooting Tips

Try masking tape instead of Scotch tape for better adhesion to the styrofoam. If students' strings do not link together form the snare, check to make sure on side of each string is fastened to the outer cup, and the other side of each string is fastened to the inner cup.

Investigating Questions

Question 1: What is the mass of the heaviest object your end effector can pick up?

Question 2: How can we improve the design? What materials could we use? Where are the weak points in this mechanical device?

Question 3: What would you do differently next time?

Assessment

Observe the students during this activity and make the following assessment based on the teacher observation:

Students will be evaluated on a scale from 0 to 4 on:

_____	_____	_____
Task Completion	Successful construction of device	Participation in discussion

Additional Multimedia Support

More activities for children from the Kennedy Space Center:

http://www.kennedyspacecenter.com/PDF/KSCEdGuide6-8.pdf

References

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