Challenge 4: What is innovative engineering?

Get Prepared

Challenge Goal: Understand the idea of innovative engineering and learn about basic engineering structures

Time Needed: Three 45-minute sessions

What You Will Need:

Printouts	Materials	
• Activity Sheet D: Build a Better Bridge	• Samsung tablets	• cardboard
• Activity Sheet E: Name That Career	• books	• pennies
	• paper	• glue and tape
	• pens or pencils	• string
	• index cards	• pipe cleaners

Note: Kids may use the activity sheet printouts or they may follow along on their tablets at: www.scholastic.com/sparks3.

Before You Begin:

- Make sure the following website is visible to kids: to.pbs.org/1hDKL4Q. They will be referring to this link in the tablet activity on the following page.
- To plan for the wrap-up activity at the end of session 3, make enough copies of Activity Sheet E: Name That Career so that each team has one complete set of cards. Cut out the activity cards along the dotted lines and keep each set of cards separate to pass out for the optional wrap-up activity.
- In large letters, write each of the following engineering careers on a separate sheet of paper: automotive engineer, drafter, landscape architect, civil engineer. (You will have four signs when done.)

Connect With the Home:
Download and print out the Council-to-Home Communication: Unit 2 Overview for kids to take home and share with their family members.

SESSION 1

Spark Exploration: STEM Careers (10 mins.)

Direct kids to take out their tablets, open the STEM Career Flip Book and read about civil engineers in the Engineering section. Ask: ***What role do you think civil engineers played in the engineering of your community? What goals did these engineers set out to achieve in your community?***

Goal Selection:
If you were a civil engineer, what would you build? Why would it be important to you and others in the community? What goals would you set?

Setting the Strategy: Engineering in the Community (35 mins.)

1. Engineers are problem solvers. Part of their job is to come up with strategic and often new ways to meet people's needs and their own goals. This characteristic is called being innovative. Ask:
   - ***What do you think it means to be innovative?***
   - ***Can you think of some examples of innovative engineering?***

- ***Is innovation a skill that can grow with effort and practice or simply something you are born with?***

  Hint: Abilities improve with effort and practice. Engineers constantly grow their skills and challenge themselves to ensure they learn throughout their career!

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Strategy: Engineering in the Community (continued)

2. Use your tablet to show kids three examples of innovative engineering. Each of the following structures was designed to meet a specific goal or need. Review the innovations and discuss strategies used to meet the community's needs.
   - **SkyCycle (London, England):** This elevated pathway was proposed to help cyclists travel safely through the city: bbc.in/1hvQAHq
   - **Water-Generating Billboard (Lima, Peru):** An engineering school created this billboard, which collects water from the air and turns it into clean drinking water: bit.ly/OJwM6C
   - **Makoko Floating School (Lagos, Nigeria):** This school was built for children living in a poor area in Africa prone to frequent flooding: nyti.ms/1kvwyPi

3. Discuss how these structures meet a community need. **What materials were used to build these structures? How would you change the innovations to benefit your own community?**

Wrap-up Session and Reflection:

4. Wrap up session 1 by having kids choose one of the three innovations that would benefit their community. Pass out paper and ask teams to adapt the existing design to make it fit their community's needs. Ask students to think about what needs their improved design will meet and what strategies they will be using to meet those needs. If there is time, have teams present their adaptations to the entire group.

SESSION 2

Use the Tablets! 45 mins.

To Get Started: Remind kids that they discussed the role engineers played in their communities and innovative engineering in the previous session. Ask them to discuss their favorite engineering innovation and why.

1. Explain that to create innovative designs, engineers start with some basic building blocks. These simple structures include things like arches to support bridges and domes to cap buildings.
2. Have kids access the building challenges on the Building Big website: to.pbs.org/1hDKL4Q. Kids should use the website to experiment with different materials and building techniques for different locations. Tell kids to investigate the basic structures used by engineers in their designs. As they discover different building blocks, ask them to find one or two purposes each structure serves and note them on a whiteboard or chalkboard. When finished, have the kids reflect on and discuss why these engineering building blocks are useful.
3. Explain that engineers have many things to consider when building structures. One of the important things engineers have to consider is a structure's *load*. Loads are forces that push, twist, and stretch a structure. Have kids complete the interactive labs on the Building Big website to learn how loads affect a structure's stability. They'll also learn how the right materials and shapes can make a structure sturdier: to.pbs.org/1hlikxx.

Wrap-up Session and Reflection Activity:

4. Encourage kids to use the Building Big website to illustrate what different forces can do to a bridge. For example, what does a bridge that has been warped under a great weight look like? Have kids reflect on why it is so important to test and retest structures.

