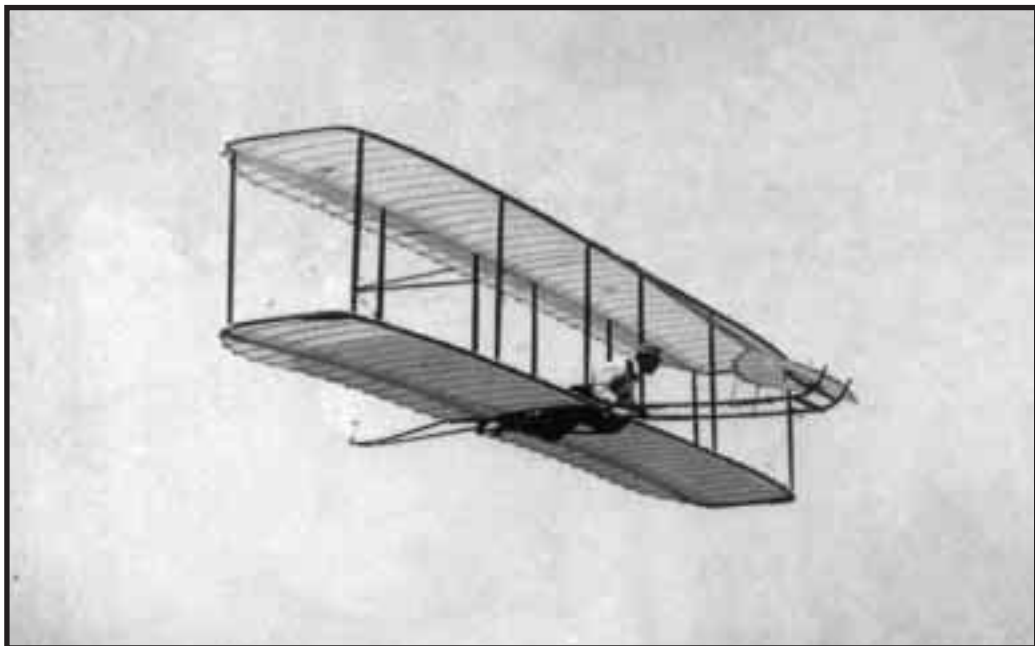




**Learning OnLine™**

# **The Wright Brothers and the Invention of Powered Flight**



**A Thematic Approach with Links to**

- *Science*
- *Social Studies*
- *Mathematics*
- *Language Arts*

**Eugene F. Provenzo, Jr.      Charles T. Mangrum II**

**CURRICULUM ASSOCIATES®, Inc.**

# Welcome to *Learning OnLine*<sup>™</sup>

*Learning OnLine* is a program that will help you learn how to use the Internet, a worldwide network of computers that communicate with one another. These computers are run by companies and corporations, schools, libraries, universities, and government agencies.

The World Wide Web, also called the Web or WWW, is a system that allows people to publish information on the Internet. Web sites, called “pages,” display text and colorful pictures, and include sound, video, and animation. You find these Web pages by using a software program called a “browser.” An important feature of the Web are its “hyperlinks,” which allow you to instantly connect to another Web site. Web sites could be as near as the computer next door or as far away as the other side of the world. The Web is a great way to find up-to-date information, check facts, and get different views on a subject.

Think of the Internet as a road map for finding information. Once connected, you are the navigator. By using your browser and the hyperlinks, you can access millions of pages on the Web. It’s up to you to decide where you want to go, what you want to see, and what you want to learn.

On the back cover, you will find a glossary of computer terms. Use this glossary if you come across a term that is unfamiliar to you.

## Online Safety

Because the Internet is so vast, it’s easy to get lost. It’s also easy to come across inappropriate sites. Here are some tips that will help to keep you safe while you are online.

