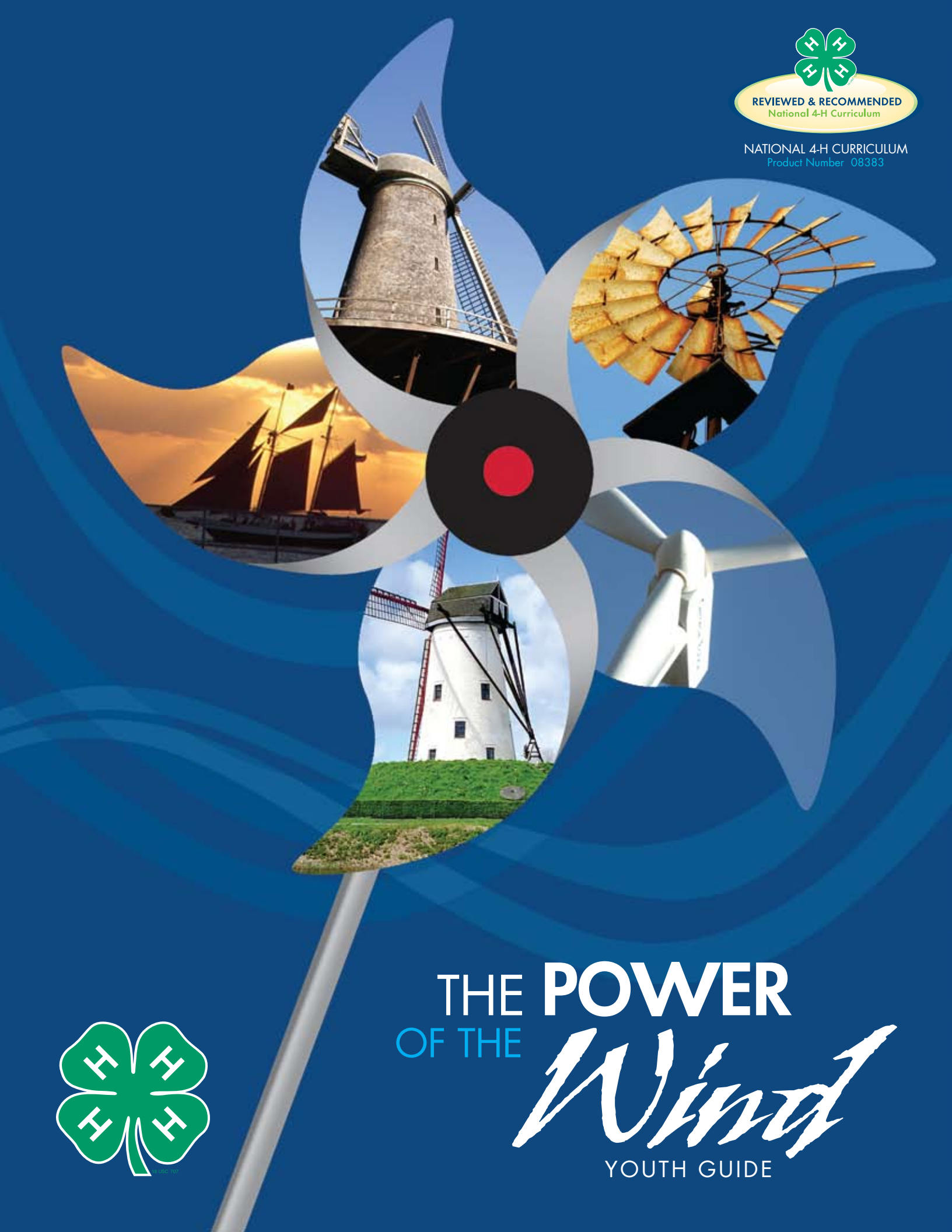

REVIEWED & RECOMMENDED
National 4-H Curriculum

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THE POWER OF THE Wind

YOUTH GUIDE

Acknowledgments

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The Office for Mathematics, Science, and Technology Education (MSTE) is a division of the College of Education at the University of Illinois at Urbana-Champaign. The goal of MSTE is to serve as a model-builder for innovative, standards-based, technology-intensive mathematics and science instruction at the K–12 levels. The Office serves as a campus-wide catalyst for integrative teaching and learning in mathematics, science, and technology education.

