Build Glider Prototypes: Taking Flight with the Wright Brothers

Warming Up

Review the photographs of aircraft from the past and the present below:

Aerodynamics is the way air moves around things. Rules of aerodynamics explain why airplanes, rockets, and kites are able to soar through the air. Study each aircraft photograph. What characteristics do all the aircraft share? How do they differ? What conclusions can you draw about how the shape of an aircraft helps it become more aerodynamic, or better able to move through the air?

This activity was funded by a Library of Congress Teaching with Primary Sources Grant.

Getting Started

Long before the Wright brothers could attempt powered flight, they had to build and develop an intricate knowledge of the principles of lift and drag. To experiment, they first built large kites. By 1900, they had developed enough knowledge to build and test a glider. A glider resembles a plane, but lacks an engine or any other propulsion device. It flies by being launched into a headwind or from a high elevation. The first glider the Wright brothers built in 1900 had a wingspan of 17 feet, a weight of 52 pounds, and was just over 11 feet long. While impressive to look at, it was a terrible failure in practice. However, the brothers were persistent and dedicated. They made careful notes about what worked and what did not; they were determined to come back the next year with a new and improved design. Unfortunately, the 1901 glider performed, in some ways, worse than the first. The brothers again consulted their data and tried again. Only in 1902 did they achieve the results they had hoped for. The following year they returned with a powered aircraft and made history.

Left rear view of glider in flight, Kitty Hawk, NC. 1911. LOC Prints and Photographs; http://www.loc.gov/pictures/item/2001696628/

As a member of their engineering support staff, you will be in charge of making some of the early calculations that will eventually be applied to the design of their later gliders. To do this, you will make and compare four model paper gliders. By adjusting some key variables in each model, you will have an opportunity to experience the same challenges that the Wright brothers faced in building their first glider in 1900. As you read their words describing their efforts to build a "flying machine," you will see how they followed the engineering design process, which closely follows the scientific method that is used in all valid scientific research. You will also follow this process as you construct and test your own gliders.

Real-World Topics

- All valid scientific and engineering investigations follow a specific process that can be repeated until a solution is found.
- The engineering design process is a way of thinking that allows you to solve simple and complex problems.

Readings

The following list of readings and sources should be used to complete the activity. Use the Research Note Taker to record bibliographical information about each source and important notes from each reading.

- Family Papers: Correspondence—Wright, Wilbur, 1900-1901 (images 2, 3, 5 and 20)
- Some Aeronautical Experiments From the Smithsonian Report for 1902 [Wilbur Wright, Government Printing Office]
- Chanute, Octave—Photographs, Kitty Hawk, North Carolina, Originals, 1901

This activity was funded by a Library of Congress Teaching with Primary Sources Grant.

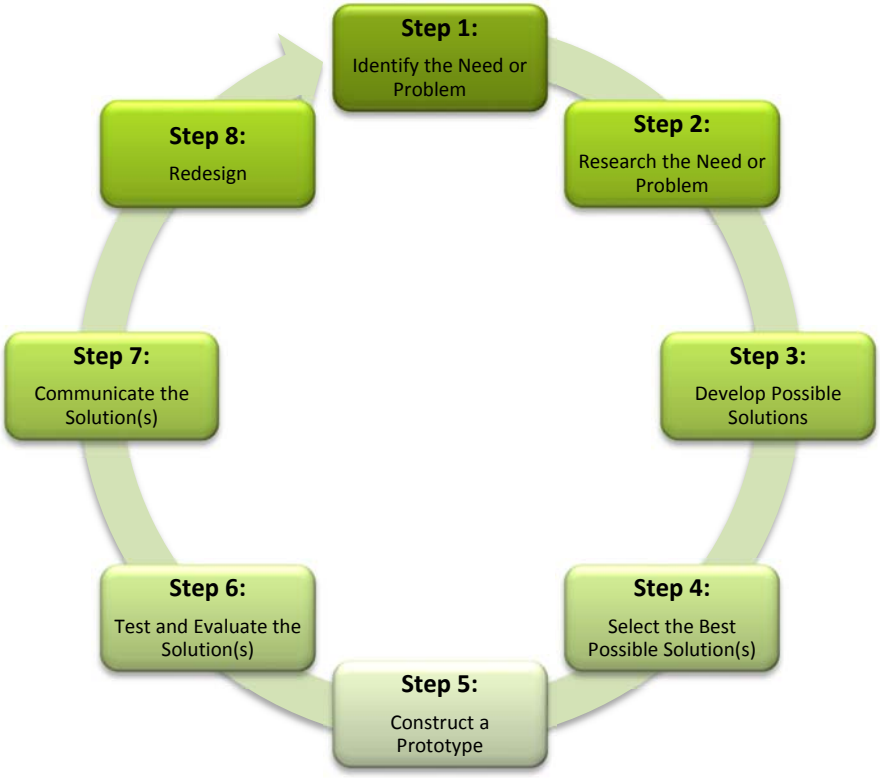
Glossary

- **drag:** the aerodynamic force that opposes an aircraft's motion through the air. Drag is a mechanical force created by the interaction and contact of a solid body with a fluid or gas. It is generated by every part of an airplane.
- **lift:** the mechanical force produced by the motion of the airplane moving through the air. It is the force that opposes the weight of an airplane and holds it in the air.

Building Background

Use the following graphic and table to gain a better understanding of the engineering design process.

