Engineering Activity 6: Put It Together: Creating a Remote Sensing Device

Educator Preview

Activity Snapshot

Learners work in groups to plan, create, and test remote sensing devices that use the different technologies from the previous activities to gather data from a distance.

Timing | 45 minutes

Get Ready and Team Up	5 min.
Design a Remote Sensing Device	30 min.
Reflect	10 min.
Total	**45 min.**

Prep Snapshot*

Prep Time 60 min.

If you have not yet done so, create model landscapes and (optional) Space Screens.

Set up a Materials Table.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Collaboration
- Critical Thinking

Habits of Mind

- Consider problems in context.
- Weigh the implications of solutions.

Guiding Question

How can we create remote sensing devices to gather different types of data from a distance?

Learners Will Do

Design remote sensing technologies that gather specific types of data and test them.

Learners Will Know

Engineers apply what they learn from investigations to inform their design decisions.

Connecting Across Activities

Activity 5: Taking Shape	Activity 6: Put It Together	Activity 7: The Final Test
Last time, learners designed straw model LiDAR systems to gather data on topography. These systems are a third technology they can use when designing their complete remote sensing technologies.	**Today,** they combine tools and systems from previous Activities and use their engineering design process to design and test remote sensing devices.	**Next time,** they will use what they learned from testing to improve their devices.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction, pgs. iii-xxvi. Access more PLANETS units, research, and pathways at https://planets-stem.org/.

QR Code for Activity Resources

weblink: https://hov.to/78d51c48

Materials and Preparation

Materials

For the model landscape sites and Space Screens

- Mineral Paper
- 4 boards, tri-fold
- 1 bottle of glue, white
- 20 cups, paper, 3 oz. (approx. 90 mL)
- 1 sheet of felt
- 1 sheet of foam, craft
- 1 knife, utility
- 1 sheet of paper
- 4 shoeboxes, with lids, 7" × 5" × 12" (approx. 18 cm × 13 cm × 30 cm)
- 6 sheets of Styrofoam, 12" × 12" × 1" (approx. 30 cm × 30 cm × 3 cm)
- 1 roll of tape, masking
- 1 set of pattern blocks (optional)

For each learner

- Engineering Notebook (PDF)

For the whole group

- *Our Ideas* poster (on paper or a shared digital document). See Prep & Setup Guide (PDF) Examples | Templates
- 12 sheets of cellophane, blue
- 12 sheets of cellophane, red
- 60 clips, binder, medium
- 25 cups, paper, 8 oz. (approx. 240 mL)
- 25 sheets of felt
- 25 sheets of foam, craft
- 25 folders, manila
- 20 mirrors
- 100 rubber bands
- 25 sheets of paper
- 50 sticks, craft
- 50 sticks, fuzzy
- 2000 straws, regular
- 2000 straws, thin

For each group of four

- 1 ruler
- 1 pair of scissors
- 1 roll of tape, masking
- light redirection system from Engineering Activity 3
- 2 Data Collection Grids
- Test Sites from Engineering Activity 4

Teaching Tip

Stores that display and sell shoes without boxes may have the shoeboxes in storage and donate them if asked.

Activity 6 Materials Preparation (60 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide - Examples (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. If you have not yet done so, read through the instructions for Model Landscape Assembly, pgs. 85-87 and Space Screen Assembly, pgs. 88-89. You can also watch a video about how to build the model landscapes. Then decide whether to use the Space Screens. This activity should be safe and inclusive. Use the Space Screens only if learners can reach through them safely. Make the choice that is best for your group but still allows all learners to gather data "remotely."
3. Before beginning this activity, make sure you have finished preparing the model landscapes and, if appropriate for your group, the Space Screens. There should be two models each of Site A and Site B, one behind each Space Screen, so multiple groups can access them during testing. (If your group is small, you will need only one model of each site.)

In Your Space

4. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
5. Set up the model landscape sites and Space Screens.
6. Create a Materials Table with the materials listed above for the whole group and for each group of four.

Activity Guide

Get Ready and Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We designed model LiDAR devices to learn about the topography of Mars and answer questions about where it is safe to land.)*
2. Draw learners' attention to the three kinds of technology on the *Our Ideas* poster: light redirection systems, filters/scrapers, and LiDAR. Check for understanding of these technologies. If needed, return to these terms and have learners discuss the terms and make drawings for them. Say: **You will now use all the ideas you have investigated so far: light redirection systems, filters and scrapers, and LiDAR.**
3. Say: **Today we will start the final design challenge: designing a remote sensing device to gather information about Mars from far away.** Share the Guiding Question with learners aloud and in writing on the *Our Ideas* poster *(using multiple languages as needed)*: **How can we create remote sensing devices to gather different types of data from a distance?**
4. Organize learners into groups of four. Learners will stay in these groups for Activities 7–9.

Support Learner Differences

- If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii-xvi).
- If learners have struggled with previous activities or concepts, consider starting them with Caris, the scientist who has the simplest mission (landforms). Once successful, learners can select a more challenging mission.

