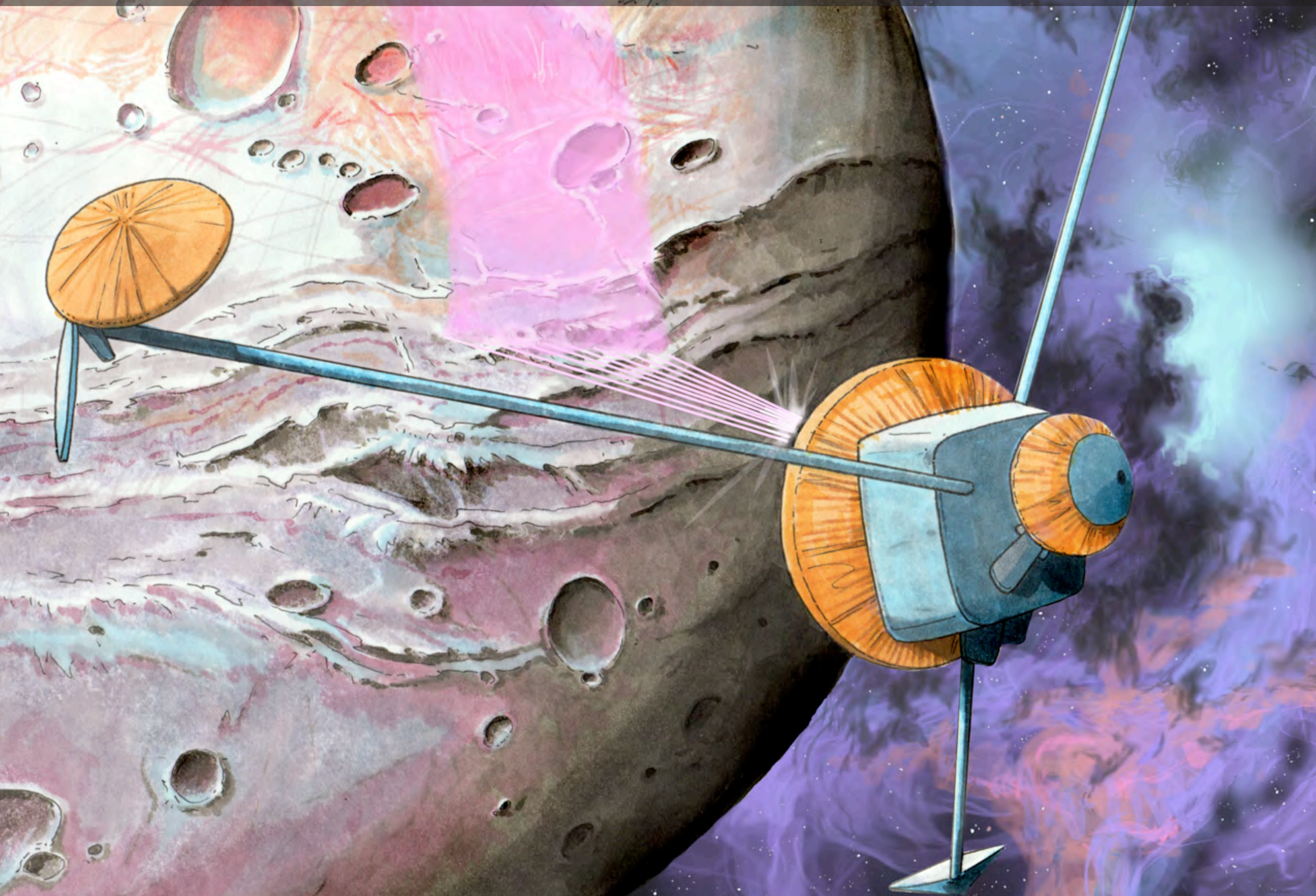
Engineering Everywhere™

# Worlds Apart: Engineering Remote Sensing Devices

Remote Sensing Engineering for Out-of-School Time • Grades 6–8



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EiE Engineering is Elementary® | Engineering Everywhere™
Developed by the Museum of Science, Boston



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Developed by the Museum of Science, Boston

Pilot Sites:

This unit would not be possible without the valuable feedback from our pilot sites!
**ACCESS Educational Services, Inc.** Bridgeport, CT
**Arlington Education Collaborative** Arlington, MA
**Bagdad Middle School** Bagdad, AZ
**BASIS Flagstaff** Flagstaff, AZ
**Boys and Girls Club of Central VA** Charlottesville, VA
**Boys and Girls Club of Flagstaff** Flagstaff, AZ
**Boys and Girls Club of Greater Salem** Salem, MA
**Brentwood Magnet Engineering School** Raleigh, NC
**Cactus Middle School** Casa Grande, AZ
**CHARISM** West Fargo, ND
**Dilcon Community School** Winslow, AZ
**EdBoost Education Corporation** Los Angeles, CA
**Girls Inc. of Lynn** Lynn, MA
**LEAP Afterschool Program** San Rafael, CA
**Saints Peter and Paul Catholic School** Tucson, AZ
**Salvation Army Cleveland Temple Corps** Cleveland, OH
**Seabrook Adventure Zone** Seabrook, NH
**Show Low Unified School District** Show Low, AZ
**Sinagua Middle School** Flagstaff, AZ
**St. Michael School** Lowell, MA
**STEM Kids NYC** New York, NY
**Quabbin Regional School District** Hubbardston, MA
**Veterans Memorial Middle School** Brick, NJ
**Winthrop Middle School** Winthrop, MA

## *PLANETS*

Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (*PLANETS*) is an interdisciplinary and cross-institutional partnership that integrates planetary science, education, technology, and engineering (NASA #NNX16AC53A).

The Center for Science Teaching and Learning at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center, and the Museum of Science, Boston have partnered to develop, pilot, and research the impact of three curriculum units and related professional development resources (http://planets-stem.org).

The purpose of *PLANETS* is to increase public awareness and use of NASA resources by highlighting the relationship between science, technology, engineering, and mathematics in the context of planetary science in out-of-school time settings.

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# Unit Map

Here is an overview of the activities in this unit and how they all fit together.

**Prep Activity 1: What is Engineering?**

Youth are introduced to the Engineering Design Process as they work together to engineer a tower to support a model antenna.

**Prep Activity 2: What is Technology?**

Youth match technologies based on the problem they solve and *imagine* ways to *improve* the newer version.

**Activity 1: Looking Beyond**

Youth use mirrors to change the way light travels in order to see hidden objects.

**Activity 2: Secret Messages**

Youth explore how manipulating light and color can help them interpret information from a distance that would otherwise be difficult to see.

**Activity 3: Taking Shape**

Youth engineer a technology that models LiDAR to gather topographical information about the features of a surface.

**Activity 4: Create a Remote Sensing Device**

Youth work in groups to *create* remote sensing technologies that can collect data about the Mystery Moon.

**Activity 5: Improve: Final Launch**

Youth will *improve* their remote sensing devices and use them to take a final reading from two locations on the Mystery Moon.

**Activity 6: Engineering Showcase**

Youth *communicate* their knowledge of remote sensing devices and the information they gathered about the Mystery Moon at the Engineering Showcase.

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# About Engineering is Elementary

Engineering is Elementary® (EiE®) fosters engineering and technological literacy among children. Most humans spend over 95% of their time interacting with technology. Pencils, chairs, water filters, toothbrushes, cell phones, and buildings are all technologies—solutions designed by engineers to fulfill human needs or wants. To understand the world we live in, it is vital that we foster engineering and technological literacy among all people, even young children! Fortunately, children are born engineers. They are fascinated with building, taking things apart, and learning how things work. Engineering is Elementary harnesses children's natural curiosity to promote the learning of engineering and technology concepts.

The EiE program has four primary goals:
- Increase children's technological literacy.
- Increase educators' abilities to teach engineering and technology.
- Increase the number of schools and out-of-school time (OST) programs in the US that include engineering.
- Conduct research and assessment to further the first three goals and contribute knowledge about engineering teaching and learning.

The first product developed by the EiE program was the Engineering is Elementary curriculum series. Designed for use in elementary school classrooms, this curriculum is hands-on, research-based, standards-driven, and classroom-tested. For more information about EiE, visit: www.eie.org.

In 2011, EiE began development of Engineering Adventures® (EA), a curriculum created for 3rd–5th grade children in OST environments. EA is designed to provide engaging and thought-provoking challenges appropriate for the OST setting. More information about EA can be found online at: www.engineeringadventures.org.

In 2012 the Engineering Everywhere™ (EE™) curriculum was created. EE is designed to empower middle-school-aged children in OST settings to become engineers and solve problems that are personally meaningful and globally relevant. For more information, visit: www.engineeringeverywhere.org.

