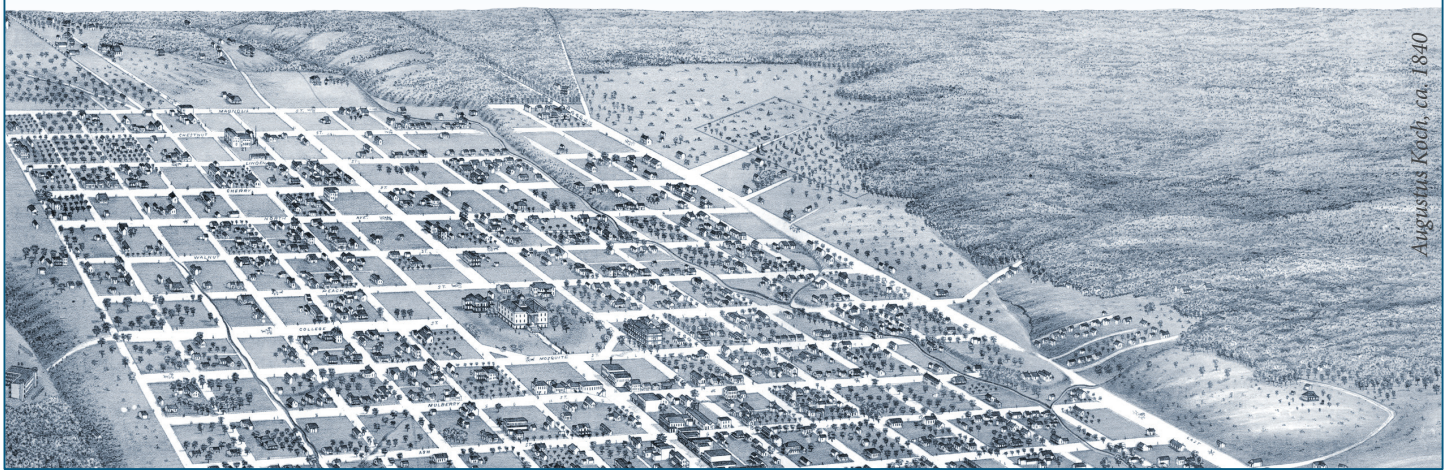
THE BOB BULLOCK TEXAS STATE HISTORY MUSEUM

TANGO ★ ALPHA ★ CHARLIE

Texas Aviation Celebration

Educator Guide



Augustus Koch, ca. 1840

A Note from the Head of Education

Dear Educator,

This Educator Guide is the product of three years of exhibition, program and curriculum development culminating with the *Tango Alpha Charlie: Texas Aviation Celebration* special exhibit. The exhibit is on view at the Museum between September 12, 2010 - January 9, 2011.

We have written and designed this guide to be easily adapted to the diverse needs of educators and their students. Our goals were three fold: The first was to create a guide that worked hand-in-hand with the exhibit, and that would be a stand-alone resource to educators long after the close of the exhibit at the Museum. Second we wanted the guide to focus on Science, Technology, Engineering, and Math (STEM) curriculums. Third the guide had to be aligned with current Texas Essential Knowledge Skills (TEKS). To fully accomplish our goals we developed the guide around one primary learning objective: the design process, with particular emphasis on

1. The development and general knowledge about flight
2. How technology develops and changes over time
3. The physical principals of flight
4. The roll of imagination, creativity, and trial and error

This interdisciplinary guide is divided into three sections. **About the Guide** provides teachers with the information necessary to get the most out of the resource materials. **The Lessons** includes 11 distinct lesson plans. **Assessment and TEKS** provide educators additional information needed for planning. In addition to the guide, a *Student Flight Log Book*, that corresponds with the lessons has been created for use in the exhibit.

Museum Visit
To complement any of these activities, we recommend you visit the *Tango Alpha Charlie: Texas Aviation Celebration* exhibit, and or the Museum's third floor exhibits. Please visit our website for up to date information on programs and educator activities related to aviation.

Feedback
We are interested in receiving your feedback about this guide. What works? What would you improve? What did your students learn? Your comments will help us improve our future guides. Send us an email at education@thestoryoftexas.com and please put in the subject line: "Aviation Resource Guide feedback" We look forward to hearing from you.