The Engineering Design Process



Consulting the Historical Record

The Wright brothers' writings are full of examples of the engineering design process. As you read, identify the steps in how Wilbur Wright describes the sources of some of his ideas, or the explanations for his solutions to some of the problems they encountered in building their glider. Record examples of the engineering design process steps the brothers used in the Engineering Design Process Table. Record the phrases or sentences that match each step. You may not find examples of each step, but identify as many as you can.

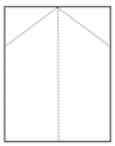
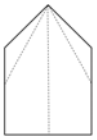
This activity was funded by a Library of Congress Teaching with Primary Sources Grant.

Activity: Build Glider Prototypes

It is 1899, the year before the Wright brothers test their first actual glider. As a member of their engineering team, your job is to collect data on what works and what does not. To do this, you will create four types of flying paper gliders. For this job, you will need the following materials:

- White printer paper (8.5 × 11 inches)
- Colored construction paper
- Scissors
- Ruler

Building a Glider Aircraft

1. Fold a piece of printer paper in half lengthwise. Use a ruler edge along the fold to sharpen the crease. Then, unfold the paper.	
2. Hold the creased paper lengthwise and fold down the top corners of the paper toward the crease. Once folded, the paper should resemble an arrow.	
3. Hold the folded paper lengthwise so that the arrow is pointing away from you. Then, fold from the right and the left so that the edges of the paper meet along the crease. The end result should be paper that resembles a sharper arrow.	
4. Now fold the paper in half lengthwise along the crease created in Step 1.	
5. Turn the folded paper 90°. Then, fold down each side to create wings. Make a wing crease that begins about 4 cm from the 'nose' of the glider (the pointed end) and runs roughly parallel with the folded crease made in Step 1.	
6. You should now have a 3-dimensional shape that resembles a glider or an airplane.	
7. Repeat the steps using a piece of construction paper.	

This activity was funded by a Library of Congress Teaching with Primary Sources Grant.

Testing Your Gliders

You should now have two paper gliders: one made of printer paper, the other made of construction paper. Follow the instructions below to test your gliders properly.

1. Find a Suitable Testing Location

Find an area large enough to fly your gliders. You want to have as few environmental variables as possible, so a large indoor location such as an empty gymnasium is best. However, anywhere with minimal wind will work.

2. Mark and Measure

Mark the testing location with tape or chalk. You should mark a launching location and mark off at least 15 feet from the launching line. Be sure to note on the tape or with chalk each foot of the measured distance.

3. Throwing Your Gliders

To throw your glider, hold it between your thumb and forefinger along the crease that runs from the back to the nose of the glider. Point the nose in the direction you plan to throw it. Be sure to keep a firm grip to keep the plane steady, but not so tight that it will be difficult to let it go.

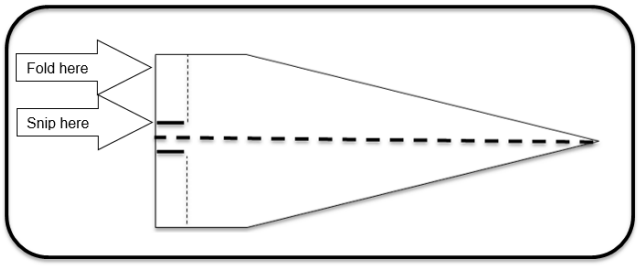
Then, with your elbow forming a 90° angle, swing your arm back and then forward, releasing the plane when your arm is fully extended. The motion is similar to throwing a dart or baseball. Be sure that your hand does not pass over the launching line. Consider holding your hand out toward the launching line so that you know exactly where to stand when throwing. Aim to use the same amount of force for each throw.

Test both gliders four times each and record your results on the Flight Record Sheet.

4. Adding Drag

Now you will modify both gliders to add drag. Once the modifications are made, you will effectively have two new gliders: one of printed paper with added drag and one of construction paper with added drag.

You can add drag by folding up the edge of the wings at the back of the glider. To perform this modification, make two 1-cm snips at the back of the glider on either side. Then, fold up the flaps made from the small cuts. The following diagram shows the glider from the top with the flaps made.



Be sure to record the results with drag on the Flight Record Sheet.

This activity was funded by a Library of Congress Teaching with Primary Sources Grant.

Analyzing the Data

Using the data you have collected, answer the following questions on the Glider Data and Analysis sheet.

1. Which glider material resulted in longer flight distances? What do you think is the reason for these results?

2. Did adding drag help or hinder the glider's flight? Why do you think adding drag had this result?

Thinking Deeper

Record your responses to the following questions on the Glider Data and Analysis sheet.

1. How were the flight problems that you encountered similar to those that the Wright brothers faced? What process did you find most effective in solving those problems?
2. Most people do not build gliders every day, but the process of solving a problem can be used in a number of ways. What common problems that you might face might be solved using the same thinking process as you did with your glider? Give some examples.
3. The Wright brothers tried to solve the problem of flight more than 100 years ago. Even so, they followed a process of problem-solving that is still effective today. Can you think of other examples throughout history where this approach to solving problems proved successful? Give some examples.

Reflect

Consider the following reflection prompts, and submit your answers in the form of a short essay or through class discussion:

> How did the use of primary documents help you better understand the significance of the accomplishments of the Wright brothers? What did the primary documents you researched reveal about how the Wright brothers used the engineering design process?

This activity was funded by a Library of Congress Teaching with Primary Sources Grant.