Engineering is Elementary is a part of The National Center for Technological Literacy (NCTL) at the Museum of Science, Boston. The NCTL aims to enhance knowledge of technology and inspire the next generation of engineers, inventors, and innovators. Unique in recognizing that a 21st century curriculum must include today's human-made world, the NCTL's goal is to introduce engineering as early as elementary school and continue through high school, college, and beyond. For more information, visit: www.nctl.org.

## About Engineering Everywhere

The mission of Engineering Everywhere is to create engaging out-of-school time learning experiences for 6th–8th graders that positively impact youth's attitudes about their abilities to engineer. Our goal is to provide youth with personally meaningful and globally relevant challenges that empower them to problem solve, think creatively, and learn from one another.

The main ideas that guide the developers of EE are listed below.

We believe youth will best learn engineering when they:

- engage in activities that are fun, exciting, and connect to the world in which they live.
- choose their path through open-ended challenges that have multiple solutions.
- have the opportunity to succeed in engineering challenges.
- communicate and collaborate in innovative, active problem solving.

Through EE units, youth will learn that:

- they can use the Engineering Design Process to help solve problems.
- engineers design technologies to help people and solve problems.
- they have the talent and potential to design and improve technologies.
- they, too, are engineers.

As youth work through their engineering design challenges, they will have the opportunity to build their problem solving, teamwork, communication, and creative thinking skills. Most importantly, this curriculum is designed to provide a fun learning opportunity!

## Unit Goals

In this unit, youth will be introduced to engineering and the eight-step Engineering Design Process as they work together to engineer remote sensing devices for partner scientists. Youth will *investigate* different technologies used in the field of remote sensing—periscopes, optical filters, and LiDAR—before engineering their own remote sensing devices to solve one of the research problems posed by the scientists.

By the end of the unit, youth will be ready to present what they learned about remote sensing and the Engineering Design Process by sharing the engineering work they have done.

# The Engineering Design Process

The Engineering Everywhere Engineering Design Process (EDP) is the backbone of each Engineering Everywhere (EE) unit. It is an eight-step process that guides youth in solving engineering challenges. Our goal for each EE unit is for youth to understand that the EDP can help them solve problems not only in engineering, but also in other areas of their lives.

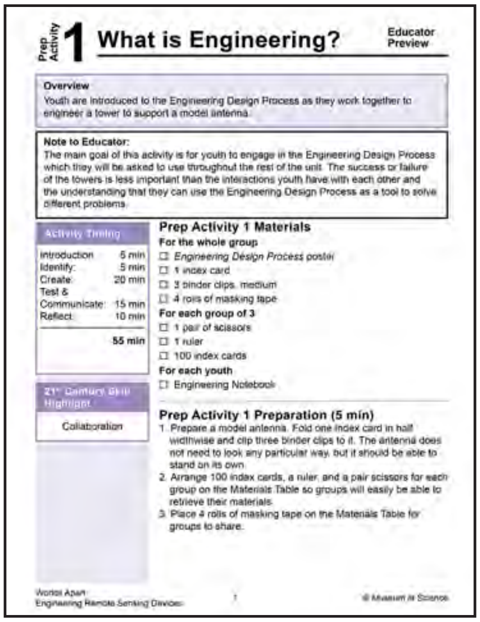
While there are many versions of the EDP used in academic and professional fields of engineering, we developed an eight-step process that builds on the five-step process used in our elementary curriculum. There are guiding questions throughout the activities for the educator to ask to promote discussion about the EDP. There are also sections in the Engineering Notebook to encourage youth to engage in the process.


The EDP begins with identifying a problem that needs to be solved and investigating what has already been done. Next, engineers imagine different solutions and plan their designs. Then, they create and test their designs and make improvements based on the test results. Finally, engineers communicate their findings to others. While the process is shown as linear, youth may jump around to different steps as they are engineering. For example, they may need to imagine and plan new designs in order to improve.

To further highlight the EDP throughout the unit, the steps are italicized in this guide. Youth are also provided with an explanation of each step, which can be seen in their Engineering Notebooks. The EDP used in EE units is illustrated to the right.

# Educator Guide Components

An **Educator Preview** with background information, activity timing, key concepts, materials lists, and preparation.



Prep Activity **1** What is Engineering? Educator Preview

**Overview**
Youth are introduced to the Engineering Design Process as they work together to engineer a tower to support a model antenna.