Sincerely,

Catherine Kenyon
Head of Education
The Bob Bullock Texas State History Museum

A Note from the Curator

The exhibit Tango Alpha Charlie: Texas Aviation Celebration upon which this curriculum is based highlights the major achievements of Texas aviators, many of whom set numerous U.S. national and world aviation records, including notable world record "firsts," during the years 1910 to 2010. The people in this exhibit developed new technologies and revolutionized air travel. They established several of the country's major airports, airlines, manufactured and designed extraordinary aircraft, raced across America, circumnavigated the world, and traveled in space. The exhibit shows how pivotal Texas has been in military training, aircraft manufacturing during wartime, in defending national interests in peace time, as well as in providing services for the agricultural industry, commercial, military, and general aviation.

This guide is based on extensive archival research at the McDermott Library of the University of Texas at Dallas, National Archives in College Park, Maryland, National Air and Space Museum, Manuscript Division of the Library of Congress, Center for Southwest Research at the University of New Mexico, C.R. Smith American Airlines Museum, Frontiers of Flight Museum in Dallas, No. 1 British Flying Training School Museum at Terrell, Stanzel Model Aircraft Museum, Texas Air Museum in San Antonio, Lone Star Museum in Galveston, Johnson Space Center in Houston, and public libraries in Dallas, Austin, and Houston. Over the course of the year, I interviewed dozens of individuals, including B-24 World War II pilots and bombardiers, Women Air Force Service Pilots, aeronautical engineers, the first woman airline pilot hired by American Airlines, a Vought test pilot, and the children of several individuals who were responsible for world record "firsts," such as the designer of the first composite aircraft in the world. I toured the Johnson Space Center in Houston, where I visited the original Mission Control room and sat in the seat of the Director of Mission Control that took us to the moon in 1969, and crawled through the mock up training modules for the International Space Station and the Space Shuttle. I also watched the Space Shuttle Atlantis mission STS-129 take off from Kennedy Space Center. I visited the production lines of aircraft factories, including Air Tractor, Mooney, Bell Helicoper, American Eurocopter, Vought, and Lockheed Martin. By visiting these locations first hand, I gathered a far greater appreciation and understanding for the history of air and space in Texas since 1910.

My goal is to impart new knowledge about the dynamic role Texas has played and continues to play in the history of aviation and the aeronautical industry. This educator's guide is specifically designed to enhance the learning experiences of students by engaging their interests in the subject and providing them with some of the basic skills necessary to become aviators or at least aviation enthusiasts. Texas aviators, airplane designers, and manufacturers were clearly passionate about aviation. Hopefully, many of your students will realize the importance of developing a real passion in life, whether it be aviation or another subject.

Barbara Ganson, Ph.D. (University of Texas, 1994)
Curator

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Texas Aviation Celebration

Getting Started

First flight of Wright Brothers at Kitty Hawk, North Carolina, December 17, 1903.
Courtesy Library of Congress, LC-DIG-ppprs-00626, Washington, DC

About the Educator Guide

The *Tango Alpha Charlie: Texas Aviation Celebration* Educator Guide provides eleven interdisciplinary lessons to facilitate student learning about the history of aviation in Texas. Each lesson is based on a theme that corresponds with a section of the *Tango Alpha Charlie: Texas Aviation Celebration* special exhibit, showing between September 2010 and January 2011 in the Albert and Ethel Herzstein Hall of Special Exhibitions at The Bob Bullock Texas State History Museum. While participating in real-world, hands-on lessons, students build science background, apply mathematical thinking and skills, solve design challenges, research the people and advancements important in aviation history, and create multi-media presentations to share new learning. The Educator Guide is designed for teachers to use even when the exhibit is no longer on display. Each lesson includes:

Set the Stage:
Presents a brief description of the people, groups, and companies who contributed to the discoveries and advancements in Texas aviation history. Their stories provide the background for the lessons.

Overview:
Summarizes student activities and learning that occurs during the lesson.

Objectives:
Identifies the knowledge and skills students are expected to learn during the lesson.

Guiding Questions:
Poses questions for students to think about and discuss as they work through the lesson activities.

Vocabulary:
Identifies the terms and meanings that are important for students to know and understand.

Materials:
Identifies materials students and teachers need to complete each stage of the lesson.

Suggested Literature:
Identifies books that support lesson content.

Texas on the Web:
Lists the web sites that are incorporated throughout the lesson.

Lesson Procedure:

Engage Students:
Students participate in an activity to determine their current understanding of the lesson content. The teacher engages students' interests to build background knowledge and prepare them for future learning experiences in the classroom and at the Museum.