Design a Remote Sensing Device (30 min.)

Imagine and Plan (10 min.)

5. Have learners turn to *Remote Sensing Engineering Challenge, pg. 14,* in their Engineering Notebooks (PDF). Say: **When planning missions, NASA chooses sites on Earth that are similar to the planets they want to investigate, so engineers can design and test devices before sending them into space.**
6. Gather learners around the Space Screen setups. Demonstrate as you say: **The closed shoeboxes behind these screens contain model landscapes that represent sites on Earth that are similar to two sites on Mars that NASA scientists want to explore: Site A and Site B. The Screen makes it difficult to learn about the landscape. You will be on one side of the Space Screen. Site A and Site B will be on the other side. You will design remote sensing technologies to explore the sites through the Screen.** As needed, give learners time to feel and reach through the screens.
7. Say: **For your missions, you will design remote sensing devices to help scientists learn about other planets. Read the *NASA Scientist Cards, pgs. 15-17*, in your Engineering Notebooks**. After they have read, say: **Notice how the designs have different things they must do, or criteria. This is because the scientists have different questions. However, notice we all have the same limitations of materials and time. These are our constraints. With your group, choose a scientist whose mission sounds interesting.**

Teaching Tip

If you have enough materials, encourage learners to work in pairs. Consider strategic pairing and groups that place together learners who complement each other's strengths and areas where they are growing.

8. Point to the *Our Ideas* poster. Say: **You explored different technologies that you can use in your designs: portable light redirection systems, filters, scrapers, and LiDAR. NASA often sends multiple remote sensing technologies on a single spacecraft to collect all the information they need. In the same way, you should combine multiple technologies to get the information the scientist needs.**
9. Answer any remaining questions about the design challenge.
10. Give each group a few minutes to imagine and plan their design, keeping their scientist's criteria and constraints in mind. It may be useful for learners to come up with ideas individually or in pairs, then combine those ideas into a single plan as a group. Learners can record their ideas on *Remote Sensing Plan, pg. 18*, in their Engineering Notebooks (PDF).
11. As groups are planning, circulate around the room and ask: **Which remote sensing technologies will help you gather the information your scientist needs?** *(Light redirection systems and LiDAR to learn about topography; light redirection systems, filters, and scrapers to search for minerals.)*

Create and Test (20 min.)

12. After groups have finished planning, have them gather materials from the Materials Table and begin creating their remote sensing devices. Say: **Remember, your devices must fit through the opening in the Space Screen to reach the model landscapes.**
13. Give learners an opportunity to test their remote sensing devices as they build using the *Test Sites* and *Data Collection Grids* from Engineering Activities 4 and 5.
14. When groups are ready to test their remote sensing devices on the model landscapes (Site A or Site B), remove the lids from the shoeboxes that are behind the Space Screens so that they can collect information.
15. Have groups record what they learn on *Data Collection Grids*. While they work, ask: **What types of information can you collect?** *(Information about the topography and information about the minerals.)* **Are you meeting your scientist's criteria? Are your remote sensing devices working the way you imagined they would?** Make sure learners visit Site A and Site B.

Level Up!

If there are unanswered questions on the chart, use these weblink: https://science.nasa.gov/mars/ to help learners research the answers for themselves. (10 min.)

Support Thinking

If learners are using scrapers in their devices, let them know that they may need to attach objects to extend the scrapers so they are able to reach the model landscapes.

Teaching Tip

Have learners gather small amounts of materials at a time to avoid running out of materials.

If the Space Screen is unstable, have learners take turns holding it still.

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials.

16. Let groups know when they have ten and five minutes remaining. If they need more time, inform them they will be able to improve their designs during the next session. Have groups label their remote sensing devices.

Reflect (10 min.)

17. Gather groups. Ask: **Did anything surprise you about collecting data with your remote sensing devices?** *(It was difficult to use certain technologies; different technologies were better at different tasks, etc.)* **How might you improve your designs?** *(Make them smaller; make them more accurate.)* Record ideas on the *Our Ideas* poster.

18. Revisit the Guiding Question on the *Our Ideas* poster: **How can we create remote sensing devices to gather different types of data from a distance?** *(It is necessary to combine technologies to get the data we need.)* Remind learners of the terms *criteria* and *constraints*.

19. Say: **Good job working as engineers today! The information your designs gather will help the scientists learn more about Mars and possibly expand our understanding of life and the solar system. Next time, you will improve your designs.**

After the Activity

1. Clean up:
   - Save the *Our Ideas* poster for Activity 7.
   - Label groups' designs and store them in a safe location.
   - Save any remaining materials for the next activity.
2. Plan ahead for Engineering Activity 7. See Activity 7 Materials Preparation on pg. 90.
3. Take time to reflect on the following educator prompt. **How did you help learners embrace and learn from failure during this activity?**

Support Thinking

Learners may say that they have failed. Emphasize that engineers think about designs failing, not about people failing. Explain that failure is an important way in which engineers gather information to improve their designs. Ask: **What did you learn from the failure of this design?** *(The system needs to be a different size; the model LiDAR needs more straws, etc.)*

Level Up!