**Note to Educator:**
The main goal of this activity is for youth to engage in the Engineering Design Process which they will be asked to use throughout the rest of the unit. The success or failure of the towers is less important than the interactions youth have with each other and the understanding that they can use the Engineering Design Process as a tool to solve different problems.

**Activity Timing**

| | |
|---|---|
| Introduction | 5 min |
| Identify | 5 min |
| Create | 20 min |
| Test & Communicate | 15 min |
| Reflect | 10 min |
| | **55 min** |

**21st Century Skill Highlight**
Collaboration

**Prep Activity 1 Materials**
**For the whole group**
☐ *Engineering Design Process* poster
☐ 1 index card
☐ 3 binder clips, medium
☐ 4 rolls of masking tape
**For each group of 3**
☐ 1 pair of scissors
☐ 1 ruler
☐ 100 index cards
**For each youth**
☐ Engineering Notebook

**Prep Activity 1 Preparation (5 min)**
1. Prepare a model antenna. Fold one index card in half widthwise and clip three binder clips to it. The antenna does not need to look any particular way, but it should be able to stand on its own.
2. Arrange 100 index cards, a ruler, and a pair scissors for each group on the Materials Table so groups will easily be able to retrieve their materials.
3. Place 4 rolls of masking tape on the Materials Table for groups to share.

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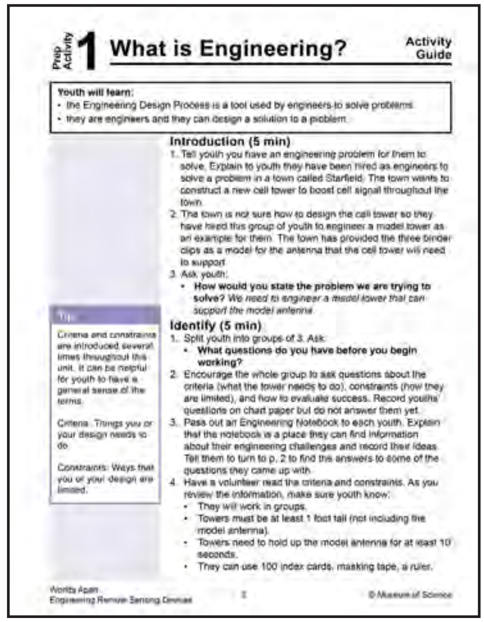
An **Activity Guide** with step-by-step instructions, including discussion questions, extension ideas, and tips.



Prep Activity **1** What is Engineering? Activity Guide

**Youth will learn:**
- the Engineering Design Process is a tool used by engineers to solve problems
- they are engineers and they can design a solution to a problem

**Introduction (5 min)**
1. Tell youth you have an engineering problem for them to solve. Explain to youth they have been hired as engineers to solve a problem in a town called Starfield. The town wants to construct a new cell tower to boost cell signal throughout the town.
2. The town is not sure how to design the cell tower so they have hired this group of youth to engineer a model tower as an example for them. The town has provided the three binder clips as a model for the antenna that the cell tower will need to support.
3. Ask youth:
   - **How would you state the problem we are trying to solve?** *We need to engineer a model tower that can support the model antenna.*

**Identify (5 min)**
1. Split youth into groups of 3. Ask:
   - **What questions do you have before you begin working?**
2. Encourage the whole group to ask questions about the criteria (what the tower needs to do), constraints (how they are limited), and how to evaluate success. Record youths' questions on chart paper but do not answer them yet.
3. Pass out an Engineering Notebook to each youth. Explain that the notebook is a place they can find information about their engineering challenges and record their ideas. Tell them to turn to p. 2 to find the answers to some of the questions they came up with.
4. Have a volunteer read the criteria and constraints. As you review the information, make sure youth know:
   - They will work in groups.
   - Towers must be at least 1 foot tall (not including the model antenna).
   - Towers need to hold up the model antenna for at least 10 seconds.
   - They can use 100 index cards, masking tape, a ruler,

**Tip:**
Criteria and constraints are introduced several times throughout this unit. It can be helpful for youth to have a general sense of the terms.

Criteria: Things you or your design needs to do.

Constraints: Ways that you or your design are limited.