- Use only your first name when you are posting notes or sending messages online.
- Never give out personal information, such as your address, telephone number, or the name and location of your school.
- If you come across information that makes you feel uncomfortable, tell your teacher or parents. Do not respond to any messages that make you feel uncomfortable.
- Do not agree to send a picture or anything else without first checking with your teacher or parents.
- Be polite and respect the people with whom you communicate on the Internet.

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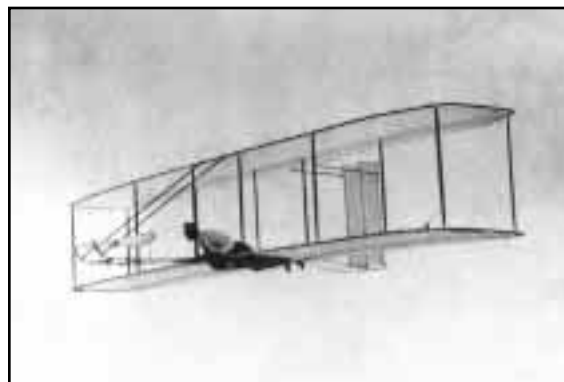


## Introduction to *The Wright Brothers and the Invention of Powered Flight*

For centuries, people had dreamed of flying through the air like a bird. Many people tried it and failed. Wilbur and Orville Wright achieved the dream of human flight. They developed the first machine ever to lift off the ground under its own power. This book is about the Wright brothers and the invention of the first powered aircraft.

Your tools for this exploration are the World Wide Web and the Internet. **Learning OnLine** will show you how to use these powerful electronic tools to learn about these two extraordinary Americans and one of the most important inventions of the twentieth century.

What do you know about each of these pictures? This book and the Web sites it will lead you to will help you learn more about the pictures.



## A Web Page

Here is a Web page as it would look on your computer screen if you were using the Netscape Navigator™ browser.

**Back button**—takes you to the previous page

**Forward button**—takes you forward to the next page

**Title of this Web site**

**Tool bar**

**Internet address of this site (URL)**

**Hyperlink button**—clicking on this will take you to a new site

**Hyperlink button**—clicking on this will take you to a new site

**Hyperlink button**—clicking on this will take you to a new site



## Connection to Social Studies

Click the hyperlink for *Connection to Social Studies* on *The Wright Brothers* page. The *Connection to Social Studies* page will appear. Click the hyperlink to go to the Web site that will help you answer each question.

1. Who was Otto Lilienthal? What type of aircraft did he fly? How many flights did he make? Why was he important to the Wright brothers?

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2. How were the Wright brothers able to make the first successful powered flight when so many others before them had failed? In what way did they follow the example of Lilienthal and Chanute?

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3. What did the Wright brothers do that inventors before them did not do? How do you think this may have helped mark their place in history?

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4. No newspaper reporters witnessed the first powered flights at Kitty Hawk. Why was there so little interest at first in the Wright brothers' achievement?

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## Photo Storybook

While Orville and Wilbur Wright were making history with their flying experiments, they were recording history with a camera. They took more than 300 pictures of their early experiments. They carefully recorded the date and other important information on the back of each picture. They studied the photographs and often discovered mistakes that they did not see while they were conducting the experiments.

Revisit some of the Web sites to find photographs that you can use to tell the story of the Wright brothers. Print out these photographs and mount each one on a separate piece of paper. Write the approximate date and a brief description on each photograph. Then assemble the photographs in a book that tells the story. Use one of the photographs for the cover of the book. Add a title and your name as the author.

