PADDLE POWER

DESIGN SQUAD

PBS

as built on TV

pbs.org/designsquad

YOUR CHALLENGE

Design and build a boat that paddles itself across a container of water using a rubber band as its power source.

BRAINSTORM & DESIGN

Look at your materials and think about the questions below. Then sketch your ideas on a piece of paper or in your design notebook.

1. How can you use these materials to make a boat that floats well?
2. How will you attach a rubber band and paddle to your boat?
3. How big a paddle do you need so that it reaches the water and drives the boat?
4. How will you make sure your boat doesn't sink, tip, or roll over?

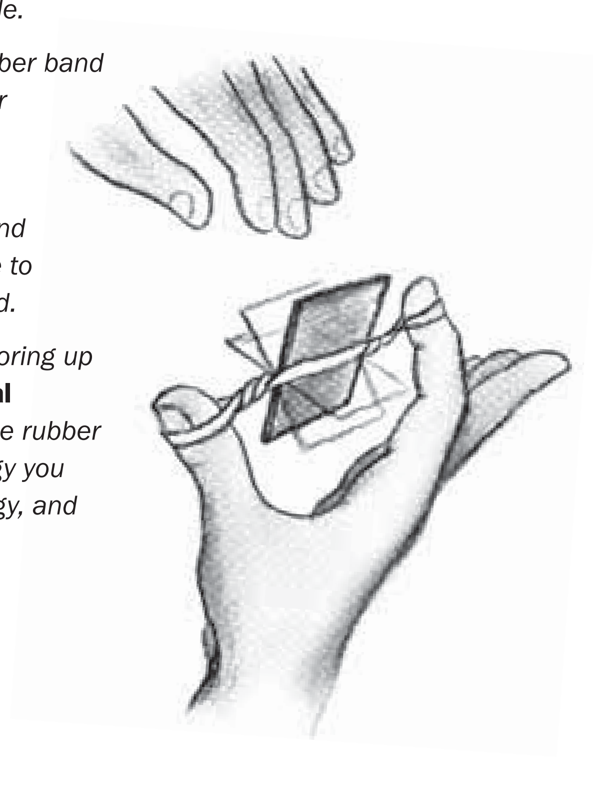
BUILD, TEST, EVALUATE & REDESIGN

Use the materials to build your paddleboat. Then test it by winding it up, putting it in the container of water, and releasing it. When you test, your design may not work as planned. The saying, "If at first you don't succeed, try, try again," is at the heart of the design process. Testing a design and then revising it based on what you've learned is a key to success. Study the problems and then redesign. For example, if your paddleboat:

- tips—*Add some weight to the bottom of the boat to help keep it upright.*
- has a warped paddle—*Think of some ways to waterproof the paddle.*
- has a paddle that hits the frame holding it—*See if moving the rubber band makes a difference. Also consider changing the size of the frame or the paddle.*
- has parts that bend when the rubber band is wound tight—*Make sure parts are taped on securely. Also, see if moving the rubber band makes a difference. The closer it is to the boat, the harder it will be to bend things. Finally, find ways to add support to any parts that bend.*
- doesn't make it across the container—*Experiment with ways of storing up more energy. Your boat moves by changing stored energy (***potential energy***) into motion energy (***kinetic energy***). The more you wind the rubber band (or the more rubber bands you use), the more potential energy you store. When you let go, this potential energy turns into kinetic energy, and the boat moves.*

MATERIALS (per person)

- chipboard (8 ½ x 11 sheet)
- wide container partially filled with water (e.g., kiddie pool, bathtub, underbed storage container, wallpaper tray)
- duct tape
- 2 paper cups (8 ounce or larger)
- 5 rubber bands
- scissors
- towels (paper or cloth)
- 4 straws
- washers (1-inch or larger)
- 4 wooden skewers



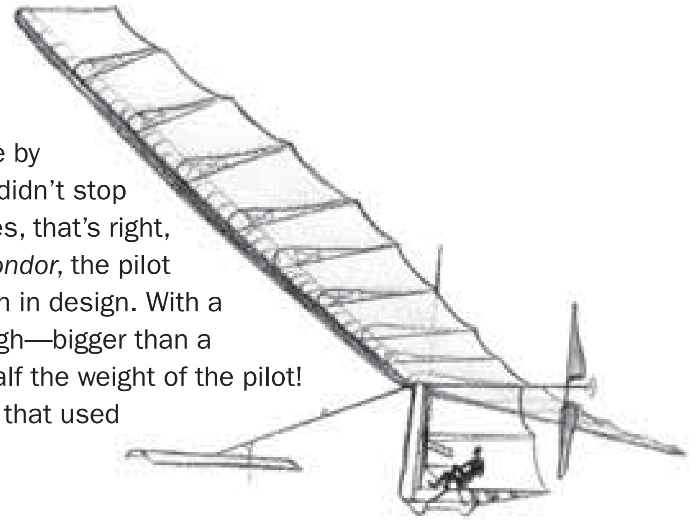
TAKE IT TO THE NEXT LEVEL

- Watch your fingers! Add an on-off switch so you can start and stop the paddle.
- Ready. Set. Go! Experiment with the paddle, the rubber band, or the boat's shape to increase its speed. Then race other paddleboats.
- Tugboat time! Carry or tow a Ping-Pong ball from one side of the container to the other.

MAKE IT ONLINE

Is that a bird or a plane?
Build an airplane that flies by flapping its wings out of wood, wire, tissue paper, rubber bands, and glue. See how on Make Magazine's project page at makezine.com/designsquad.

ENGINEERING IN ACTION



Engineer Paul MacCready was always intrigued by the way birds soared through the air. As an adult, he brought his passion to life by building gliders that won contests and set records. His success didn't stop with gliders—he built the world's first human-powered aircraft. Yes, that's right, *human* powered! In one of MacCready's planes, the *Gossamer Condor*, the pilot pedaled a modified bike to spin a propeller. It was a breakthrough in design. With a wingspan of 96 feet, the *Condor* was 30 feet long and 18 feet high—bigger than a tractor-trailer truck. And it weighed only 70 pounds—less than half the weight of the pilot! MacCready made his planes light and strong with clever designs that used materials in new ways. His motto was "do more with less."

Look at the materials below. MacCready used all but one to build the Condor. Guess which one wasn't a part of his incredible flying machine?

A. Mylar® plastic (like in silver balloons)
B. Aluminum tubes
C. Bicycle parts
D. Cardboard
E. Titanium panels
F. Piano wire
G. Clear household tape
H. Styrofoam®

(Answer: E. Titanium panels. Even though titanium is a lightweight metal, it's still a lot heavier than Mylar®.)

Watch the DESIGN SQUAD Aquatic Robotics episode on PBS or online at pbs.org/designsquad.

Mylar is a registered trademark of DuPont Teijin Films. Styrofoam is a registered trademark of Dow Chemical Company.

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