Activity 3

Taking Shape

Educator Preview

Overview

Youth will model a remote sensing device called LiDAR by engineering a technology to produce a 3D image of a landscape.

Note to Educator:

In this activity, each group will use several dozen straws to model the distance measured by lasers in their model LiDAR technology. Like real LiDAR, the straws provide data on the height and shape of a landscape from above. Unlike LiDAR, this model relies on physically touching the surface to make an impression using straws of a fixed length.

Complete the preparation for Activities 4, 5, and 6 on p. 42 in this guide before the next session.

Activity Timing

Introduction:	5 min
Investigate:	10 min
Mapping a Test Surface:	30 min
Reflect:	10 min
	55 min

21st Century Skill Highlight

Creativity
Collaboration

Activity 3 Materials

For the whole group

- ☐ *Engineering Design Process* poster
- ☐ *Remote Sensing Definition* chart paper
- ☐ 1 set of 100 pattern blocks
- ☐ 20 paper cups, 8 oz.
- ☐ 20 rubber bands
- ☐ 20 sheets of craft foam
- ☐ 20 sheets of felt

For each group of 3

- ☐ 1 pair of scissors
- ☐ 1 paper plate, small
- ☐ 1 roll of masking tape
- ☐ 1 ruler
- ☐ 200 straws, regular size
- ☐ 250 straws, thin
- ☐ optional: 1 blindfold

For each youth

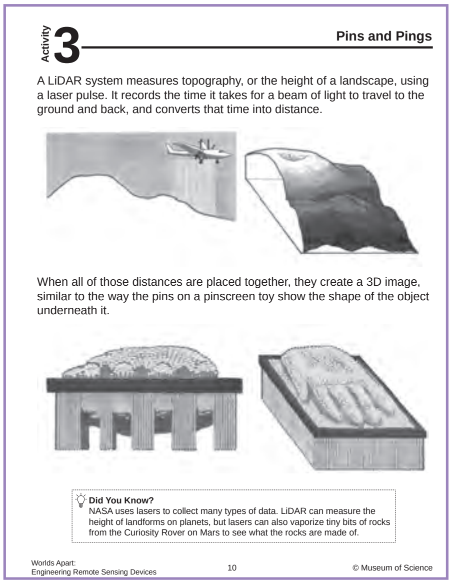
- ☐ Engineering Notebook

Activity 3 Materials Preparation (10 min)

1. Post the *Engineering Design Process* poster and the *Remote Sensing Definition* chart paper.
2. Arrange all materials on the Materials Table.
3. Bundle a handful of straws together using a rubber band or craft foam and tape, to demonstrate how youth can keep the straws packed together in their model LiDAR device.

Notebook Pages for Activity 3

Pins and Pings, p. 10


Activity 3 Pins and Pings

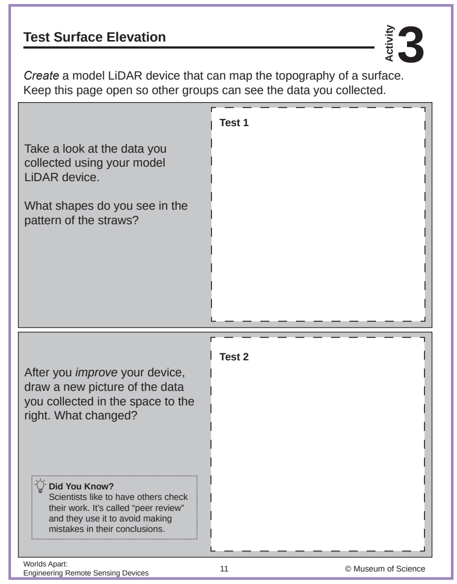
A LiDAR system measures topography, or the height of a landscape, using a laser pulse. It records the time it takes for a beam of light to travel to the ground and back, and converts that time into distance.

When all of those distances are placed together, they create a 3D image, similar to the way the pins on a pinscreen toy show the shape of the object underneath it.

Did You Know?
NASA uses lasers to collect many types of data. LiDAR can measure the height of landforms on planets, but lasers can also vaporize tiny bits of rocks from the Curiosity Rover on Mars to see what the rocks are made of.