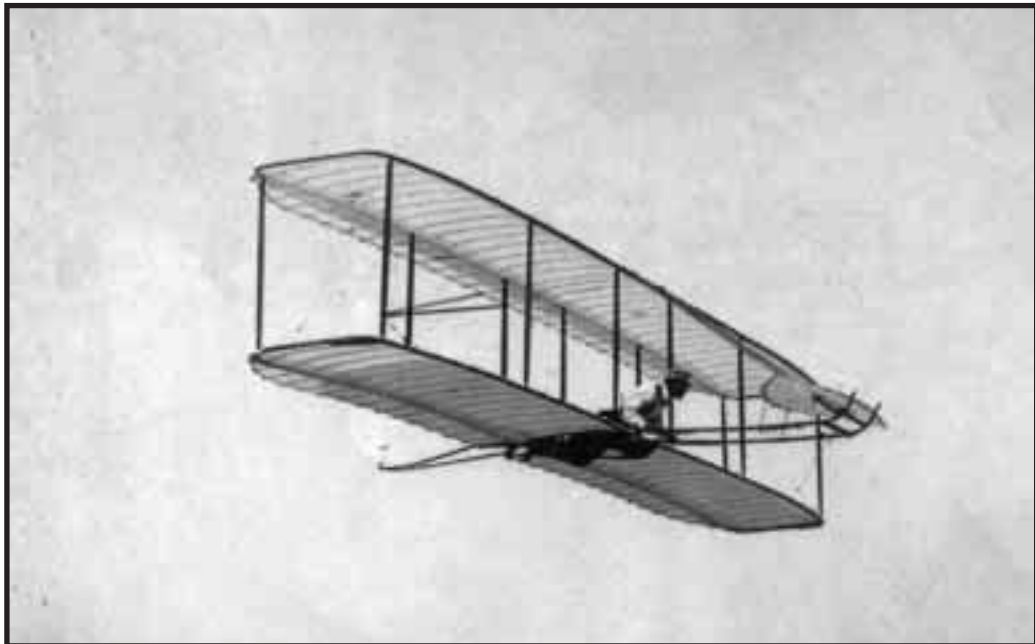
Here are some examples of photographs you might want to find.

- Wright family photographs
- The Wright brothers' family home
- The Wright brothers' bicycle shop in Dayton, Ohio
- The camp at Kitty Hawk
- An experimental glider
- The first powered flight at Kitty Hawk



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Search engines are programs designed to search the Internet for requested information. A search engine can be compared to a librarian, who suggests a list of possible books that relate to a particular topic and then helps to find the books. Each search engine has its own conventions for making queries. Some recommend using quotes around certain keywords in order to make a more precise query, thus yielding fewer matches. Others recommend using the plus and minus symbols.

Most search engines are available on the Web. Several of the most popular engines and their addresses are listed below.

Alta Vista	<a href="http://www.altavista.com">http://www.altavista.com</a>
Yahoo	<a href="http://www.yahoo.com">http://www.yahoo.com</a>
Lycos	<a href="http://www.lycos.com">http://www.lycos.com</a>
Web Crawler	<a href="http://www.webcrawler.com">http://www.webcrawler.com</a>
Excite	<a href="http://www.excite.com">http://www.excite.com</a>
HotBot	<a href="http://www.hotbot.com">http://www.hotbot.com</a>

Remind students that because anyone can have a Web site, they will find that some sites are more accurate, helpful, and well written than others. Help students develop criteria to determine the accuracy and usefulness of the information they find at different sites. A reproducible rating sheet is provided on page 17 of this teacher guide. Completing this form as they encounter new sites will encourage students to think critically about the information they find.

## ***Introduction to The Wright Brothers and the Invention of Powered Flight***

In December 1903, one of the greatest moments in aviation history took place on a cold and windy beach in Kitty Hawk, North Carolina. The flying machine that Orville and Wilbur Wright had built carried Orville into the air, marking the first time in history that a human had made a controlled, sustained, and powered flight. Though the flight lasted only 20 seconds and traveled only 120 feet, the event was a historic milestone. The age-old dream of flying had become reality.

As students progress through the student book, they will learn about the Wright brothers' experiments with flight that led to this historic moment. Students will access the Web sites to complete the activities in the student book. As they do, they will learn that the discoveries the Wright brothers made were not accidental but the result of systematic experiments, hard work, and perseverance. Students will gain an appreciation for this important milestone in history and for the efforts and courage of two brothers who gave birth to the Age of Flight.

