Western Engineering

Outreach

Building for Hurricanes

Grade 6-8

Meet Today's ENG HERO!

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Dr. Maged A. Youssef is a professor with the Department of Civil Engineering. Dr. Youssef is a structural engineer that teaches professional development courses, conducts research, and provides engineering services. His research specialties are earthquake engineering, new and innovative materials including shape memory alloys, steel, reinforced concrete, prestressed concrete, modular steel structures, structural fire engineering and performance-based design. To learn more about Dr. Maged A. Youssef visit: https://cfmm.uwo.ca/people/core_scientists/Corey%20Baron.html

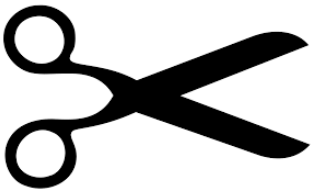
Learning Goal:

- Understand that some shapes increase a building's stability
- Be able to follow the engineering design process to improve on a design
- Identify which designs can and cannot withstand the self-weight of the tower as well as a lateral wind load.
- Explain how towers worked to withstand the lateral wind load using general engineering terms
- Curriculum Connections: Grade 6- Flight, Grade 7- Form and Function, Grade 8- Systems in Action

Materials Needed:

- Index cards (4-8)
- Straws (~10)
- Popsicle sticks (4-8)
- String (~3 feet/~1 meter)
- Pipe cleaners (4-8)
- Tape
- An electric fan or blow dryer

- A tennis ball or any small ball
- Scissors
- Ruler
- Hot Glue


Engineering and Science Connections

What is a hurricane?

A hurricane is a type of storm called a tropical cyclone, which forms over tropical or subtropical waters. When a storm's maximum sustained winds reach 74 mph, it is called a hurricane. As these storms travel, the wind, rain, and storm surge destroy the shoreline, villages, and cities in their path. Storm surge is a rise of the ocean caused by the winds of the storm. When hurricanes make landfall, they begin to decrease in strength because they no longer have the ocean water from which to gain energy.

What is the Engineering Design Process?

The engineering cycle or engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times, the solution involves designing a product (like a machine or computer code) that meets certain criteria and/or accomplishes a certain task.

What is the difference between the Engineering Design Process and the scientific method?

The engineering design process is different from the Scientific Method, which you may be more familiar with. If your project involves making observations and doing experiments, you should probably follow the Scientific Method. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process. For today's activity, we will be using the engineering design process.

Scary Hurricanes!

Whether you live in an area prone to hurricanes or not, you've seen images of the destruction caused by such storms (e.g. during Hurricane Katrina.) In late August through early September 2017, Hurricane Harvey inundated Houston, Texas, dropping so much rainfall that maps had to be redesigned because the current system didn't go high enough. Then Irma ripped through the Caribbean, followed by Hurricane Maria's Category 5 fury that wreaked havoc in Puerto Rico.

Building in areas at high-risk of hurricanes

Builders in areas at risk for hurricanes need to plan for that in their designs. That is the role you will take on today designing a building that can withstand a (simulated) hurricane using limited supplies in a limited amount of time. Damage to buildings can come because of wind, storm surge, or heavy rainfall leading to flooding. For today's activity, we will focus primarily on

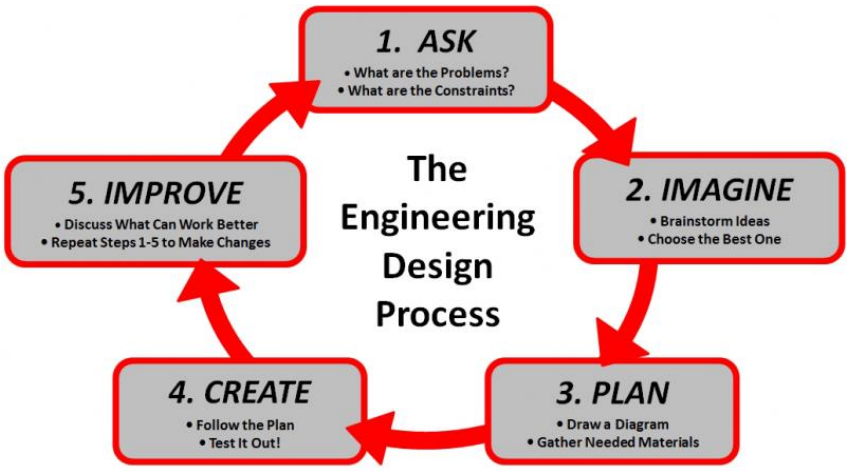
wind damage, although you may choose to think about others as well. The tower must be as tall as you can make it, but also stable enough to stand up to a wind load since it will be built in a hurricane-prone region.