Worlds Apart: Engineering Remote Sensing Devices 10 © Museum of Science

Test Surface Map, p. 11


Test Surface Elevation Activity 3

Create a model LiDAR device that can map the topography of a surface. Keep this page open so other groups can see the data you collected.

Take a look at the data you collected using your model LiDAR device.

What shapes do you see in the pattern of the straws?

Test 1

After you *improve* your device, draw a new picture of the data you collected in the space to the right. What changed?

Did You Know?
Scientists like to have others check their work. It's called "peer review" and they use it to avoid making mistakes in their conclusions.

Test 2

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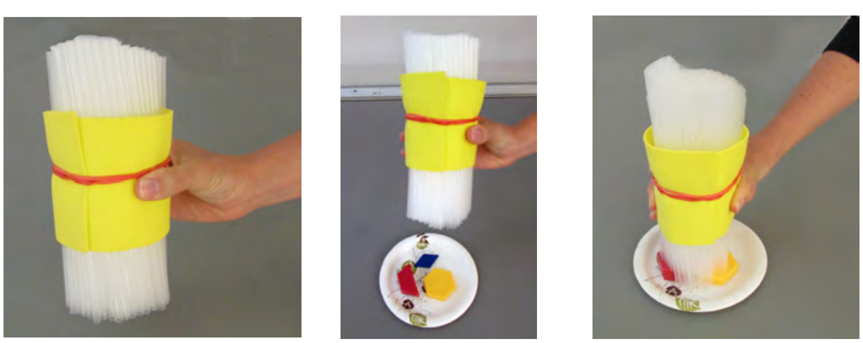
Activity Preparation (continued from p. 41)

Preparation for Activities 4, 5, and 6 (60 min)

The final design challenge for this unit requires the educator to prepare a multi-part model so youth can test their remote sensing devices on the surface of a Mystery Moon. **Consider preparing the following models in parts, or set aside at least an hour to assemble them in one session.**

- Model Landscapes for Site A (2 copies) and Site B (2 copies) on the Mystery Moon
- Space Screens that prevent youth from looking at the model landscapes on the opposite side and represent the distance between the Earth and the Mystery Moon

The complete instructions for building Sites A and B and the Space Screens are outlined on pp. 51–53 in this guide. Since remote sensing engineers would not be able to see the surface of the Mystery Moon up close, it is important that youth use only the remote sensing devices they create to gather information about each site. Keep the model landscapes covered when not in use until groups complete their tests in Activity 5.



Example model LiDAR device and test surface

Activity 3 Taking Shape

Activity Guide

Youth will learn:
- Scientists and engineers use remote sensing devices to gather information about the topographical features of a landscape.
- Engineers often use models to represent the technologies or materials they are investigating.

Tip

Replay the *Special Report* video from (3:54-5:19) to remind youth how scientists and engineers at NASA's Jet Propulsion Laboratory use LiDAR to collect topographical information from a distance.

Tip

Some animals, such as bats and whales, have evolved the ability to remotely sense their surroundings using sonar, which relies on bouncing sound waves instead of light.

Introduction (5 min)

1. Remind youth that a group of scientists is interested in finding out more about the landscape and features of the Mystery Moon before they send astronauts to explore it. They need the help of engineers to design remote sensing technologies that can collect the data they need, even from far away. Ask:
   - **What remote sensing technologies have we learned about already?** *Periscopes, optical filters, and other technologies that manipulate light and color to reveal information.*
2. Explain to youth that the scientists need to know more about the topography, or the arrangement, elevation, and height, of the landforms on the Mystery Moon. Ask:
   - **What kinds of landforms would you expect to find on the Mystery Moon?** *Craters, flat areas, mountains.*
3. Have youth think back to the *Special Report* video they watched earlier. Ask:
   - **How do you think we could collect information about the shape of a landscape that is far away?** *Accept all answers.*
4. Tell youth that scientists and engineers use a remote sensing technology called LiDAR (or "Light Detection And Ranging") to map the shape of landscapes from a distance.

Investigate (10 min)

1. Have youth turn to *Pins and Pings*, p. 10 in their Engineering Notebooks. Have a volunteer read the information about LiDAR and pinscreens. Ask:
   - **How is the pinscreen similar to LiDAR?** *They both measure topography and create a 3D image.*
   - **How are they different?** *LiDAR collects data from a distance by using a laser pulse that moves across an area. The pins in a pinscreen are all the same length and need to physically touch an object to measure its*

topographic data.

