BioEd℠

Think like an Engineer

TEACHER'S GUIDE

Ring Wing Gliders

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Baylor College of Medicine

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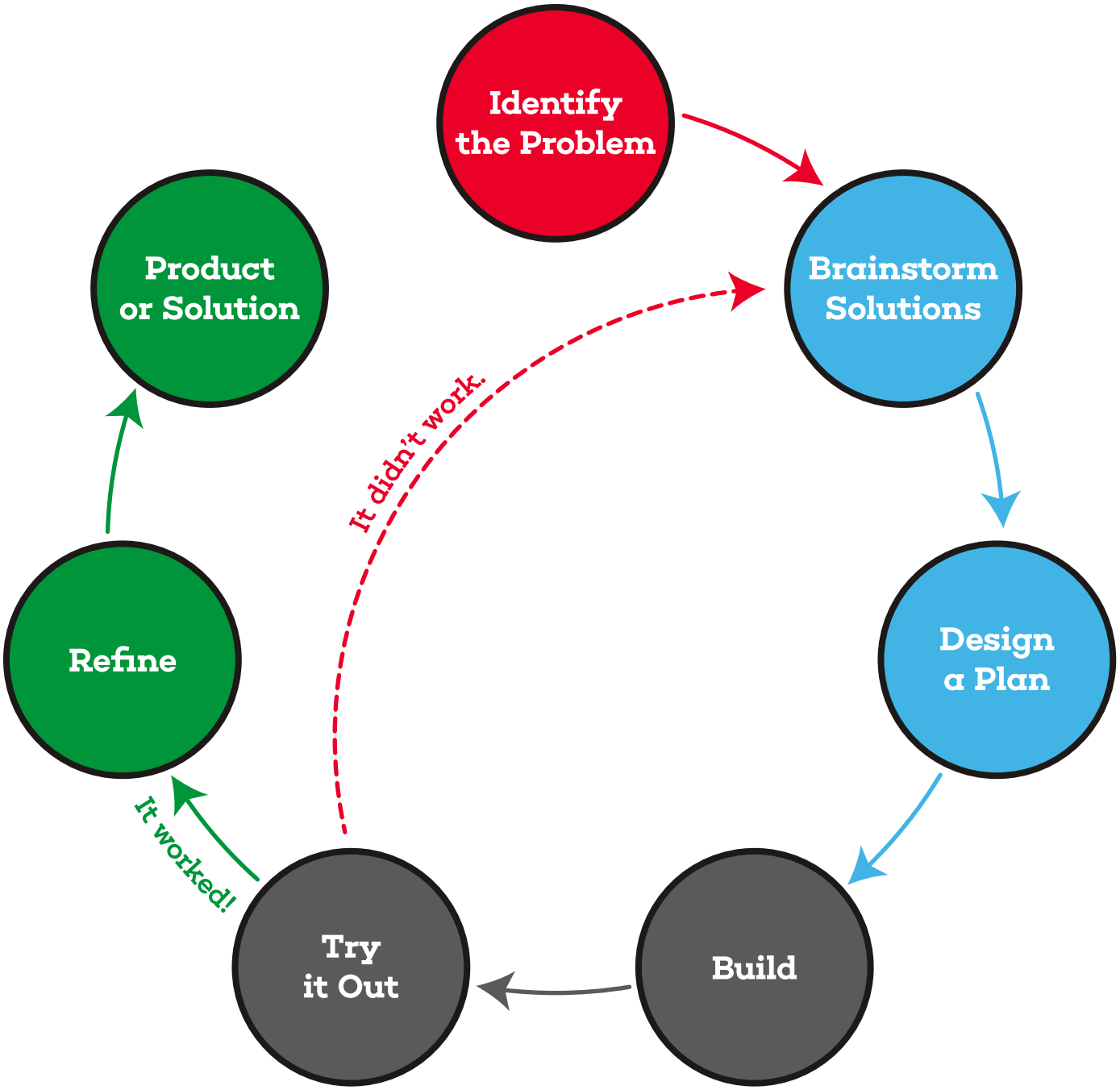
An Engineer's Approach



1

Ring Wing Gliders
Investigating Engineering

Time
1–2 sessions

Before You Start
Make samples of the two gliders. Practice throwing the gliders.

Make 24 copies of "An Engineer's Approach" page (one per student).