## **The Wright Brothers—A Historical Look**

More than 500 years ago, Leonardo da Vinci, one of history's great thinkers and inventors, thought that humans could fly like birds. Observing that eagles supported themselves by beating their wings against the air, Leonardo was convinced that humans could overcome the resistance of air if they used nature as their guide. He analyzed birds in flight and used his findings to draw detailed sketches of several heavier-than-air flying machines.



For hundreds of years after Leonardo, people dreamed of the possibility of human-controlled flight. Artists illustrated humans flying; writers wrote books about human flight. Some people actually attempted to fly by strapping on a pair of wings and flapping their arms.

With time, experimenters gave up the idea of human-controlled flight and turned their thoughts toward developing a successful flying machine. By the turn of the nineteenth century, dozens of experimenters were working toward this goal. Many of these early experimenters, however, lacked the understanding of the basics of flight. What would it take to overcome the natural forces of gravity and air resistance and launch a human-powered airplane?

The Wright brothers built on the findings of others. They read everything they could find on the subject of flight. Beginning with gliders, which they flew like kites, they experimented with wing shape and methods of controlling their gliders while in the air. Eventually they built larger gliders that could carry a person. They kept careful records, and after testing hundreds of wing designs in a six-foot wind tunnel, they discovered the key to lifting power—the curved shape of a wing's cross section.

After more than a thousand glider flights and countless hours of experiments, the Wright brothers became experienced pilots. The next step was powered flight. On December 17, 1903, they were ready to test their first powered flying machine. Orville became the first person in history to take off in a machine raising itself into the air by its own power, flying without a reduction of speed, and landing at a point as high as that from which it started. For the first time, the elements of aviation—pilot, power, control, and sustained flight—had been combined.

The Wright brothers' accomplishment did not immediately capture the public's attention. There was little newspaper coverage. It would take several years for people to fully understand the importance of achieving powered flight.

The *Wright Flyer I* was very fragile, built primarily of balsa wood, cloth, and wire. It still couldn't be called a practical invention. The Wright brothers had to prove that their aircraft was capable of more than brief flights in a straight line. They built a stronger *Flyer* with a more powerful motor. The brothers flew the *Wright Flyer II* for the first time in May 1904, with only a few friends and neighbors as witnesses. The *Wright Flyer III* was the next improved model. In 1905, the brothers completed more than 40 successful flights, spending more than 5 hours in the air. That same year, Wilbur circled the field 30 times in 39 minutes, covering a distance of about  $24\frac{1}{2}$  miles.

Some experts consider the Wright brothers' development of the combined wing-warping and rudder action the most important invention in the history of heavier-than-air craft. Once the Wright brothers received their patent for this invention in 1905, the details became public, and other inventors went to work copying their discoveries and developing airplanes as effective as the *Wright Flyer*.



Other historic flights followed, including a 125-mile trip in 1909 at a speed of 40 miles per hour. On October 4, 1909, Wilbur's 20-mile flight up the Hudson River was witnessed by a million New Yorkers, very few of whom had ever before seen an airplane fly. Bells, whistles, and foghorns from boats and ships on the river saluted the aviator hero.

Wilbur and Orville continued to make refinements to their *Flyers*. They added landing wheels and moved the elevator to the back of the airplane to achieve better control. They began to supply military planes to the United States government. In 1909, they established a company in Dayton, Ohio, to manufacture *Wright Flyers*.

In the years following that first historic flight, aviation developed at an incredibly rapid pace. But the Wright brothers had paved the way by solving the problems that had puzzled scientists and engineers for generations. Wilbur and Orville Wright had launched the era of aviation.

## Teaching Suggestions

Listed below are suggested answers to the questions in the student book. To help students understand how the Internet works, you might compare the Web site to a book and the hyperlinks to the book's index. Just as the index will take them to a particular page, the hyperlink takes them to a page in the Web site. Students can use the forward and back buttons to take them to other pages in the site, as well as the home page button on the tool bar or at the end of the site document to take them to the site's home page. For additional hints about how to use the Web, students can click on "Tips for Researching on the Web" on the *Learning OnLine* home page.