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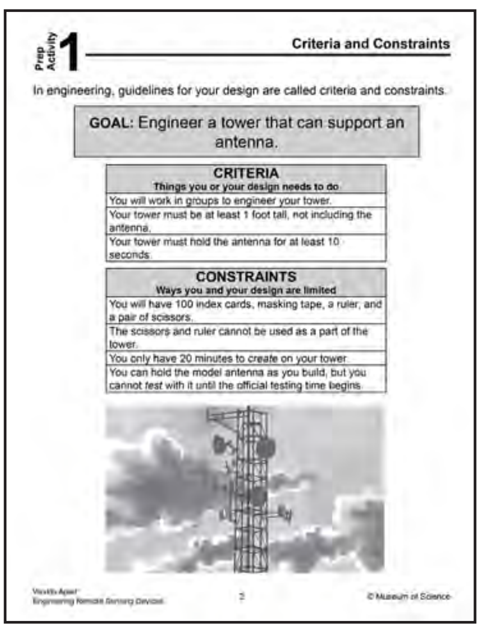
**Engineering Notebook** pages that allow youth to record their findings and reflect on their learning.



Prep Activity **1** Criteria and Constraints

In engineering, guidelines for your design are called criteria and constraints.

**GOAL:** Engineer a tower that can support an antenna.

| **CRITERIA** Things you or your design needs to do |
|---|
| You will work in groups to engineer your tower. |
| Your tower must be at least 1 foot tall, not including the antenna. |
| Your tower must hold the antenna for at least 10 seconds. |

| **CONSTRAINTS** Ways you and your design are limited |
|---|
| You will have 100 index cards, masking tape, a ruler, and a pair of scissors. |
| The scissors and ruler cannot be used as a part of the tower. |
| You only have 20 minutes to create on your tower. |
| You can hold the model antenna as you build, but you cannot *test* with it until the official testing time begins. |

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# What You Need to Know Before Teaching an EE Unit

## Engineering is Fun

The EE team hears this from many OST educators and youth. Engineering is a way of problem solving—a way of thinking about the world—that is very fun and creative. Any time you need to solve a problem in order to reach a goal, you are engineering.

## There are No Right or Wrong Answers

There are often many great ways to solve the same problem. Not only is this a good engineering lesson, it is a good life lesson for the youth in your program.

## You are a Guide

As the educator, it is your role to guide youth through these activities by encouraging them to pursue and communicate their own ideas, even if you think they might not work. Every problem has many possible solutions and multiple ways to reach them.

## Ask Questions

Throughout the activities, you can ask questions prompting youth to share their prior knowledge, predict what they might find, or remind them of criteria that will help them as they engineer. Asking questions like these sets your youth up to succeed and feel confident in their ability to engineer.

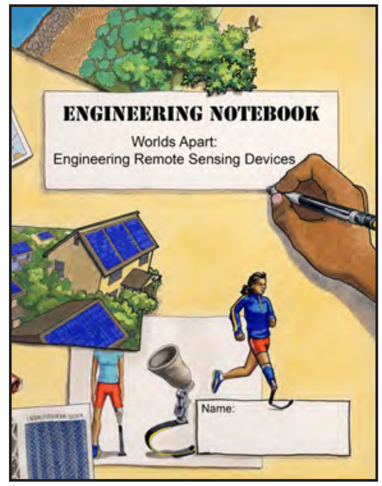
## It is Okay to Try It Out

It can be very helpful to try out the engineering challenge yourself—either beforehand or right alongside the youth in your program as they work through the adventures. This can help you understand the challenges they might face.

## Support Reflection

Each activity includes 5–10 minutes at the end for youth to communicate with their peers by sharing their work. This gives youth the chance to discuss new ideas, think about their own work and the work of others, and reflect on what was learned. Group reflection can help reduce competition by encouraging youth to support each other as they move through the Engineering Design Process.

## Engineering Notebooks




Make a copy of an Engineering Notebook for each youth before you begin working through this Engineering Everywhere unit. Youth will use them as directed in the Educator Guide during every activity.

The Engineering Notebook serves as a central location for youth to record their thoughts and ideas as they move through the unit. Its pages guide youth through the Engineering Design Process, pose questions, and prompt youth to reflect on their engineering work. The time youth spend with their Notebooks during each activity will allow them to create a personalized record of their engineering learning.

There are a few ways you can use the Engineering Notebook. You may want to have groups share one Engineering Notebook as a central recording spot for all group data and findings. This allows group members who enjoy writing and recording to do so. You may also encourage groups to share the responsibility by having group members rotate who records.