You Need This Stuff
Teacher Materials
- Computer with projector and Internet access
- Video: Engineer Your Life

Per Pair of Students
- 10 small paper clips
- 5 pennies, washers and other small weights
- Aluminum foil
- Clear tape
- Markers
- Metric ruler
- Pair of scissors
- Several sheets of paper in different sizes and weights (for example, newspaper, tracing paper, card stock, etc.; see step 6)
- Copy of "Ring Wing Glider 1," and "Ring Wing Glider 2" pages

Per Student
- 2 sheets of color copy paper (8.5-in. x 11-in.)
- Copy of "An Engineer's Approach" page

What It's About
This activity introduces students to engineering practice and encourages them to think like engineers. Students will learn about factors that affect flight as they design and build two types of flying cylinders. Then, they will use "An Engineer's Approach" page to test and improve their gliders.

Individual civil French jet AOK Spacejet (closed wing design) at the 2013 Paris Air Show.

About Flight

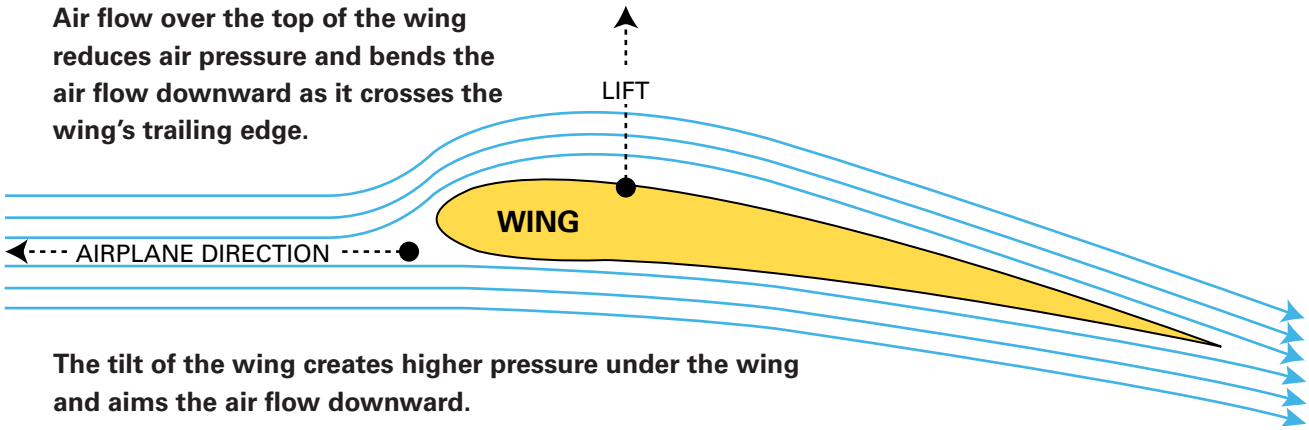
Airplanes come in many sizes and shapes. Most have a body, one or more sets of wings, a tail section and one or more engines. As long as the plane achieves flight, almost anything goes!

Aeronautical engineers must account several factors when designing a new airplane: lift, weight, thrust and drag. These are called the four forces of flight.

Lift is what gets an airplane off the ground. In most planes, lift is generated by the shape of the

Newton's Third Law of Motion

For every action there is an opposite and equal reaction. Air forced downward by the wing (action) produces an equal and opposite force (reaction) that provides lift to an airplane.



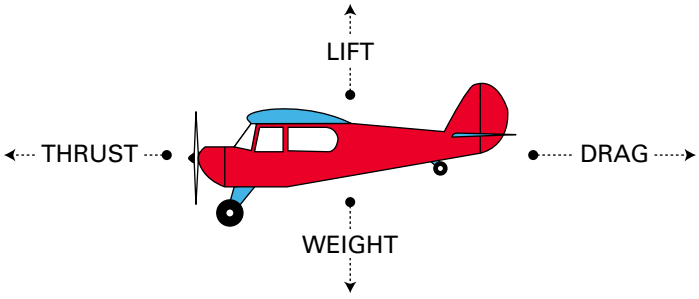
wings. As a plane moves forward, its wings push air downward. The downward push is known as an "action force." Simultaneously, the airplane experiences an equal and opposite "reaction force" that pushes it up. Aeronautical engineers call this reaction force "lift."

Most airplane wings are curved on top, flat on the bottom and tilted slightly downward towards the back. The forward edge of the upper surface is rounded, while the backward edge of an airplane wing is gently sloped. As a plane moves forward, some air moves above its wings and some flows beneath the wings. Because the upper surface is curved, air pressure over the wing is reduced by the airflow. This causes the air to bend downward as it passes the wing's trailing edge, producing a downward force. At the same time, air beneath the wing also is pushed downward by the slightly tilted underside. The downward force produced by the upper and lower wing surfaces creates the opposite and equal force that lifts the plane off the ground (see illustration above).