Explore in the Classroom:
Students participate in hands-on activities to explore concepts and build new learning. Students may collect and analyze data, apply critical thinking and problem solving skills, ask questions, and discover answers to their questions. Together, the teacher and students share their experiences, clarify new learning, and identify and define vocabulary.

Several activities are included to accommodate grades K-12. Each activity is identified by a suggested range of grade levels. Because the concepts and skills progress in complexity with each activity, teachers may teach one or several of the *Explore in the Classroom* activities.

Extend Student Learning:
Students extend their learning to new situations in Science and Math, and in Social Studies, and Language Arts.

Science and Math – Students participate in design challenges, research topics further, and create presentations that leads them to investigate the science and math behind lesson concepts.

Social Studies and Language Arts – Students research the lives and events that are important in the history of Texas aviation and then create a variety of multimedia presentations to share their learning.

Suggestions for using the guide:

- Teachers may choose to teach all or part of each lesson, or cover the lessons that are most relevant to their grade level curriculum standards.
- After completing the *Explore in the Classroom* portion of the lessons, students select any of the extensions to complete based on their areas of interest. The class then conducts an Aviation Fair to present their projects.

Correlation to State Standards:

All lessons are aligned with the Texas Essential Knowledge and Skills (TEKS). Teachers reference grade level objectives in the *Texas Ties to the TEKS* section of the guide.

Design Process Diagram

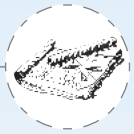
The design challenges that are incorporated into the lessons allow students to work through an engineering design process to solve real world problems. The flow chart outlines the steps students will follow to develop solutions to the design challenges included in the educator guide.

STEP 1

Identify the Problem
Identify a problem that needs solving.

STEP 2

Design
Design a solution to the problem. Use graph paper to create a 2-dimensional, labeled diagram of the working model.



STEP 3

Build
Build a working model using the design. The plan for the solution may change as design issues arise.

STEP 4

Test
Test the working model, making note of the modifications that need to be made to improve the design.

STEP 5

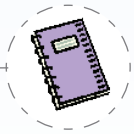
Revise
Revise and improve the working model based on the outcome of the test.

STEP 6

Present
Present and demonstrate the design solution to the class. Answer questions from teachers and other students.

STEP 7

Evaluate
Complete a written evaluation, including what was successful about the solution, how to improve it further, and what was learned from the experience.



Lesson Summary

Lesson	Engage Students	Explore in the Classroom	Extend Science and Math	Extend Social Studies
Aviation Takes Off 1910 – 1911	• Complete *Can it Fly? Cards* • Observe and compare designs of early airplanes	• Investigate air and flight • Investigate wings and flight • Investigate forces of flight	• Design Challenge - Design and test an airplane that can stay in flight the longest	• Write and present an aviator interview
World War I and the Stinson Family 1910s	• Match the parts of an airplane to a corresponding diagram	• Simulate pitch, yaw, and roll with movement and web sites • Use PowerPoint to create an animated airplane that demonstrates controls	• Design Challenge - Modify a paper airplane by adding ailerons, elevators, and flaps to control where it lands	• Create a scrapbook showing the major events of Katherine Stinson's life
Barnstormers	• True/False • Observe and discuss an advertisement	• Build an airplane that can complete stunts • Participate in a class Air Circus	• Research a modern day stunt or extreme activity • Dress as the person performing the activity and give an oral presentation	• Create and present a Barnstormer News Report based on Bessie Coleman or Ormer Locklear
Record Setters 1930s	• Make observations and inferences about image of Wiley Post in pressure suit	• Use a map to locate paths of record setters • Demonstrate air pressure using a milk carton • Complete the *Altitude Cards*	• Research the development of the pressure suit and create a timeline showing designs, materials, and functions	• Write a newspaper article describing the details of one of the record setting flights
World War II 1940s	• WASP video and discussion	• Teach a skill to a partner • Identify geography and climate of Texas training fields	• Research WWII airplanes and create a poster displaying and explaining the different aircraft	• Create a PhotoStory documentary about a WWII group
Cold War 1950-1970s	• B-36 bomber. How was it different from other airplanes?	• Test two airplanes that have different sized-wings • Construct and test an airplane using two different sized wings	• Design Challenge – Build the largest airplane that will stay in flight the longest	• Make a B-36 mobile containing information about the airplane's history, structure, roles, and records
1980s, 1990s, and Today	• Students discuss uses of helicopters and airplanes • Complete a class Venn diagram comparing a helicopter and an airplane	• Complete the *Parts of a Helicopter Diagram* • Create and test a helicopter and identify lift • Complete the *Around the World Cards*	• Research how a helicopter flies, create a multimedia presentation, and demonstrate with a remote controlled helicopter	• Develop a proposal for a flight around the world • Create a display showing map of path, stopping points, mileage, and distance