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Challenge 4: What is innovative engineering? (continued)

SESSION 3

Shifting Gears: STEM Challenge! 45 mins.

To Get Started: Remind kids that they discussed engineering structures, materials, and load. Ask them to name and explain two engineering structures as a group.

1. Hand out **Activity Sheet D: Build a Better Bridge**. Kids will test what kind of load a simple bridge can hold. Then they'll modify their bridges using a variety of materials, shapes, and supports to see which design aspects allow their bridges to withstand the greatest force. Explain at the outset that many projects fail and that engineers have to shift gears or experience road blocks and revise their designs many times before achieving the goal of the project.

Innovation in engineering depends on the idea that structures and things can always be improved. This is true of our own abilities as well.

Wrap-up Session and Reflection Activity:

2. Wrap up session 3 with the following interactive challenge that gets kids thinking about roles engineering plays in communities.
3. Have kids separate into their teams and give each team a set of the activity cards you cut out from **Activity Sheet E: Name That Career**. Ask each team to write their name on the back of their cards so that the teams can be identified.
   Put each of the four signs with the names of engineering careers in a different corner of the room.
4. Tell the teams that they have five minutes to match the cards with the correct sign. This will require them to match the STEM skills on their cards with the appropriate engineering career. They can refer back to the **STEM Career Flip Book** to research the career if necessary. The first team to finish placing the most cards in the correct place wins the game.

Answers

- **Career: Automotive engineer**
- **Cards:** *Protect people from car crashes, protect the environment by designing more efficient cars, make sure cars function properly to prevent car crashes*
- **Career: Drafter**
- **Cards:** *Help architects plan buildings by drawing up the plans, create solutions for problems in building plans and make improvements to building plans, work with teams to draw the plans for new innovations*
- **Career: Landscape architect**
- **Cards:** *Fix damaged areas like wetlands or rivers, design parks for neighborhoods, help the environment by designing gardens that collect storm water or trap air pollution*
- **Career: Civil engineer**
- **Cards:** *Test buildings to make sure they are strong and people are safe inside them, plan where to put new buildings, make sure buildings are using the right building materials and following safety codes*

Photo: © northlightimages/iStockphoto.

NAME: _____

Build a Better Bridge

You just learned about the techniques engineers use to build structures that hold up under all sorts of conditions. Remember to manage your goals instead of simply setting them. Through GPS you will make your goal selection, create your plan, try it, and even "shift gears" to improve your design if you encounter challenges. Now it's your turn to build a sturdy structure of your own.

Instructions: Read the passage below to learn how engineers build superstrong bridges. Then follow the instructions to construct your own bridge that won't buckle under pressure.

Loaded Up

All structures experience *loads*, forces that push, twist, and stretch. Changes in a structure can be caused by the weight of objects pushing down on the structure, strong winds, or even vibrations.

In the case of a bridge, cars and people create a heavy load that pushes down on the bridge. Strong winds and vibrations can cause the bridge to twist or collapse.

Engineers have to account for these forces to make sure the bridges they build won't collapse. Three ways engineers do this are choosing the right materials, shape, and supports for their structures.

Parts of a bridge can be made out of materials like wood, metal, or concrete. It can be shaped like a beam to form a straight span across a gap or an arch. Bridges can be made stronger by reinforcing them. Engineers use supports, such as trusses and suspension cables. These supports reduce the force of a load by spreading it over a larger area.

Build It:

1. **Stack the books:** Make two stacks of books that are the same height, with 3 inches between the stacks.
2. **Lay the bridge:** Lay an index card lengthwise across the gap.
3. **Add the load:** Pile pennies in the middle of the card. How many can it hold before collapsing?

Reflect and Shift Gears:

4. **Adapt your bridge:** Reflect and come up with three adaptations your team can make to better strengthen your bridge. Consider what materials you can add or how you can change the shape of your bridge using engineering structures.

Adaptation 1	Adaptation 2	Adaptation 3

5. **Retest your bridge:** Test all three adaptations to your bridge to see which holds the most weight. Remember to interact with other teams and your leader to share adaptation ideas.

Name That Career

Make five or six copies of this activity sheet and cut up the cards for an interactive game. Each team will get a complete set of cards.

Protect people from car crashes	Protect the environment by designing more efficient cars	Make sure cars function properly to prevent crashes
Help architects plan buildings by drawing up the plans	Create solutions for problems in building plans and make improvements to building plans	Work with teams to draw up the plans for new innovations
Fix damaged areas like wetlands or rivers	Design parks for neighborhoods	Help the environment by designing gardens that collect storm water or trap air pollution
Test buildings to make sure they are strong and people are safe inside them	Plan where to put new buildings	Make sure buildings are using the right building materials and following the safety codes