HURRICANE FORCE

SIEMENS STEM DAY Science Technology Engineering Math

Level of Difficulty: 2
Grade Range: 9-12
Activity Time: 45-60 min
Career Path: Energy
Topic: Architecture

OVERVIEW

In this lesson, students will work in teams to create a structure that will withstand simulated hurricane force winds. Students will test their structures against the high winds created by a fan in order to evaluate the integrity of their design. In doing so, students will learn how engineers reduce possible hurricane damage when designing buildings. They will apply this knowledge to explain how building technologies can help keep citizens safe in times of emergencies.

STEM LESSON FOCUS

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

Engineering Design Cycle	**21st Century Skills**
• Creating or Prototyping	• Critical Thinking (Analysis, Synthesis, Flexibility, Evaluation)

OBJECTIVES

Students will be able to:

- create an original prototype and subject it to simulated hurricane force winds.
- evaluate their prototype's effectiveness at withstanding the hurricane simulation.
- apply the knowledge they gained through the simulation to broader engineering practices.

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MATERIALS

Cardboard, cardstock, straws, tape, scissors, string, fan with multiple settings, chalkboard or whiteboard

HAVE YOU EVER WONDERED…

How buildings are designed to withstand all kinds of natural disasters?

What we can do to keep safe during a hurricane?

MAKE CONNECTIONS!

How does this connect to students?

Students will rely on the structural integrity of buildings throughout their lives. The homes, offices and institutions they utilize must withstand nature's many unpredictable elements. By gaining understanding of how building materials withstand these elements, students can make educated choices when it comes to their living conditions.

How does this connect to careers?

- **Civil engineers** use a variety of materials to construct buildings, roads, and other structures that can withstand lots of use, as well as nature's elements.
- **Architects** conceptualize and design buildings using the latest technology. The create space with purpose, function and beauty in mind.
- **Humanitarian Aid and Disaster Relief** professionals are on the front lines. They help get citizens to safety and ensure that their basic needs of food, water, and shelter are met.

How does this connect to our world?

Earth's climate is increasingly unpredictable and natural disasters are happening with frequency. As such, students must think critically about how they can be good stewards of the environment and do their part to help others when disaster strikes.

If you want students to further explore career opportunities connected to this topic, please allow for more classroom time.

HURRICANE FORCE

BLUEPRINT FOR DISCOVERY

1. Provide the following context:
    a. In hurricane-prone areas like the Southeast United States, homes and buildings must be built to withstand hurricanes. These powerful storms are characterized by strong winds and flooding.
    b. Buildings can withstand hurricanes if they use the correct materials and are designed to certain specifications.
    c. In today's activity, we will use the materials available to us to create a prototype of a home. We will then hold our home prototypes up against a blowing fan, which will simulate hurricane-force winds. By observing what happens to our structures, we will analyze which methods and materials worked, and which did not. We'll apply what we've learned to general building practices and discuss how engineers and architects can better design buildings in order to keep people safe during hurricanes.

2. Assemble students into groups of 2-4, depending on class size.

3. Provide each group with the following materials:
    a. Cardboard: 1-2 large pieces
    b. Cardstock: 4-5 pieces of 8 ½x 11
    c. Straws: 4-8
    d. Tape: one roll of general clear tape and/or other types of tape (masking tape, duct tape, etc.)
    e. Scissors: one pair per person/group
    f. String: 3 yards of twine/thread/other thread per group

4. Instruct each student group that they will design a home to the following specifications—these can be typed, printed, and handed out to groups to save time:
    a. It must be constructed with the provided materials and nothing else.
    b. Students have 10-15 minutes to design and build their structure.
    c. It must be structurally sound (must be sturdy on its own without additional support).
    d. It must withstand the wind created by the high setting of a fan.

5. Allow students to use the provided materials to build their structures.

6. Place the fan in the front of the classroom.

7. When all groups are finished, call on groups individually to bring their structures in front of the class and test them against the fan:

a. Write a T-chart on the board with four sections. On the top left side of the chart, write "Group Name." Then, write "What Worked?" in the second section of the chart. Write "What Didn't Work" in the third section of the chart, and write "Fan Speed" in the last section.
b. Call the first group up to the front of the class and have them briefly explain the design of their structure.
c. Write the group's name in the first section of the chart under "Group Name"
d. Place the structure on the floor and turn on the fan. Begin at the lowest setting and progress to the highest setting. Stop at the setting where the structure shows significant signs of damage. Write the fan setting at which the structure deteriorates on the board under the "Fan Speed" section (ex: Medium setting, setting #2, etc.)
e. Ask student to identify one thing about their structure that worked, and one thing that didn't work or could be improved. Write their answers on the board under the appropriate chart sections.
f. Repeat steps b-e with each additional group.

8. Once all groups have tested their structures against the fan, review the data in the "What Worked?" and "What Didn't Work?" columns aloud with the class.

9. Next, invite students to calculate the wind speed. Have students first calculate the rotations per minute and convert this value to speed. If time does not allow for their own calculations, see below for general guidelines of m/s.

Box Fan on Hi (3) Setting
1.5-5 meters per second

Box Fan on Med (2) Setting
1-2.5 meters per second

10. Invite students to convert their data to miles per hour to compare to a Saffir-Simpson Hurricane Wind Scale. This scale estimates potential property damage.
http://www.nhc.noaa.gov/aboutsshws.php

11. Summarize with students using the following guiding questions:
- How much faster would the winds need to be to become a category 1 hurricane according to the Saffir-Simpson Hurricane Wind Scale?
- What do you think would have happened if different angles of the home were impacted by strong winds?
- Ask students to imagine that they are engineers and architects designing homes in hurricane-prone environments. What materials and structural techniques would you use in order to keep people safe? Call on 3-5 students to respond out loud and record their answers on the board.

TAKE ACTION!

Inspired? Students and educators can use the following resources to learn more about disaster preparedness and civil engineering:

National Oceanic and Atmospheric Administration (NOAA)/National Aeronautics and Space Administration (NASA) Sci-Jinx: Hurricane Simulation
The American Society of Civil Engineers: Civil Engineering Games
Federal Emergency Management Agency (FEMA) photo galleries: Hurricane Matthew

NATIONAL STANDARDS

Science	Next Generation Science Standards **Planning and Carrying Out Investigations** Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
Technology Education	Next Generation Science Standards and International Technology and Engineering Educators Association **National Technology Standards** 9: Students will develop an understanding of engineering design. L: The process of engineering design takes into account a number of factors.

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