Lesson Summary

Early 1930s and World War II Manufacturers	• Blindfolded students follow a partner's directions to travel through an obstacle course • Students draw a picture based on a partner's directions	• Take a flight using *Google Earth Flight Simulator* • View a video of women manufacturing airplanes during World War II	• Create a manufacturing company that will produce aircraft to supply to students in another classroom	• Create a video interview simulating a woman who has worked in an aircraft factory during World War II
Today's Manufacturers	• Create a Venn diagram comparing tilt rotor and rotary aircraft	• Read an online story about rotor aircraft • Participate in a card match to identify the different jobs the helicopters perform • Play a helicopter flight simulation game	• Build a model of a Eurocopter from a design	• After researching aircraft manufacturing companies in Texas, design a new company, and create a brochure to advertise the aircraft and services that it provides
Materials of Flight	• Demonstrate how strong a piece of paper can be when shaped into a cylinder	• Test different materials for strength to determine which one would make the best flying disc • Visit *NASA's Future Flight Design: Materials* to learn about materials used to build aircraft over time. • Build a jet engine online	• Design and build a scale model of an aircraft, and develop a sales plan for its construction	• Create a labeled diagram of an aircraft built with composite materials and a graphic organizer identifying the advantages and disadvantages of using composite materials in aircraft. • Participate in a debate
Commercial Airlines	• Compare advertisements for commercial airlines from the past and present	• Learn the aviation alphabet and practice using with partners • Match pictures of flight attendants with the decades they represent. Discuss how their role has changed over time	• Create a flight plan from a destination in Texas to another state	• Locate the nearest airport and find out about its services and operations. Create an Airport Guide for a first-time flyer

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Texas Aviation Celebration

Lesson Plans

WASPs check their map prior to flight,
Avenger Field, Sweetwater, Texas, August 1943.
Courtesy Texas Women's University, Denton

Aviation Takes Off 1910 – 1911

Set the Stage

On December 17, 1903, the **Wright Brothers** flew the first powered, heavier-than-air machine at Kitty Hawk, North Carolina. The successful airplanes that future aviators piloted, all incorporated design elements of the 1903 Wright Flyer.

Louis Paulhan was a French pilot who taught himself to fly in 1908. He competed in races and set many records, including being the first person to fly a powered, heavier-than-air machine in Texas in 1910.

Benjamin Foulois is considered the "father of U.S. military aviation" because he was the first United States officer assigned to pilot a military airplane, which was purchased from the Wright Brothers. In 1916 Foulois and two other officers made the first reconnaissance flight by the U.S. military over foreign territory. Foulois was also responsible for locating a permanent site for organizing, training, and operating new air units. The site he chose was located in San Antonio and eventually became Kelly Air Force Base.

After witnessing Louis Paulhan's first airplane flight, **L.L. Walker** set out to build and fly his own aircraft. Walker barnstormed around Texas, entertaining crowds. During World War I, he trained military pilots to fly at locations throughout Texas and the United States.

Overview:
Students observe and compare designs of early airplanes and then explore the properties of air to understand its importance in flight. Students investigate lift, thrust, weight, and drag, and then apply new learning to design, build, and test their own paper airplane. After learning about early aviators, students write and present an interview to share what flying an airplane in the early 1900s might have been like.

Objectives:
- Students conduct tests to determine that air is matter, has mass, and takes up space
- Students complete an investigation to determine how lift, thrust, weight, and drag are important to flight
- Students compare the designs of airplanes and research aviators from the 1900s to understand the contributions of individuals to advancements in aviation
- Using problem-solving and critical thinking skills, students complete a design challenge to build a paper airplane that will fly in the air the longest

Guiding Questions:
- What is air?
- How do airplanes fly?
- How have early aviators impacted aviation today?