Invite a family or community member to come in as a special guest and share their knowledge about topics related to light and landscapes. (45 min.)

Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the *Engineering Design Process* did you use today?** *(We brainstormed, planned, created, and tested our remote sensing devices.)*

Remote Sensing Additional Resources

QR code leads to resources available for this unit.

weblink: https://hov.to/248cf0d9

Model Landscape Assembly

The final design challenge requires the educator to prepare model landscapes so learners can test their remote sensing devices. Read the following instructions or watch a setup video on how to build a model landscape.

Materials for each Model Landscape:

- Mineral Paper
- glue
- paper cups
- felt
- craft foam
- utility knife
- paper
- shoeboxes
- Styrofoam
- masking tape

Teaching TIps

- Make the sites in advance and keep them hidden. Learners must not see them until Activity 9.
- Styrofoam can create dust when cut. Consider cutting it underwater or (if you can do so safely) using a hot wire cutter to minimize dust. You could also wear a face mask while cutting.

Model Landscape Site A

Prepare two shoeboxes for Site A, each with the following features:

Must Have

- Lots of Mineral Paper (PDF) printed with triangles, the symbol for clay minerals, and stars, the symbol for sulfate minerals that form in water.
- At least one triangle on the *Mineral Paper* covered in felt, which also represents clay minerals. To do this, cut felt into a triangle shape and glue it over a triangle on the Mineral Paper.
- Mountains or varied terrain made from Styrofoam sheets and cups. Cups must be glued very securely so they do not fall off.
- No flat, open spaces.

Consider Adding

- At least one star on the *Mineral Paper* covered with foam. To do this, cut a piece of foam into a star shape and glue it over a star on the mineral paper. The star and foam both represent sulfate minerals, which form in water.
- At least one circle on each *Mineral Paper* covered with paper. To do this, cut a scrap of paper into a circle and glue it over a circle on the *Mineral Paper*. The circle and the paper represent volcanic minerals.
- Paper cups to create landforms.

An example of Test Site A, which features a low area on the left with two cups providing height and higher areas on the right. The left part of the lowlands is covered with blue Mineral Paper, while red Mineral Paper appears in the center lowlands and blue Mineral paper on the highland at the right side of the box.

Model Landscape Site B

Prepare two shoeboxes for Site B, each with the following features:

Must Have

- Flat, open space, at least 3" × 4" (7.5 cm × 10 cm).
- Mineral Paper, different colors.
- Craters, dips in terrain using Styrofoam sheets

Consider Adding

- At least one star on the mineral paper covered in foam, which represents sulfate minerals.
- At least one circle on each mineral paper is covered in paper, which represents volcanic minerals.
- Craters, dips in terrain using Styrofoam sheets.

Use a utility knife to cut foam sheets and build layers, or stack objects from around the room.

An example of Test Site B, which features a low area covered in blue Mineral Paper on the left. On the right, progressively higher areas appear like stair steps, all of which are covered with red Mineral Paper.

Space Screen Assembly

You will need to assemble four Space Screens in total, one for each model of Site A and one for each model of Site B. Before assembling Space Screens, determine whether the learners in your group can reach through them safely. Make the choice that is best for your group but still allows all learners to gather information "remotely."

Materials for each Space Screen:

- tri-fold board
- ruler
- utility knife
- felt (optional)
- scissors
- duct tape

1. Use a utility knife to cut a 12" × 22" (31 cm × 56 cm) rectangle approximately 10" (25 cm) from the bottom of the trifold board.

Tri-fold board with cutout

2. Optional: Cut a 1" (2.5 cm) wide fringe across four pieces of felt, leaving enough space around the edges to tape each piece to the board. Tape the two pieces of felt to each side of the board so the hole is completely covered.

Felt cut into fringe

Tri-Fold board with cutout and fringe

3. Label two of the screens "Site A" and two of the screens "Site B." If time allows, decorate all screens using paint or stickers. Decorating the screens provides a visual reminder that they represent a significant distance between the engineers and the landscape site.

Space Screen "Site A" Front

4. Position the Space Screen at the edge of a table so learners can easily access it and reach inside.

Space Screen "Site A" Back

5. Tape one of the model landscapes to the table directly underneath the hole in the Space Screen. The model landscapes are positioned correctly if learners can reach through the Space Screen and collect data from the surface of each site. Keep the lid on the shoebox until groups are ready to test.
6. Tape the Space Screen to the table for extra stability.
7. Repeat to complete the remaining three Space Screens.
8. Position the Space Screens back-to-back or against a wall, so the model landscapes remain hidden as much as possible.

Educator view from Space Screen "Site A" as learners reach through to experiment