## Alternate Prep Activities

The two prep activities, “What is Engineering?” and “What is Technology?,” introduce youth to engineering and technology. “What is Engineering?” gives youth the chance to collaborate, experience a mini hands-on engineering challenge, share their designs, and learn about the Engineering Design Process. This activity sets the stage for what they can expect in the rest of the unit.

“What is Technology?” has youth interact with technologies, working with the definition that a technology is anything designed by humans to help solve a problem or meet a need. Most youth think of technology as things that can be plugged into the wall. They do not realize that the items that they interact with every day—including pencils, paper, and water bottles—are also technologies. This activity introduces the definition of technology that they will refer to as they engineer their own technologies to solve the problem presented in the unit.

While the prep activities for Engineering Everywhere are unit-specific, there are alternative prep activities you can use if you would like to reinforce the concepts and vocabulary related to these activities. You can find the alternate activities online at www.engineeringeverywhere.org. If you have questions about these activities, please email engineeringeverywhere@mos.org.

# Tips and Tricks for Teaching the Unit

## Post a Daily Agenda

Giving youth a sense of the day's activity will help them to plan ahead and manage their time.

## Facilitate Teamwork

Being able to work well in teams is an important skill for any engineer. You may want to assign team roles to help youth that struggle with teamwork. Possible roles include: the note taker, the materials gatherer, the tester, and the presenter.

This unit requires a collaborative workspace. Tables, desks, and chairs should be movable. It is a good idea to establish a materials table where you can set up materials for the day. Then, groups can be in charge of gathering their own materials when they are ready.

## Invite Others to the Engineering Showcase

The Engineering Showcase, the last activity in the unit, is a big deal! This is a chance for youth to highlight the engineering they have done and share their accomplishments with others. Consider inviting families, program staff, and other youth to come to the Showcase.

## Scheduling the Activities

Each activity requires 50-60 minutes of teaching time. We recommend that you budget at least 8–9 hours in order to complete this unit, as some activities may run longer than expected.

You can schedule this unit in several ways: once a week, several times a week, or daily. It is also possible to group certain activities together. The chart below shows which activities are easily taught together. Use this chart to help you plan your schedule.

| | |
|---|---|
| Prep Activity 1: What is Engineering?<br>Prep Activity 2: What is Technology? | 2 hours |
| Activity 1: Looking Beyond<br>Activity 2: Secret Messages | 2-3 hours |
| Activity 3: Taking Shape | 1 hour |
| Activity 4: Create a Remote Sensing Device<br>Activity 5: Improve | 2-3 hours |
| Activity 6: Engineering Showcase | 1 hour |

# Background

## Remote Sensing Engineering

Remote sensing engineering is an interdisciplinary field that deals with the collection of data remotely, or from a distance. It has a wide variety of applications, from creating models of cities or natural landscapes to helping scientists predict the effects of climate change to precisely tracking orbiting satellites. Remote sensing engineers use techniques from many fields, such as cartography, civil engineering, software engineering, and computer science.

In this unit, youth will engineer remote sensing devices to gather and visualize information about a newly discovered moon for scientists at NASA. The data they collect will help the scientists meet their scientific goals, such as gathering data on the geological features of the landscape, looking for evidence of water, or safely landing a rover.

## Remote Sensing Technologies

In this unit, we introduce youth to three technologies associated with remote sensing: periscopes, optical filters, and LiDAR.

> Periscopes are tools that use angled mirrors to redirect the path of light from an object to a person’s eye. They allow people to observe objects on Earth and in space that are hidden behind obstacles or otherwise out of sight.
>
> Remote sensing technologies can be combined with other technologies, like optical filters, to enhance the information they receive. Optical filters can manipulate light and color to help scientists and engineers categorize the information they are looking at and make sense of complex data.
>
> LiDAR, or Light Detection and Ranging, is a tool that sends out laser pulses from an airplane or spacecraft to a landscape and measures how long those pulses take to return. The data gathered from LiDAR can be used to create precise, three-dimensional maps of the terrain.

## Online Resources

The *PLANETS* website (http://planets-stem.org) supports both educators and youth through science extension exercises, educator support materials, and youth content enhancements. Science extension exercises are intended to integrate and apply planetary science concepts with the engineering unit. The educator support materials include immediate management tips and provide additional resources for meeting the unique needs of youth in out-of-school-time settings. Be sure to check out these videos, infographics, and connections to other NASA resources!

# Vocabulary

**Constraint:** A factor that limits how you can solve a problem.

**Criteria:** The requirements of a design.

**Data:** Information that is collected through scientific investigation.

**Engineer:** Someone who uses his or her creativity and knowledge of math and science to design technologies that solve problems.