Materials:

Engage
- *Can it Fly? Cards* (1 set per group of 2 to 3 students)
- Chart paper
- Early Flight Images

Explore in the Classroom
- *Air and Flight Student Page*
- *Air Pressure and Flight Student Page*
- 1 strip of paper per student
- 1 legal-sized piece of paper per student
- *Wings and Flight Transparency*
- *Forces of Flight Student Page*
- 1 paper plate per group or station
- Clay for each group or station
- 2 boxes

Extend Student Learning
- *Design Process Diagram*
- Design Challenge Design a Paper Airplane
- Basic Airplane Templates
- Paper for paper airplanes
- Graph paper
- Small paperclips
- Stopwatch
- Outside area

Vocabulary:

Air pressure	Particles of air pressing down on the Earth's surface
Airfoil	A special shape that helps create lift
Drag	The air resistance that is caused when air molecules bounce off an object; opposes the motion of the object
Flight	The ability to fly
Force	A push or a pull
Lift	The upward force that causes an object to fly
Mass	The amount of matter something contains
Matter	Anything that has mass and takes up space
Weight	The measure of the force of Earth's gravity on something

Literature
The Story of Flight by Judith E. Rinard

Texas Aviation on the Web
Refer to the following web sites during the lesson and to extend learning.

Wright Brothers First Flight
youtube.com/watch?v=A-CvkEUSAO4

First Flight
youtube.com/watch?v=1mQjXUiINh4&feature=related

NASA Future Flight Design Center
futureflight.arc.nasa.gov/map.html

NASA Future Flight Design Center: Lift
futureflight.arc.nasa.gov/aeroLift.html

NASA Future of Flight Design Center: Drag
futureflight.arc.nasa.gov/aeroDrag.html

NASA Future of Flight Design Center: Weight
futureflight.arc.nasa.gov/aeroWeight.html

NASA Future of Flight Design Center: Thrust
futureflight.arc.nasa.gov/aeroThrust.html

NASA Future of Flight Design Center: Forces
futureflight.arc.nasa.gov/aeroForces.html

NASA: How do Planes Fly?
nasa.gov/audience/forstudents/k-4/stories/ames-how-planes-fly-slideshow.html

PBS: The Wright Flyer

Amazing Paper Airplanes
amazingpaperairplanes.com

Fun Paper Airplanes
funpaperairplanes.com/Plane%20Downloads.html

10 Paper Airplanes
10paperairplanes.com

Early Flight in San Antonio video
texancultures.com/education/aviationvideopage.html

Benjamin Foulois
earlyaviators.com/efoulois.htm

Louis Paulhan
earlyaviators.com/epaulhan.htm

L. L. Walker
1940airterminal.org/history/galleries/historical/FirstFlightInTexas

Lesson Procedure:

Engage Students

1. Copy the *Can it Fly? Cards* for groups of two to three students. Each group places the things they think can fly in one column and the things they think cannot fly in another column.

2. Discuss answers as a class. Students' answers will vary depending on their definition of flight. As a class, decide what it means to fly. Some students may say that flying includes those things that are thrown into the air such as balls and paper airplanes. Categorize the cards by what can fly alone and what cannot fly alone.

   - The cards containing things that fly include airplanes, bluebirds, mosquitoes, helicopters, rockets and grasshoppers. Turkeys can fly, but not far
   - Flowers, cars, and bicycles do not usually have an ability to fly. Balls can fly through the air after being hit or thrown. Parachutes float down to the ground, but are slowed by air resistance

3. Next ask students to identify the factors or characteristics that allow something to fly. Create a chart with the class using chart paper. Ask students to give their ideas about why some things can fly and some things cannot fly. Students may want to refer to the examples in the card activity to determine the characteristics they share. Students then identify reasons why some things cannot fly.

Example

Characteristics That Allow Things to Fly	Factors That Do Not Allow Some Things to Fly
lightweight shape wings	gravity weight

4. Show a video clip of early airplane flight such as YouTube: Wright Brothers First Flight or First Flight. Ask students to share their ideas and observations about how the Wright Brothers were able to fly their airplane.

5. Display the Early Flight Images on a screen to compare the planes the Wright Brothers, Louis Paulhan, Benjamin Foulois, and L. L. Walker flew.

6. Students identify what they think allowed the early aviators' planes to fly such as wings and propellers. Add their responses to the chart previously created under Characteristics That Allow Things to Fly.

