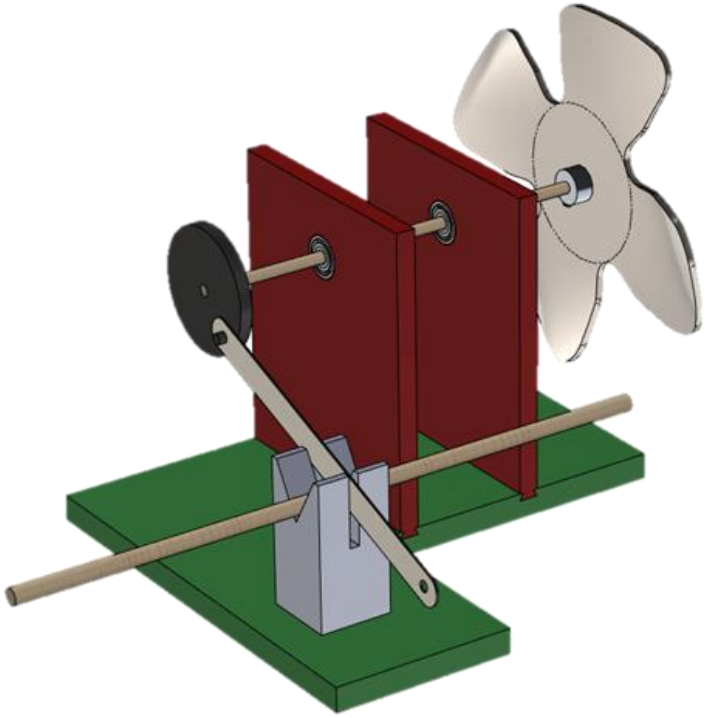
DESIGN PROJECTS



WIND-POWERED SAW

GRADE LEVEL

Grades 9–12

MODELING TIME

12-20 hours

MATERIALS

- Wind-catching fan blade or propeller
- Small saw blade
- Bearings
- Pine dowels (3/16" & 1/4")
- Structural materials (e.g., plywood, MDF, or 3D-printed parts)
- CAD software (SOLIDWORKS or xDesign)
- 3D printer (Approximately 500g filament)
- Drill, saw, or laser cutter (for manufacturing parts)

DESIGN OBJECTIVES

- The machine must use wind power to rotate a cutting blade.
- Students can design the structure and gear system to optimize cutting.
- Aesthetic choices like paint, engravings, or decorative features are encouraged.

EDUCATIONAL CONCEPTS

ENGINEERING PRINCIPLES

- Mechanical energy conversion
- Lever mechanics and cutting forces

PHYSICS CONCEPTS

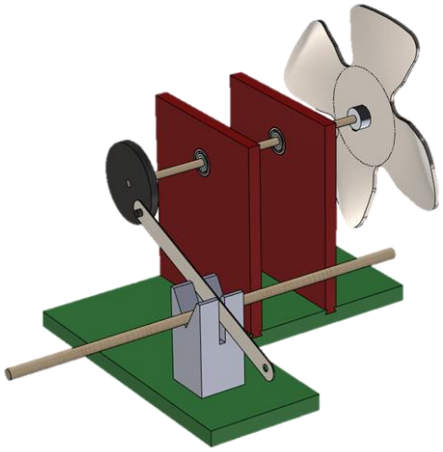
- Torque, friction, and rotational dynamics
- Energy transfer and efficiency

TECHNOLOGY

- CAD design for custom components
- Integration of off-the-shelf and custom-made parts

PROBLEM-SOLVING

- Designing systems to achieve specific outputs (cutting a dowel cleanly).



DESCRIPTION

Using a combination of purchased components like a fan blade, bearings, and a saw blade, along with custom-designed parts created in CAD, students will explore the mechanics of energy transfer and rotational motion.

HISTORY

The windmill is one of humanity's oldest machines, dating back to the 9th century, used for milling grain and pumping water. This project draws inspiration from those early wind-powered mechanisms, teaching students how wind energy can be harnessed to perform mechanical tasks.

LESSON TOPICS

Phase 1: Planning and Research

- Understand the goal: Use wind energy to power a blade capable of cutting wooden dowels.
- Sketch initial ideas for transferring wind energy to the cutting mechanism.
- Identify which parts will be purchased (e.g., fan blade, bearings) and which will be custom-made.
- Optional: Have students research and procure components (fan blade, bearings, etc.)

