FUTURE U.

Sit Down Activity

Objectives

Students will:

- **Design** and **construct** an aqueduct.
- **Evaluate** their peers' work through the lens of a reliability and maintainability engineer.
- **Develop** recommendations based on their review to **optimize** their peers' design.

Itza Hanai Rodriguez, Reliability and Maintainability Engineer

Grade Range

5–8

Overview

In this activity, students will be inspired by the work of a reliability and maintainability engineer at Boeing as they use their engineering skills to build an aqueduct that delivers water from Point A to Point B. After testing their own design and reviewing the work of another group, students will develop recommendations that increase the reliability and/or maintainability of their peers' water delivery system.

Timing

45–60 minutes

Materials

- Device with the ability to project video, one for the teacher
- Itza Hanai Rodriguez, Reliability and Maintainability Engineer video, to project
- *"Reliability and Maintainability Assessment"* handout, enough for one quarter of the class
- For groups of four students:
    - One 2-liter soda bottle with the bottom (i.e., the end opposite the cap) cut off
    - Clear tubing that can fit in the top of the bottle (when the cap is taken off), about 4 feet
    - One bucket large enough to hold two liters of water
- For the class to share:
    - Duct tape

- Cardboard
- Blocks and/or books
- Plastic wrap
- Aluminum foil
- Scissors
- Large water pitchers or empty gallon containers, at least 4

- Access to a faucet (to fill the pitchers with water)

Procedure

1. **Warm-Up:** After showing the Itza Hanai Rodriguez, Reliability and Maintainability Engineer video…
    - Encourage students to summarize the main responsibilities that Itza Hanai Rodriguez has in her job. Be sure they understand that reliability and maintainability engineers like Itza analyze systems with the goal of improving them. They try to prevent failures, stop problems from recurring, help repairs last longer, and increase the overall reliability of machines and equipment.
    - Then ask students to consider: What skills do you think reliability and maintainability engineers must have in order to succeed in their work? Encourage students to consider both STEM skills and 21st century skills like collaboration, critical thinking, collaboration, and communication.
2. Explain that today students will be using some of these skills as they focus on a global issue: water scarcity. Share a few facts about water scarcity to help students better understand the issue:
    - Water scarcity occurs when there is not enough fresh water resources to meet the demand.
    - Around the world, four billion people experience severe water scarcity for at least one month each year.
    - By 2025, half the world's population could be living in areas facing water scarcity.[1]
3. Ask the class to pretend that they are now working in a community with water scarcity. Thankfully, a potential water source has been identified not too far away. Their job is to create an aqueduct (or channel for transporting water) from Point A: The water source, to Point B: The community. For the sake of this activity, Point A is about three feet away from Point B.
4. Divide students into groups of four and provide each team with a bottle and a bucket.
5. Bring students' attention to the other available materials and explain that their aqueduct system should carry a pitcher full of water from the bottle source at Point A to the bucket site at Point B with as little water wasted as possible. Other than the bottle and the bucket, the materials that they use will be up to them.
6. Give teams about 20 minutes to construct their designs. They may use scrap paper to sketch their ideas first if they would like to.
7. Then bring the class back together and explain that students will now take on the role of reliability and maintainability engineers as they assess their peers' aqueduct system. Prepare the class for this portion of the activity by performing the following:
    - Pair student groups with each other.
    - Explain that each group should demonstrate how one full pitcher of water can travel from Point A to Point B three times in a row. If groups need to make repairs to their system during the demonstration, they may!

1 https://www.unicef.org/wash/water-scarcity

- Distribute one "Reliability and Maintainability Assessment" handout to each student. Review the questions provided and explain that after reviewing their peers' design and discussing the questions with their group, each student should write down their own responses.

8. **Wrap-Up:** Before class comes to a close, bring the class back together and reflect on the reliability and maintenance review that they just completed. Discuss:
    - What impact does the role of reliability and maintainability engineer have?
    - Why is this role important across all systems and products?

National School Standards

Next Generation Science Standards
M.S. Engineering Design

- 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.

Reliability and Maintainability Assessment

Instructions: Observe the water system that your peers created. Then help them optimize their design by discussing the following questions with your group and recording your own answers below.

How **reliable** is this system? (Remember: Reliability refers to how consistently a machine or system produces the intended result.)

Consider:

- Is it dependable?
- Does it consistently deliver all of the water from Point A to Point B?

How **maintainable** is this system? (Remember: Maintainability refers to how easily a system can be repaired after a failure occurs.)

Consider:

- If the system malfunctioned, was it repaired quickly and easily?
- If the system did *not* malfunction, does it appear that any part of the system is at risk for breaking or malfunctioning?

What changes or modifications could be made to help this system increase its reliability or maintainability?