### Questions for Beginning Your Exploration—Page 6

1. Wilbur and Orville became interested in flying after their father gave them a toy helicopter. They also observed birds in flight and built and flew kites.
2. In 1899, Wilbur wrote to the Smithsonian Institution for information on aeronautical research. He read everything he could find about the topic of flight.
3. The Wright brothers first built a biplane glider. It weighed 50 pounds.
4. The Wright brothers tested their flying machine at Kitty Hawk, North Carolina. They decided on this location because of the strong, steady wind. The weather bureau had suggested the sand dunes of Kitty Hawk as a good site.
5. The Wright brothers built the 1903 *Wright Flyer* at their bicycle shop in Dayton, Ohio. They sent it by train to Kitty Hawk for its flight trials.
6. On December 17, 1903, Orville Wright made the first controlled, sustained, and powered flight in history. The airplane flew 120 feet in 20 seconds.
7. The longest flight of the day was 852 feet in 59 seconds. Wilbur was the pilot of this flight.



jetliner, the Boeing 747 jumbojet. Each decade during that 70-year span saw the development of a newer and faster airplane. Students will use the information on the Web site to determine how long it would take to travel from Kitty Hawk, North Carolina, to San Francisco, California, in each of 6 different aircraft. (They should not take into account the time it would take for refueling.)

On a map of the United States, show students the location of Kitty Hawk and San Francisco. Provide students with an example of how to use the formula  $t = \frac{d}{r}$  to find time. (If a car is traveling at a rate of 50 mph, how many hours would it take to travel 100 miles?  $t = 100 \text{ m} \div 50 \text{ mph} \quad t = 2 \text{ hr}$ )

### Airplanes Then and Now

Airplane	Date	Distance (From Kitty Hawk to San Francisco)	Rate (approximate speed)	Flying Time (approximate in hours)
Wright Flyer	1903	3,000 m	30 mph	100 hr (4 days)
Curtiss NC-4	1919	3,000 m	90 mph	33 hr (1½ days)
Ryan NYP Monoplane	1927	3,000 m	110 mph	27 hr (1 day+)
Gee Bee R-1	1932	3,000 m	250 mph	12 hr (½ day)
Bell XP-59-A	1943	3,000 m	410 mph	7 hr
Boeing 747 Jumbojet	1969	3,000 m	630 mph	5 hr

### Connection to Social Studies—Page 9

1. Otto Lilienthal was a German engineer who made over 2,500 successful glider flights. The Wright brothers studied his book of aerodynamic data that was published in 1889 and used it as a guide for the design of their gliders.
2. The Wright brothers learned from the successes and failures of those who came before them. They studied carefully what others had done and read everything they could about the findings of other experimenters. They followed the example of Lilienthal and Chanute by experimenting with a glider first. After they solved the problems of gliding flight, they took on the challenge of building a powered machine.
3. The Wright brothers took more than 300 glass-plate photographs of their early experiments with gliders and powered flyers. Aware of the historical importance of their invention, the brothers wanted to leave a detailed pictorial record of their work.
4. The press did not see any news value in a flight that lasted less than a minute. In addition, a local reporter gave an inaccurate report of the details, saying that the *Wright Flyer* was a huge two-propeller machine and that it had traveled a distance of three miles. Because there were so many different accounts of the event, people began to doubt that it had even occurred. The Wright brothers were also reluctant to share some of the details of their invention for fear that they would be copied before they received their patent.



## Connection to Language Arts—Page 10

Encourage students to revisit some of the Web sites they have seen thus far to gather more information for their journal article. Remind them that a journal is similar to a diary. The journal that the Wright brothers kept of their experiments proved invaluable to them as they continued their experiments over a period of years.