Phase 2: CAD Modeling

- Create a base and frame to support the components, ensuring stability during operation.
- Use CAD to design custom shafts, gears, or pulleys.
- Test the fit and alignment of purchased parts within the assembly using in-context design.

Phase 3: Prototyping and Assembly

- Manufacture structural components using a 3D printer, laser cutter, or hand tools.
- Assemble the parts, ensuring they are securely mounted.
- Connect the mechanical system, ensuring proper alignment and smooth motion.

Phase 4: Testing and Iteration

- Test the machine in a controlled environment with a fan or natural wind.
- Observe if the dowels are cut cleanly and if adjustments are needed (e.g., blade alignment, torque increases).
- Iterate on the design based on test results.

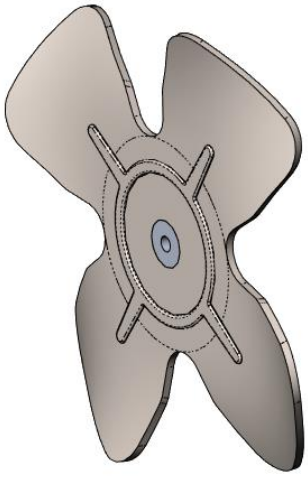
Phase 5: Presentation

- Explain the design process, challenges faced, and how they were resolved.
- Demonstrate the machine's functionality.

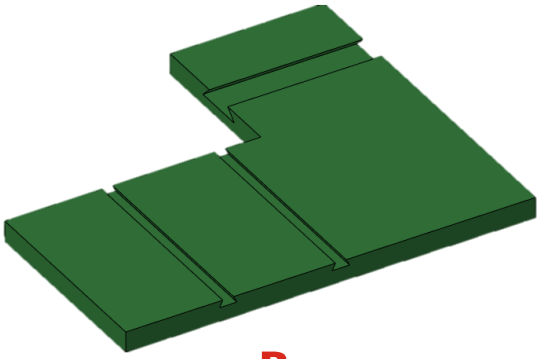
DISCUSSION STARTERS

- What are the key factors that influence how much torque the fan blade produces?
- How can gears or pulleys be used to increase the cutting force?
- How do design choices impact energy efficiency and material usage?
- What safety considerations must be made when designing machines like this?

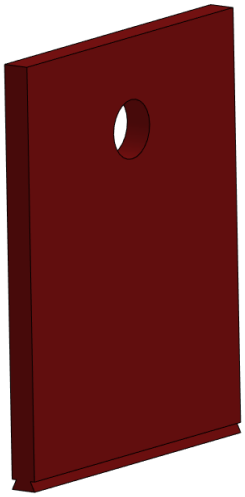
COMPONENTS



Fan



Base

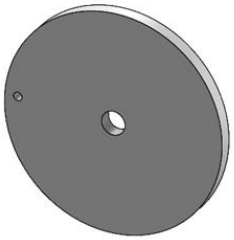


Support (2x)

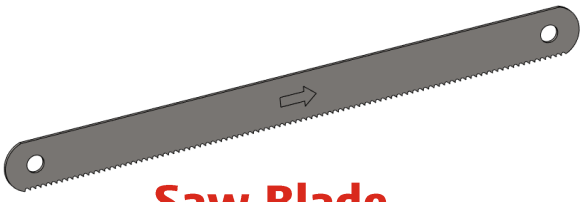
Dowel (2x)

Screw

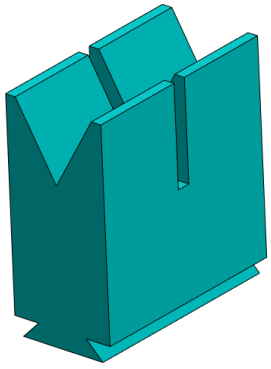
Bearing (2x)
(Match ID to Drive shaft)



Crank



Saw Blade



Dowel Holder

ADVANCED OPTIONS

- **Power Optimization:** Add gears or a belt system to adjust rotational speed or torque.
- **Energy Storage:** Incorporate a flywheel to store energy for smoother motion.
- **Alternative Power Sources:** Experiment with different energy sources like a hand-crank or a motor.

ASSESSMENT CRITERIA

- Do the components fit together and function as intended?
- Does the machine successfully cut dowels?
- Does the machine have a unique, innovative, and aesthetically pleasing design?
- Did the student present their design clearly and discuss challenges and successes?

ADDITIONAL RESOURCES

- LINK TO DOCUMENTS
- LINK TO YOUTUBE VIDEO
- LINK TO STEP-BY-STEP