The faster the airplane moves forward, the greater the lift produced. This is why an airplane accelerates on the runway. When speed and lift have increased to sufficient levels, the plane will become airborne. Conversely, a plane coming in for a landing must be slowed to reduce lift. To compensate for the lower air speed, the pilot tilts segments of the wings downward, thereby pushing more air from under the wings and maintaining sufficient lift to prevent the plane from falling out of the sky.

A second force, weight, opposes lift. Weight is the measure of gravity's effect on the airplane's mass. Earth's gravity "pulls" the plane down toward the ground. To overcome the force of gravity and achieve flight, an airplane must generate more lift than the total weight of the plane, its fuel, and all its contents. If an airplane loses its lift, weight (gravity) causes it to come crashing down.

Four Forces of Flight



The other two forces of flight are thrust and drag (see illustration above). Thrust is the forward force created by the propellers or jet or rocket engines as they blow air or exhaust backward to propel the plane. Drag—friction with the air while a plane is

moving forward—works in the opposite direction. To fly forward, an airplane must produce thrust greater than the forces of drag impeding it. Aeronautical engineers try to streamline their airplane designs so that planes cut through the air smoothly. A plane with a lot of drag will not be very efficient. As long as lift is greater than weight and thrust is greater than drag, any shape of airplane will fly.

In this activity, students will make and test flying tubes, called ring wing gliders. Students' muscle power will provide thrust, and lift will come from their gliders' shape.

What's the Question?

Can you work like an engineer?

What To Do

1. Ask students if they know what engineers do. Write their ideas on the board. Then ask them to identify similarities among the jobs listed. Explain that engineers work with materials to solve problems. Some build bridges across rivers. Others design structures to support heavy loads under many different conditions. Still others create roads over mountain passes and tunnels through mountains. But engineers do more than build things; they apply all types of science to solve a wide variety of problems. Not surprisingly, there are many kinds of engineers: civil, biological, structural, geomechanical, municipal, biomaterials, mechanical, chemical, computer, agricultural, climate, and even laptop carrier engineers.
2. Distribute copies of "An Engineer's Approach," to students and discuss the process. Then show students the video (URL below) of Judy Lee, a mechanical engineer and product designer. She explains what it's like to be an engineer and the process she and her colleagues follow to design a new product. After viewing the video, Engineer Your Life, have students share what they learned about Ms. Lee and her work.

   http://www.engineeryourlife.org/cms/6167/6196.aspx?eylprofile=Video

3. Explain to students that they will begin investigating the world of engineering by learning how things work. Using the step-by-step instructions on the "Ring Wing Glider 1" page, have students follow as you model the process for forming the paper into a glider. Do not tell them what they are making. When the glider is completed ask, *What is this?* Students will have a variety of answers. After they have had a chance to examine the cylinder and offer all their ideas, throw the glider across the room. The best way to achieve a "good" flight is to throw it like a football—but don't share this technique with students just yet.
4. Have students throw their cylinders. Do not give them advice or instructions; Instead let them experiment with different techniques. After students have had sufficient time to test different throwing styles, regroup and have them share their observations. Ask, *How did you throw the cylinder to make it fly the farthest or stay in the air the longest?* Students will discover that for best results, the cylinder should be thrown with the heavy end facing forward. You can demonstrate why by holding a sheet of paper horizontally and letting it fall. Students will observe that the paper wobbles as it drops to the ground. Add a couple of large paper clips to one end and the sheet of paper starts gliding as it falls. Have students test their cylinders again with this new information.
5. Have students make and test a second glider of a different design, using the set of instructions on the "Ring Wing Glider 2" page.
6. After students have tested and explored the flight of each cylinder, ask, *Could you modify your cylinders to make them fly further or stay in the air longer?* Have students brainstorm and discuss ways to improve the performance of their gliders. They may suggest adding weight to the front, changing shapes, using different types of paper or other modifications.
7. Let students work in pairs to design a new cylinder that will fly further and/or longer. Each team should draw a diagram of its new cylinder, label the parts, and consider possible modifications they could make after testing to improve its flight. Then, have students choose materials from those available (card stock, newspaper, paper clips, etc.) to build their new gliders.