**Engineering Design Process:** The steps that engineers use to design technologies to solve a problem.

**Landform:** A natural feature of a planet's surface, such as a hill, valley, mountain, canyon, or crater.

**Laser:** A device that generates an intense beam of light.

**LiDAR (Light Detection And Ranging):** A remote sensing technology that collects data from lasers to map the shape of a landscape.

**Optical filter:** A technology that manipulates light and color to help reveal visual information.

**Periscope:** A remote sensing technology that uses mirrors to change the path of light in order to see over or around an object.

**Remote sensing:** The process of using technology to obtain data about an object from a distance.

**Technology:** Anything designed by people to solve a problem.

**Topography:** The arrangement, elevation, or height of the landforms in an area.

## Materials List

This kit is prepared for 8 groups of 3.

| Quantity | Item |
|---|---|
| **Non-Consumable Items** | |
| 1 | *Engineering Design Process* poster |
| 1 | *Engineering Everywhere Special Report* video |
| 1 set | pattern blocks, 100 |
| 8 | rulers |
| 8 | scissors |
| 50 | flat mirrors, approx. 2.5” x 3.5” |
| 100 | binder clips, medium, 5/8” capacity, 1 1/4” width |
| **Consumable Items** | |
| 1 bottle | white glue |
| 4 | shoeboxes with lids, 7” x 5” x 12” |
| 4 | tri-fold boards, 48” x 36” |
| 6 sheets | styrofoam, 12” x 12” x 1” |
| 8 packs | crayons, 8 assorted colors |
| 8 packs | highlighters, 6 assorted colors |
| 8 | plates, paper, small |
| 8 rolls | tape, masking |
| 20 | cups, paper, 3 oz. |
| 24 sheets | cellophane, blue |
| 24 sheets | cellophane, red |
| 40 sheets | craft foam |
| 50 | craft sticks |
| 55 | cups, paper, 8 oz. |
| 60 sheets | construction paper |
| 60 sheets | copy paper |
| 60 sheets | felt, 9” x 12” |
| 75 | manila folders |
| 80 | pipe cleaners |
| 100 | rubber bands, 3” x 1/8” |
| 1000 | index cards |
| 4000 | straws, regular |
| 4000 | straws, thin* |

# Materials List (continued)

| NOT INCLUDED IN KIT | |
|---|---|
| 1 pad | chart paper |
| 1 | utility knife |
| 8 | blindfolds |
| 8 packs | markers, 8 assorted colors |
| 9 | small boxes or stacked textbooks for obstacles in Activity 1 |
| 8–12 | optional: curved mirrors or lenses |
| 8–12 | optional: recycled containers (e.g., juice cartons, yogurt containers) |
| 4000 | optional: straws, thin* |

*The thin straws used in this unit are commonly called coffee stirrers or cocktail straws and are typically 1/8” in diameter. Youth use 4,000 thin straws throughout the unit. Consider providing more thin straws for youth to use in Activities 4 and 5.

# National Education Standards

Engineering Everywhere units are written with the goal of teaching engineering skills and critical thinking practices. Many Engineering Everywhere units also touch upon a variety of science topics and principles. The engineering standards taught in this unit and the science topic links in this unit are noted below.

| | | Prep Activity 1: What is Engineering? | Prep Activity 2: What is Technology? | Activity 1: Looking Beyond | Activity 2: Secret Messages | Activity 3: Taking Shape | Activity 4: Create a Remote Sensing Device | Activity 5: Improve | Activity 6: Engineering Showcase |
|---|---|---|---|---|---|---|---|---|---|
| National Science Education Standards | Science as Inquiry | ✓ | | | | | ✓ | ✓ | |
| | Physical Science | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Life Science | | | | | | | | |
| | Earth and Space Science | | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | Science and Technology | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Science in Personal and Social Perspectives | | ✓ | | | | | | |
| | History and Nature of Science | | | | | | | | |
| ITEEA | The Nature of Technology | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Technology and Society | | ✓ | | | | | | |
| | Design | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Abilities for a Technological World | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | The Designed World | | | | | | | | |

| | | Prep Activity 1: What is Engineering? | Prep Activity 2: What is Technology? | Activity 1: Looking Beyond | Activity 2: Secret Messages | Activity 3: Taking Shape | Activity 4: Create a Remote Sensing Device | Activity 5: Improve | Activity 6: Engineering Showcase |
|---|---|---|---|---|---|---|---|---|---|
| Next Generation Science Standards | MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. | | | ✓ | ✓ | | ✓ | ✓ | |
| | MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system. | | | | | ✓ | ✓ | ✓ | ✓ |
| | MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions. | | | | | | ✓ | ✓ | ✓ |
| | MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. | | ✓ | | | | | | ✓ |
| | MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. | ✓ | | | ✓ | ✓ | ✓ | ✓ | |