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Contents

THE POWER OF THE *Wind*

The 4-H Youth Development Program promotes learning by doing and focuses on developing skills for a lifetime. This project is designed to teach youth about the wind and its uses while introducing them to engineering and engaging them in doing and reflecting on the activities.

CHALLENGE

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

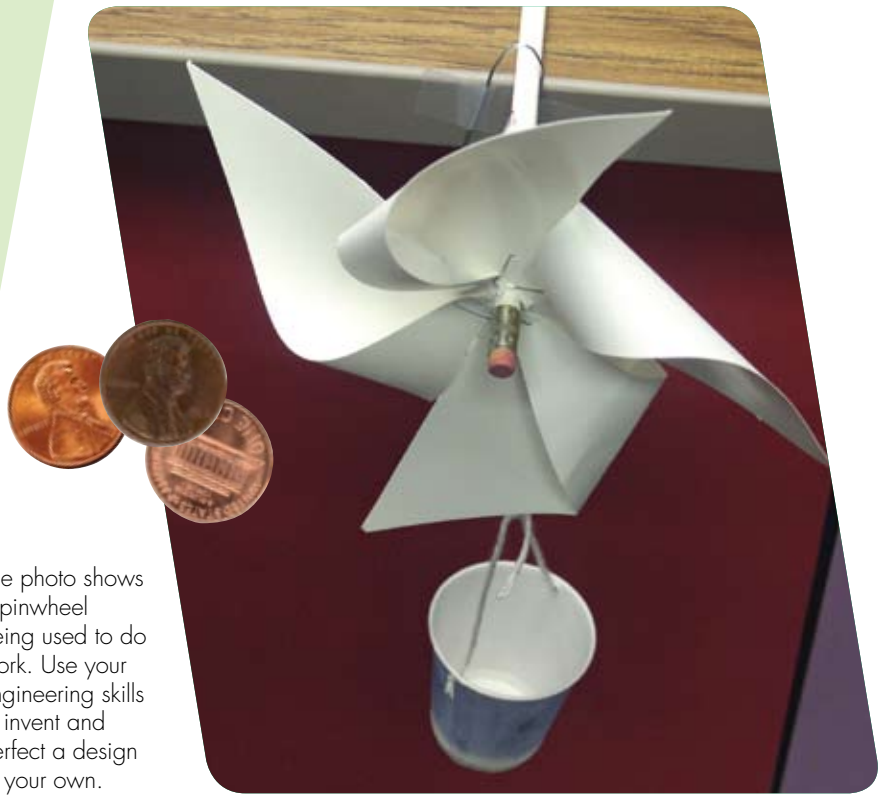
- Simulate the wind with a box fan.
- Position the "wind" near your turbine.
- Lift the load from the floor to a table top.

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 windmiller 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, Ji-Young 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

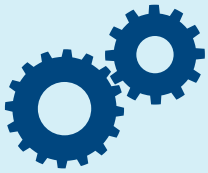
Describe your first design. What works well? What do you want to improve?

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?"

APPENDIX

Glossary

Anemometer
an instrument used to measure wind speed.

Axis
the line about which a rotating body, such as the rotor of a turbine, turns.

Beaufort Scale
a scale that uses numbers from 0 to 12 to categorize wind speed based on observing. The scale was created by the British naval commander Sir Francis Beaufort around 1805.

Biodiesel
a renewable fuel for diesel trucks, cars, buses, and tractors that is made from plants.

Chemical Energy
energy that can be released by a chemical reaction. A chemical reaction takes place inside a battery when the battery is part of a complete electrical circuit.

Constraint
a restriction on a design, such as performance, cost, and scheduling.

Criteria
the rules used to judge something.

Cyclone
any storm with circulating winds (a "twister") formed over water. Also refers to a hurricane that occurs in the Indian Ocean.

Electrical Energy
energy made available by the flow of electric charge through a conductor.

Electron
an elementary particle of an atom with negative charge.