7. Keep the chart posted to refer to throughout the lessons.

Explore in the Classroom

Air and Flight (Grades 1-3)

1. Students investigate the characteristics of air to help them demonstrate that air is matter and important in understanding flight. Students record results on the *Air and Flight Student Page.*

2. Divide students into groups of three or four. Review each of the stations and review vocabulary students must know to complete the tasks such as matter, mass, weight, and air.

3. For task one, students answer the question, "Does air take up space?" Groups use the materials to create a test to answer the question. Students record the results of their tests on the *Air and Flight Student Page.*

4. For task two, students answer the question, "Does air have mass?" Groups use the materials to create a test to answer the question. Students record the results of their tests on the *Air and Flight Student Page.*

5. For task three, students answer the question, "Does air move?" Groups use the materials to create a test to answer the question. Students record the results of their tests on the *Air and Flight Student Page.*

6. Discuss the results of each task as a class. Students decide whether air is matter based on the results of their tests. Understanding that air has mass, takes up space, and can move helps students understand how airflow and wings create lift.

Air Pressure and Flight (4-12)

1. As a class, create a list of properties of air such as air has mass, air takes up space, and air can move.

2. Ask students to explain how airplanes fly. Record their ideas on a class chart.

3. Students test different shapes of paper to see how wings are important to airplanes and to determine which shape would make the best airplane wing. Students record results on the *Air Pressure and Flight Student Page*.

   - Give each student a paper strip. Students hold one end of a strip of paper under their mouths and blow over the paper. Record what happens
   - Fold a piece of legal-sized paper in half. Students hold the edges together and up to their mouths. Then blow over the paper. Record what happens
   - Fold a piece of legal-sized paper in thirds leaving a one inch space in the middle of the paper. Students hold the edges together and up to their mouths. Then blow over the paper. Record what happens
   - Hold the opposite ends of a piece of legal-sized paper together so that the middle of the paper is curved. Students hold the edges together and up to their mouths. Then blow over the paper. Record what happens

4. Discuss what happened with each piece of paper. Show students the *Wings and Flight Transparency*. Compare Bernoulli's principle and Newton's third law of motion to explain lift. Introduce the term airfoil. An airfoil's shape combined with the way that it is tilted into the wind produces lift. After discussing the diagram, students draw an airfoil on the student page and explain lift.

5. To see more examples of lift, visit *NASA's Future Flight Design Center: Lift* web site.

6. For younger students visit *NASA's How Do Planes Fly?* web site.

Forces of Flight: Lift, Drag, Weight, and Thrust (4 – 12)

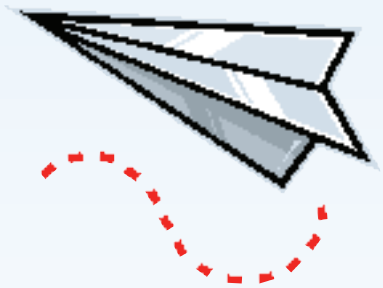
1. The following activities can be done as stations or as a class with students working in small groups. Students record their results on the *Forces of Flight Student Page.*

2. Review how lift is produced using the examples students demonstrated by blowing over different shapes of paper.

3. Demonstrate drag. Give each group a paper plate.
   - Students turn the plate so that it is parallel to the ground, and then wave the plate through the air. Record the results
   - Students turn the plate so that it is perpendicular to the ground, and then wave it through the air. Record the results
   - Students discuss the difference and identify the air resistance they feel as drag
   - Discuss how airplanes can be shaped to reduce drag. Students can view more examples of drag at *NASA Future Flight Design Center: Drag* web site
4. Demonstrate how weight affects flight. Give each group a piece of clay and a piece of paper.
   - Students mold a shape of an airplane out of the clay, and then try to make it fly through the air
   - Students make a paper airplane, and try to make it fly through the air
   - Record results
   - Discuss what happened with each model and how weight affected each airplane
   - Students can see how weight is important in flight by visiting *NASA Future Flight Design Center: Weight* web site
5. Demonstrate thrust. Place two boxes on the ground, one filled, and the other one empty.
   - Ask students to push each box
   - Discuss which box requires more force to push across the floor
   - Compare the force students applied to the boxes with the thrust needed to move an aircraft forward. More thrust is needed to move a heavy object. Students can see more examples of thrust at *NASA Future Flight Design Center: Thrust* web site
6. See how all four forces act on airplanes at *NASA Future Flight Design Center: Forces* web site.