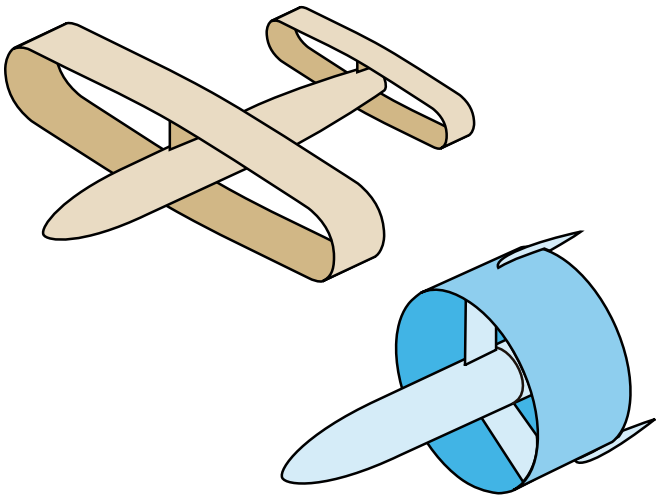
8. Teams should test their new fliers, record the results, and adjust their designs, as necessary.
9. To debrief, have each team present its results and explain the reasons for any adjustments to its design. Ask students to describe the challenges encountered when designing their fliers, and how they addressed those challenges. Refer back to the four forces of flight. Ask, *How did your team improve lift, decrease weight, improve thrust, and reduce drag in your flier?* Have each team compare its design and testing process to the list created for step 1. Ask, *What engineering jobs did you perform?*

Wrapping Up

Hold a class discussion about the potential of ring wings for future airplanes. Ask, *What are the advantages and disadvantages of this design? How would the planes look? Would you want to fly in one?*

Extras

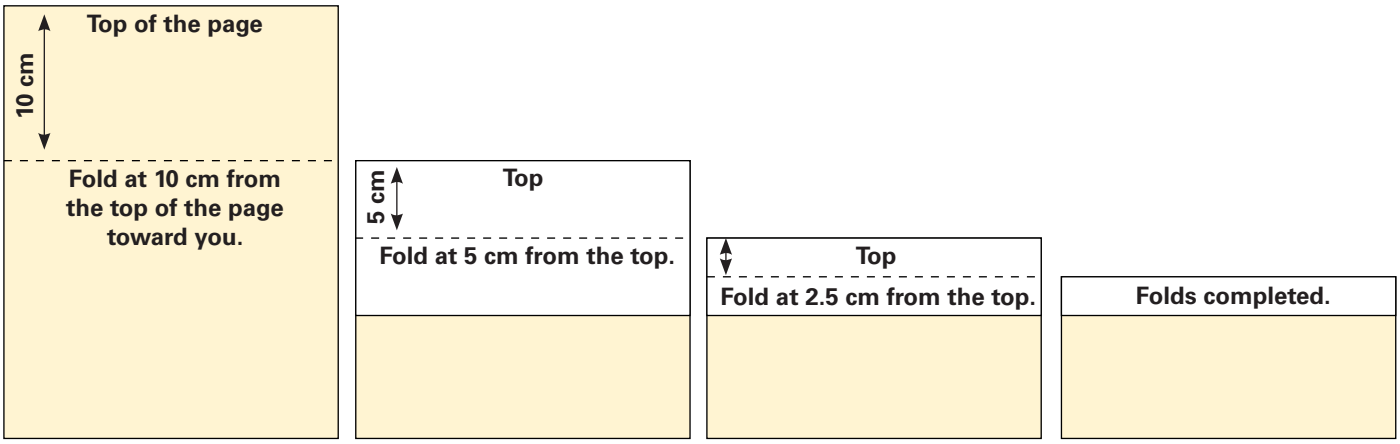
- Challenge students to build ring wing gliders from other materials (e.g., aluminum foil) and/or make gliders in different sizes and shapes (see illustrations above).
- Play the video, Aeronautical Oddities (URL below), which shows newsreel collections of unusual airplanes, including one version of a ring wing that actually flies.



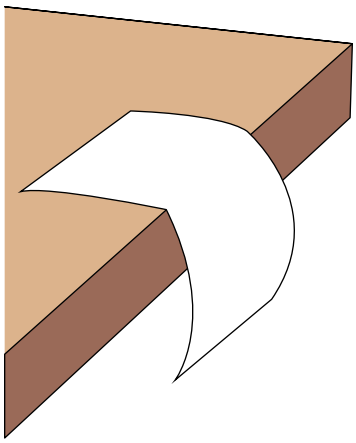
http://archive.org/details/aeronautical_oddities ■

Ring Wing Glider 1

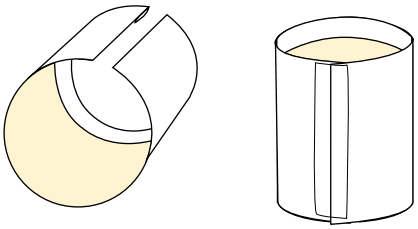
1. Lay a sheet of copy paper on the table. Measure and make the following three folds towards you, using the dimensions given. Use your fingers to make a strong crease for each fold.