One of the sites that students access while completing the activities in the student book is a description of the first flight in Orville Wright's own words. You might suggest that students read this description. Ask students what they might learn from a personal journal article that they might not learn from a secondhand point of view.

## Photo Storybook—Page 11

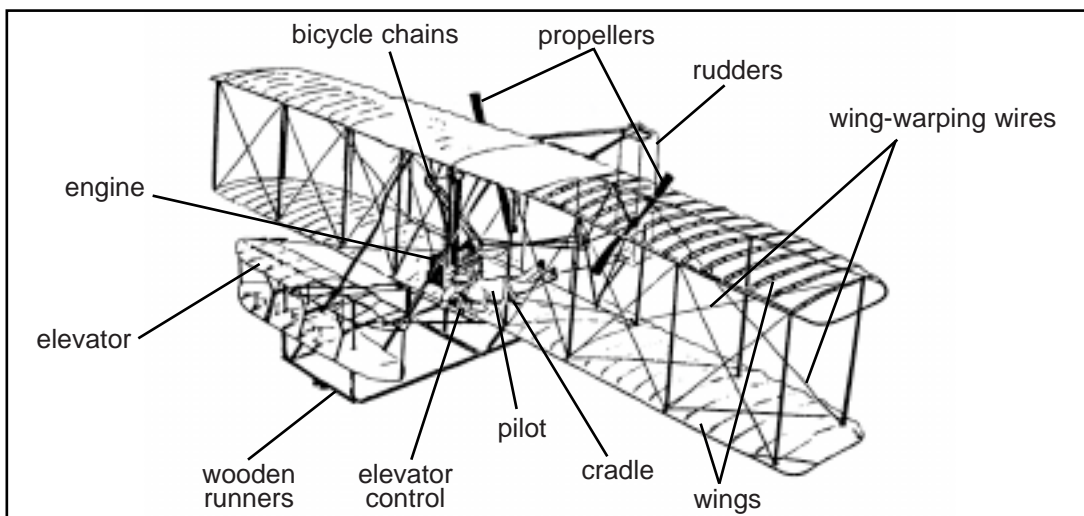
The Wright brothers were aware of the historical importance of documenting their experiments. They photographed each phase of their experiments, including their early gliders. These photographs are part of the legacy that the Wright brothers left.

The Wright brothers left behind more than 300 glass-plate negatives and hundreds of prints. The original glass-plate negatives have been donated to the Prints and Photographs Division of the Library of Congress.

Many of the sites that students visited while completing the activities in their student book contain photographs taken by the Wright brothers. One of the sites contains all 301 of the available Wright brothers prints.

## The 1903 *Wright Flyer*—Page 12

Students are asked to use the description of the 1903 *Wright Flyer* to label the diagram. As an additional activity, you might ask students to write an explanatory paragraph about how the *Wright Flyer* worked. Their paragraph should explain the function of various airplane parts and how the airplane overcame gravity and air resistance. Remind them to refer to the glossary at the back of their student book.





- Assign one group of students to investigate how flight occurs in propeller-driven planes. Have a second group investigate jet-powered flight. Have the groups compare these two forms of powered flight.

## Mathematics

- Have students go to a large open area, such as an athletic field, and measure the distance of the Wright brothers' first and fourth flights. Their first flight was 120 feet, and their fourth flight was 852 feet. Have them compare the wingspan of the Boeing 747 jumbojet with the length of the Wright brothers' first flight. (*The Web site for "Connection to Mathematics" states that the wingspan of the 747 is 195 feet.*)
- Charles Lindbergh made the first solo transatlantic flight in 1927. He traveled approximately 3,000 miles in 33 hours. Have students calculate his average speed. (*approximately 90 mph*) Assuming they had enough fuel, how long would the same trip have taken the Wright brothers in their 1903 Wright Flyer? (*The Web site for "Connection to Mathematics" states that the Wright Flyer had a speed of 31 mph. It would take the Wright brothers approximately 97 hours, or 4 days, to cross the Atlantic Ocean.*)
- Have students use the information they found on the Web site for "Connection to Mathematics" to make a bar graph showing the distance each plane could travel in one hour.