The tower must be as tall as you can make it, but also stable enough to stand up to a wind load since it will be built in a hurricane-prone region. Engineers face similar design constraints in the real world—with tight budgets, material limitations and deadlines. An engineering team that can design a structure to meet the objectives with the fewest materials (hence, less cost), is favoured over other companies that cannot utilize the given materials as effectively.

What are the steps to the engineering design process?

The steps of the engineering design process are to:

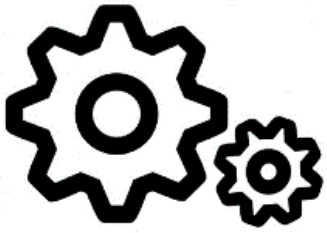
- Define the Problem
- Do Background Research
- Specify Requirements
- Brainstorm Solutions
- Choose the Best Solution
- Do Development Work
- Build a Prototype
- Test and Redesign (ITERATE)



Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change your design. This way of working is called iteration, and your process will likely do the same!

Be creative as an engineer!

Since engineers often need to get creative in the solutions they find to everyday problems, a great way to explore this line of thinking is through art. Every great engineering innovation started with an idea that no one had ever tried before, so the more creative you are, the better you can be as an engineer!

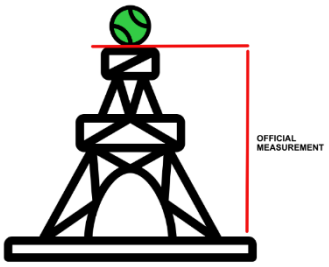


Activity

Today's design challenge is to build a freestanding tower that can support a tennis ball as high as possible off the ground (measured from the bottom of the tennis ball) while withstanding the wind from a fan.

Step 1: Brainstorm

- **You need a pencil and paper to write your ideas for brainstorming and to answer the following questions.**
- Which combination of materials will make the tower as tall as possible (measured to the bottom of the tennis ball)?
- What tower shapes could you use? Should your base be round? Square? Triangular?
- Can you be creative about unexpectedly using the materials?
- How can you get the tower to be freestanding, not taped to the table, and yet not fall over?
- Think about the forces on the tower, wind from the side and gravity pulling down. How you will build your tower to resist them?



- As you brainstorm designs for your tower, think about other structures and how they stand up. For example, a tent combines flexible and rigid materials to make a frame and covering that can stand on its own.

Step 2: Build, Test

- **Build what you have brainstormed**
- Once you've got a tower to test, put it one foot away from the fan or blow dryer and place the tennis ball on the top. See how your tower responds when you turn the fan speed on low.

Step 3: Redesign & Debrief

- If there is time after testing, redesign your tower based on what you learned from the testing. For example, if the tower tips over, the tennis ball won't stay in place, or the weight of the tennis ball collapses, then try to improve it.

What did you learn?

- What is a Hurricane?
- The Engineering Design Process
- Creativity and the Engineering Design Process
- Building a Strong Freestanding Tower to Withstand a Hurricane

Future Learning

- You can turn this design challenge into a project and build another freestanding tower that is strong enough to withstand the wind from the fan or blow dryer. However, this second building should be completely different from the first one, and this time you are allowed to use any materials that you have available at home. Compare the strength of the two towers and try to find out which one is the strongest.

Share your creations!

We would love to see what you made. Email us at discover@uwo.ca or tag us on social media.

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Thanks for discovering with us