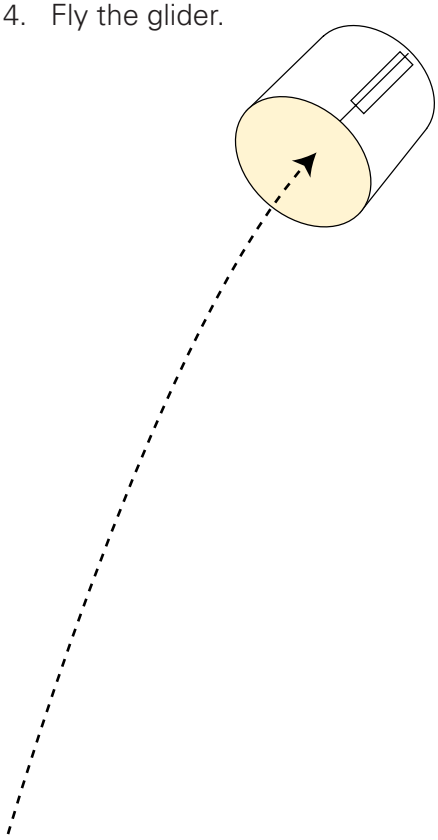
2. Hold the paper with the unfolded side toward you. Rub the sheet against the edge of a table to make a tube shape.



3. Bring the edges of the paper together to form a cylinder. Gently slide one band inside of the other band. Tape the seam shut.

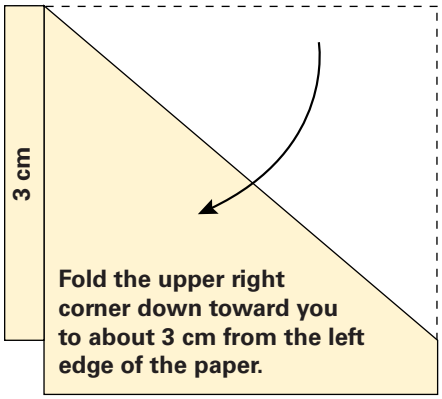


4. Fly the glider.

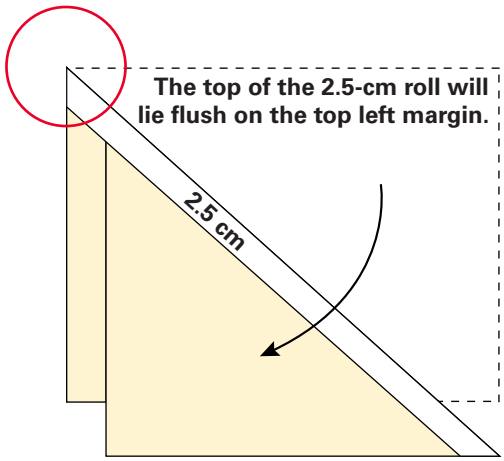


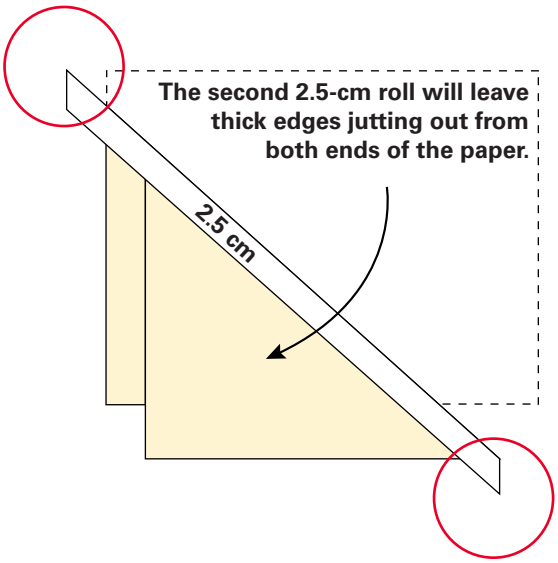
Ring Wing Glider 2

1. Lay a sheet of copy paper on the table. Measure and make the following fold toward you, using the dimensions given. Use your fingers to make a strong crease on the folded edge.



2. Roll the angled edge toward you to make a 2.5 cm fold, as shown below. The top of the angle will rest on the left margin. Make a strong crease on the folded edge. Repeat.





3. Curl the folded edges and tuck one end point inside of the other to form a cylinder. Secure the cylinder with a small piece of tape.

4. Grasp the glider lightly between the two pointed ends and fly it!