# How to Recognize Success Rubric

How do you know if you are leading these activities successfully? This tool will help you keep track of your youth's successful moments and will ask you to identify how your own actions enabled youth to succeed.

| Elements of success | What does this look like? | How does the guide help me facilitate this? |
|---|---|---|
| Youth are engaged and challenged by the activity. They persist through difficulties. | • Youth are on-task.<br>• Youth are trying out their ideas.<br>• Youth *identify* what is working well in their designs.<br>• Youth troubleshoot their own work.<br>• Youth *improve* their designs. | • Use the bold prompts to **ask open-ended questions** to help youth troubleshoot their work.<br>• Use the bold prompts to **ask youth about what they think is working well** in their designs and what they would like to improve. This will help youth feel more confident about their problem-solving abilities. |
| Youth do most of the talking, sharing their ideas with each other during the entire activity. | • Youth bring their own ideas to the activity and are comfortable sharing them.<br>• Youth brainstorm and debate within their groups.<br>• Youth share their designs with others.<br>• Youth talk about how their ideas are changing over time. | • Use the bold prompts in the guide to **encourage youth to share and explain their thinking**.<br>• Have youth **collaborate in groups** so they can brainstorm and *create* a design together.<br>• Use the bold prompts in the Reflect section to **help youth share their new ideas about designs.** |
| Youth value their engineering work as a process, not just as the end result. | • Youth go beyond talking about their design to talking about how they thought of it and why they designed it.<br>• Youth use the Engineering Design Process to describe their actions. | • Use the bold prompts in the guide to **ask youth how they use the Engineering Design Process.** Spending time talking and thinking about their process will help youth see the value in it.<br>• Use the bold prompts to **ask all youth about *improving*** their designs, even if their designs are working well.<br>• **Encourage youth to reflect individually** in their Engineering Notebooks to give them time for their experiences to sink in and be remembered. |

# How to Recognize Success Rubric Template

How do you know if you are leading these activities successfully? This tool will help you keep track of your youth's successful moments and will ask you to identify how your own actions enabled youth to succeed.

Date: Activity:

| Elements of success | Evidence: Where did I see this during the activity? | What was my role in making this happen? |
|---|---|---|
| Youth are engaged and challenged by the activity. They persist through difficulties. | | |
| Youth do most of the talking, sharing their ideas with each other during the entire activity. | | |
| Youth value their engineering work as a process, not just as the end result. | | |

Dear Family, Date: ________________

We are beginning an engineering unit called *Worlds Apart: Engineering Remote Sensing Devices*, a curriculum developed by the Engineering is Elementary program at the Museum of Science, Boston. This week, your youth will be introduced to engineering and the Engineering Design Process as the group works together to engineer a solution to a remote sensing engineering challenge. This unit is set in a real-world context: throughout the unit, your youth will work with teammates to engineer a remote sensing device that is able to gather information about the surface of a model Mystery Moon.

There are many reasons to introduce youth in grades 6–8 to engineering:

- **Engineering projects reinforce topics youth are learning in school.** Engaging students in hands-on, real-world engineering experiences can enliven math, science, and other content areas.
- **Engineering fosters problem-solving skills,** including problem formulation, creativity, planning, and testing alternative solutions.
- **Children are fascinated with building and with taking things apart to see how they work.** By encouraging these explorations, we can keep these interests alive. Describing their activities as "engineering" when youth are engaged in the natural design process can help them develop positive associations with engineering, and increase their desire to pursue such activities in the future.
- **Engineering and technological literacy are necessary for the 21st century.** As our society increasingly depends on engineering and technology, our citizens need to understand these fields.

If you have expertise in geospatial engineering, remote sensing, planetary science, or have any general questions or comments about the engineering unit we are about to begin, please let me know.

Sincerely,

If you have any of the following materials available and would like to donate them, I would greatly appreciate having them by the following date: ______________________ . Thank you!

____________________________ ____________________________

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____________________________ ____________________________