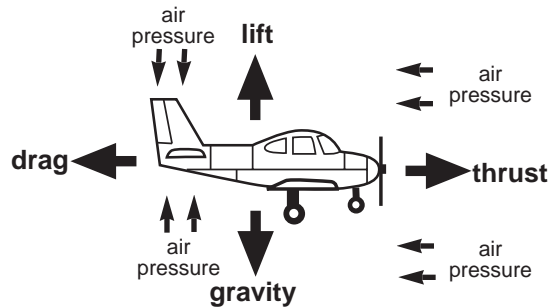
## Social Studies

- Have students research Leonardo da Vinci and his designs for a parachute, helicopter, and ornithopter (*a flapping-wing machine*). How did he influence the development of flight? Why are the sketches he drew in the fifteenth century remarkable? Would he have been successful if he had tried to build a flying machine? (*The materials available at the time were too heavy to be used in an aircraft.*)
- Have students trace the advances in flight, beginning with Leonardo da Vinci and continuing through experiments with hot air balloons, gliders, and finally, powered aircraft. Who were the leaders in flight experimentation? What were some of the successes and failures? What were the limitations of the experimental craft? Have students make a time line of the developments in aviation.
- Have students research the effect that aviation had on warfare. What contribution did the Wright brothers make? (*The Wright brothers paved the way for military aviation. The Wright military Flyer of 1909 was an improved version of the original Flyer. It had an extra seat for an observer or gunner and performed successful weapon firing trials.*)
- Have students research the advances in the field of aviation that took place while Orville Wright was alive. (*He died in 1948.*) Examples include airmail service in 1918, the first nonstop transcontinental flight in 1923, the first round-the-world flight in 1924, the first polar flight in 1926, and the first nonstop flight across the Atlantic Ocean in 1927. Ask students how they think Orville Wright reacted to these advances.



Ask students to describe a bird as it dives through the air to catch its prey. Folding back its wings makes it more streamlined, cutting down friction. The more streamlined something is, the faster it can move. Have students describe the shape of a high-speed plane or jet.

- Have students research Isaac Newton's Laws of Motion and their importance in airplane design. As a basic explanation, draw the following diagram on the chalkboard.



Use the diagram to explain to students that the Wright brothers had to devise a way to combat the forces of friction, or drag, and gravity. For a plane to get into the air and keep flying, thrust and lift must exert more force than gravity and drag. Thrust is the force of the engine, which propels the plane upward and forward faster

than gravity and drag can pull it down. The air itself supplies lift.

- Have students perform some basic experiments with lift, drag, thrust, and gravity. Many books on flight provide experiments. (See *Resources*, teacher guide p.14.)
- Discuss the concept of "form follows function." Show students some examples of objects whose form, or shape, fits their use, such as a spoon, Frisbee, wheel, and doorknob. Have students think of other examples. How did this concept apply to the design of the Wright brothers' aircraft, particularly the shape of the wings?
- Have students investigate the advances in aviation since the Wright brothers. Examples include airports and runways, gyrocompass, gyroscope, altimeter, airspeed indicator, radio navigation system, radar, and automatic pilot.
- Have students use materials such as stiff paper, drinking straws, balsa wood, and Styrofoam to construct their own airplanes. Have them include ailerons, a rudder, and an elevator in their design. Have an aircraft competition in which students compete in categories such as distance flown and length of time in the air.
- Nature has designed the seeds of some plants to be carried through the air. Have students study different types of airborne seeds, such as those of the dandelion or of the maple or sycamore tree. How are they designed so that they remain airborne? Have students design some of their own human-made seeds out of lightweight materials. Have them test their seeds and compare them to nature's seeds by dropping them in a current of air produced by an electric fan.