2. Let youth know that scientists often use models to represent the technologies or materials they need to *investigate*, when the real thing is too big, expensive or dangerous.
3. Hold up a straw. Explain to youth that they will use straws as a model for the laser used in LiDAR. Ask:
   - **How is the straw a good model for the LiDAR laser?** *It models the distances measured by the laser.*
   - **How is the straw not a good model for the LiDAR laser?** *In order to work in this case, it needs to actually touch the surface, so it is not really remote sensing.*
4. Split youth into groups of 3 and give each group two boxes of 100 straws.
5. Help youth become familiar with the procedure for collecting topographical data by having them loosely hold a small bundle of straws in both hands and press one end of the bundle onto small, flat objects with a recognizable shape, like the scissors or rolls of tape on their tables. Ask:
   - **What happens when the straws hit an object?** *The tops of the straws remain raised, showing the object's shape.*
   - **How can you tell when the straws hit a flat area?** *The straws are all the same height in one area.*

Tip

Encourage youth to keep a careful grip on the straws to prevent them from dropping onto the floor.

Mapping the Test Surface (30 min)

1. Let groups know they will make a test surface by stacking and taping pattern blocks to a paper plate. They will then trade their test surface with another group and *create* a device that can measure the topography of that surface.
2. Give groups a few minutes to make a test surface and *create* their model LiDAR device.
3. Explain to groups that when they *test*, they should look at the raised shape in the straws, using a ruler to measure any differences in height, and draw the shape in the first box on *Test Surface Elevation*, p. 11 in their Engineering Notebooks.
4. Have groups choose a volunteer who will operate the model LiDAR device while blindfolded. The volunteer will not be able to see the test surface and will rely on directions from the rest of the group during testing.
5. Have a volunteer from each group put on a blindfold and have groups exchange test surfaces when they are ready.
6. As groups are testing, ask:
   - **What information were you able to collect with your model LiDAR device?** *The general shape and height of objects on the test surface.*
   - **How might this information be useful to the**

Tip

If youth are not comfortable expressing the data they collected in a drawing, have them recreate the shapes from the test surface using pattern blocks.

scientists? *They could see if there are any flat surfaces where they could land a spacecraft on the Mystery Moon.*

7. After groups test, tell them that a new material is now available. Give each group a box of thin straws and ask:
   - **How do you predict this new material will impact the data you collect?** *Accept all answers.*
8. Give youth a few minutes to add thin straws to their model LiDAR devices and collect data from the test surface again.
9. Have youth make a new drawing of the data they collected using the thin straws, and keep their Engineering Notebooks open to page 11.

Reflect (10 min)

1. Have groups take a few minutes to walk around the room and look at the drawings for each test surface as well as the model LiDAR devices youth created. Ask:
   - **What differences do you notice between Test 1 and Test 2?** *They show the same objects at different levels of detail. Edges are more defined in Test 2.*
   - **Did the new material impact the data you collected the way you thought it would?**
2. Guide youth to recognize that the drawings from Test 2 represent a higher resolution image. Smaller straws *improve* the quality of the readings because there are more data points in the same size area, just like more pixels on a screen create a sharper, higher-resolution image.
   - **Why might the scientists want to use a high resolution image?** *So they can look at specific features of a landscape in as much detail as possible.*
   - **Can you think of a reason the scientists might want to use a lower resolution image?** *They might have budget constraints, or want to map a bigger area using less detailed data as a trade-off.*
3. Gather youth around the *Engineering Design Process* poster. Ask:
   - **Which steps of the Engineering Design Process did you use today?** Investigate, create, test, *and* improve.
4. Congratulate youth on all the great engineering work they did today! Let youth know that next time, they will learn more about the scientists and start designing remote sensing devices that can help them with their missions.
5. Remind youth to disassemble their technologies and return the materials to the Materials Table for use in later activities.

Tip

If youth are unfamiliar with the idea of trade-offs, guide them to think about how improving one variable, like resolution, might negatively impact other aspects of their design, like cost or overall size.