

How Can We Use Wind To Lift a Load?



Design and Build

a wind turbine that uses wind power to lift a minimum of four pennies in a small paper cup.

Try It

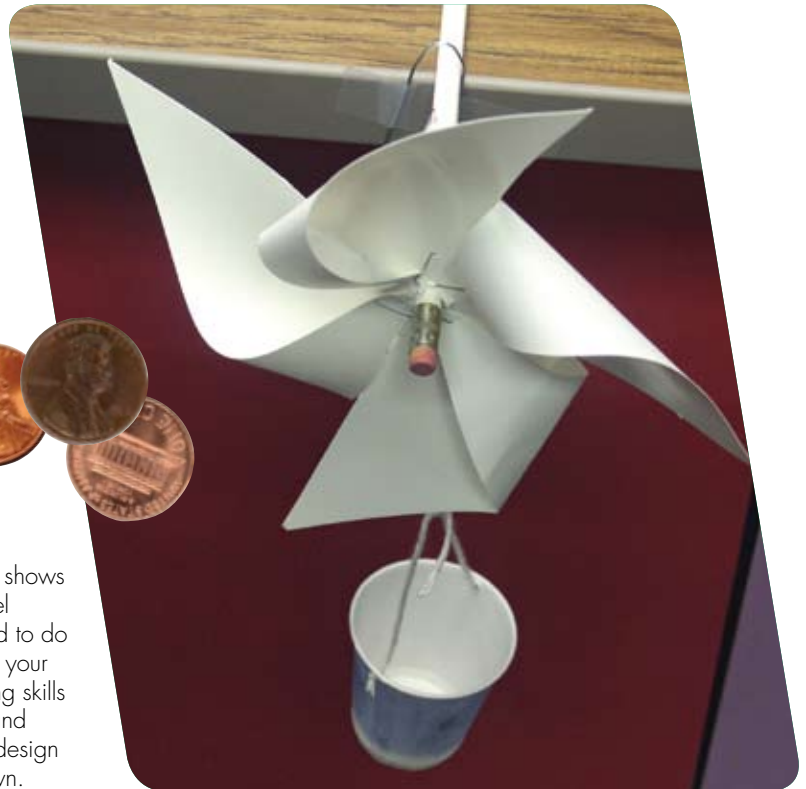
- Simulate the wind with a box fan.
- Position the “wind” near your turbine.
- Lift the load from the floor to a table top.

You Will Need:

- Pennies
- Cardboard or index cards
- Round pencils
- Straws (sturdy straws)
- Cardstock
- String (cotton or poly works best)
- Paper or plastic cups
- Paper clips
- Tape
- Box fan
- Stop watch or watch with a second hand

Other Possible Materials:

- Rubber bands
- Poster board
- Plastic beads for spacers
- Miscellaneous hardware and office supplies



The photo shows a pinwheel being used to do work. Use your engineering skills to invent and perfect a design of your own.

In Your Engineering Notebook

write or sketch answers to questions you find important or interesting.

Describe all of your attempts.

What is the maximum number of pennies your machine is able to lift?

How long does it take your machine to lift four pennies?

How long does it take to lift eight pennies? Is it twice as long?

The Working *Wind*

We know that windmills were used to do work in Persia at least 3,000 years ago (Persia is now Iran). These windmills looked somewhat like modern day revolving doors. The wind pushed against the door-like paddles and turned a center **shaft**. The shaft was connected to a pump or to a millstone used to grind grain. These were vertical **axis** windmills which work no matter which direction the wind blows.

Early European windmills first appeared about 800 years ago. These horizontal axis windmills had large blades that faced into the wind like a pinwheel. The blades were often wood frames covered by cloth sails. When the direction of the wind changed the windmill had to turn the blades to face the wind. Later, inventors developed ways for the wind to do this turning. Notice the

small set of blades on the windmill in the photo.

In the later 1800's smaller windmills were invented to help farmers in the American West pump water. These windmills were mounted on **towers** and had many thin blades. There was also a fantail or rudder to turn the blades into the wind. These windmills were used by American farmers to do many chores. Over time, improvements were made in the shape of the blades. Some were made of steel. During the years 1880 to 1935, several million windmills operated in the American West.



MSTE photo, JiYoung Kim

This Dutch style windmill in Golden Gate Park in San Francisco was built in the early 1900's to pump water from an underground aquifer to irrigate the park.

Talk About It

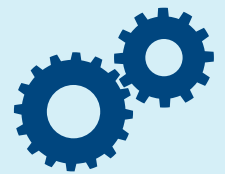
Describe your first design. What works well? What do you want to improve?

Try Something Else and Test Again

- What improvements did you make in your initial windmill?
- Which adjustments to your design made the windmill work faster and which made it stronger? Discuss your design with your partner or group. Explain the adjustments you want to make and explain why you want to make them.

Learning from Others

- Observe the turbines built by others in your group. How are they similar? How do they differ? What are some features of the turbines that lift the most pennies?
- We need energy to do work. Moving or lifting something is work. Lifting 4 pennies 20 inches is twice as much work as lifting 4 pennies 10 inches. Describe how your turbine uses wind energy to do work.



Engineering Design with Sue Larson

Have you ever heard the phrase "go back to the drawing board?" It means that something has gone wrong with a design and it's time to start over. Engineering design always contains some "do-overs" (they're called iterations), where you learn something valuable from something that went wrong and you go back and fix it. Some of these iterations happen early in the design process and some happen much later—even after something is made and the designer sees how people use it. Part of design is testing what you've made to see how it works and being willing to adjust as necessary—even to the point of "going back to the drawing board." It's all part of getting something that works just like you want it to.

In what other situations might you need to "go back to the drawing board?"