Energy
refers to the ability to do work. It is defined as power over time. The unit of energy that appears on your electrical bill is kilowatt hour (kWh). A 1000 watt hair dryer uses one kWh of electricity if it is on for one hour. Different forms of energy include electrical, solar, wind, thermal, mechanical, and chemical.

Engineering Design Process
a process used by engineers to help develop products.

Force
a force is a push or a pull that results in a change of an object's velocity or direction.

Generator
a device that converts mechanical energy into electrical energy.

Hurricane
a storm with very fast circulating winds (a "twister") formed over water near North or South America.

Kilowatt
1,000 watts is equal to 1 kilowatt (kW). The unit of energy that appears on your electrical bill is kilowatt hour (kWh). A 1000 watt hair dryer uses one kWh of electricity if it is on for one hour.

Kinetic Energy
the energy of an object in motion.

LED
light-emitting diode: a semiconductor diode that emits light when conducting current and is used in electronic equipment (e.g. a string of holiday lights).

Machine
a device that does work and uses energy.

Megawatt
1,000,000 watts is equal to 1 megawatt (MW). One MW is enough power to light 100,000 standard 100 watt light bulbs or to operate 10,000 hair dryers.

Mechanical Energy
the energy an object possess due to its motion or its stored energy of position.

Motor
a device that converts electrical energy into mechanical energy to do work.

Multimeter
a device consisting of one or more meters used to measure two or more electrical quantities in an electric circuit, such as voltage, resistance, and current.

Nacelle
the housing that contains the generator and gear box of a wind machine mounted on top of the supporting tower.

Potential Energy
the energy stored in an object because of its position.

Glossary

APPENDIX

Power
energy transferred or work done per unit of time. It is measured in watts. A watt is a measure of power at a specific instant. A 100 watt light bulb changes 100 watts of electricity to 100 watts of light and heat.

Prototype
an early attempt at a working model for an idea.

RPM
stands for revolutions per minute.

Rotational Symmetry
an object with rotational symmetry is an object that looks the same after a certain amount of turning.

Rotor
a rotating part of an electrical or mechanical device.

Rudder
A blade at the rear of the turbine that keeps the turbine turned into the wind.

Shaft
a revolving rod that transmits power or motion.

Solidity
the ratio of rotor blade surface area to the area that the rotor blade passes through; the amount of swept area occupied by the blades.

Swept Area
the area of the circle that the blades of a turbine pass through.

Tetraflexagon
in geometry, flexagons are flat models made from folded strips of paper that can be folded, or flexed, to reveal a number of hidden faces. A tetraflexagon has four faces.

Tornado
a storm with very fast circulating winds (a "twister") formed over land.

Torque
force which causes something to rotate, turn, or twist.

Tower
column upon which the nacelle is supported.

Transformer
converts high voltage to low voltage or low to high.

Tropical Storm
a group of thunderstorms with fast wind speeds rotating in a spiral formed over water.

Tsunami
an unusually large sea wave produced by a seaquake or undersea volcanic eruption.

Turbine
any of various machines having a rotor, usually with blades, driven by the pressure and movement of water, steam, or air. A turbine converts kinetic energy of a moving substance (such as air) into mechanical energy.

Typhoon
a storm with very fast circulating winds formed over water in the South Pacific Ocean.

Voltage
the force or pressure pushing the electrons. It is measured in volts.

Wind
air in motion, ranging from still (no wind) to a breeze (slight wind) to a gale (strong wind) or hurricane.

Windmill / Wind Turbine
a device that converts wind energy to other forms of energy such as mechanical or electrical.

Wind Farms
a collection of wind turbines located on the same area and used to generate electricity.

Wind Energy
energy harvested from moving air in the atmosphere. Wind energy is dependent on atmospheric conditions such as temperature and pressure differences.

Work
occurs when a force is applied over a distance.

Resources

Print Resources

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Internet Resources

For Internet Resources, please go to The Power of the Wind online at ***www.4-H.org/curriculum/wind***

4-H Pledge

I Pledge my **Head**
to clearer thinking,

my **Heart** to greater loyalty,

my **Hands** to larger
service,

and my **Health** to
better living,

for my club, my community, my country, and my world.