7. Find out how the Wright Brothers' Wright flyer was built for flight at *PBS: The Wright Flyer* web site.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Design Challenge: Design a Paper Airplane 1. Display the *Design Process Diagram* on a screen and describe the steps students will follow to complete the design challenge. 2. Students design a paper airplane that can remain in flight as long as possible. Students may use one of the templates provided or make up their own design. Add a paperclip to the airplane for weight. 3. Students may also use an example from a web site such as *Amazing Paper Airplanes, Fun Paper Airplanes,* or *10 Paper Airplanes.* 4. Students test their airplanes during a class presentation. 5. After sharing their designs with the class, students select an idea they learned from another student to help improve their airplane's performance. This may include use of materials, weight, or design elements. 6. Students improve their airplane, retest, and then present the final design to the class. 7. Students record data and reflections on the *Design Challenge Student Page.* 	**Aviator Interview** 1. Students use the information gathered through research to write and present an interview with one of the early aviators: Louis Paulhan, Benjamin Foulois, or L. L. Walker. 2. Interviews should include the following: • the aviator's achievements • the type of airplane the aviator flew • how the aviator learned to fly • the role of airplanes during the early 1900s 3. For more information, visit the following web sites: • early Flight in San Antonio (video) • Benjamin Foulois • Louis Paulhan • L. L. Walker 4. Students may video tape their interviews or present them live. Students may also want to dress up to represent the clothing of the time.

Engage Students

Can it Fly? Cards

Copy and cut out the cards. Place the things that can fly in one column and the things that cannot fly in another column.

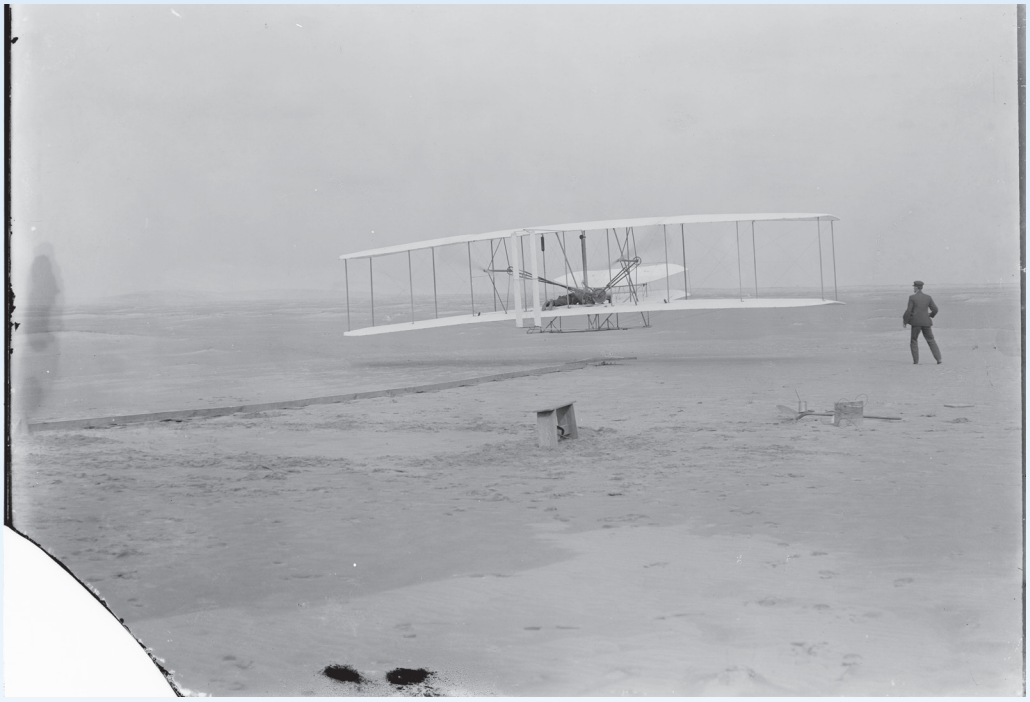
Can fly	Cannot fly
bluebird	baseball
person	flower
turkey	mosquito
grasshopper	car
bicycle	helicopter
airplane	parachute
ostrich	rocket

Engage Students

Early Flight Images

Project the images onto a screen or white board. Compare the airplane designs.

The Wright Flyer (1903)



First flight of Wright Brothers at Kitty Hawk, North Carolina, December 17, 1903.
Courtesy Library of Congress, LC-DIG-ppprs-00626, Washington, D.C.

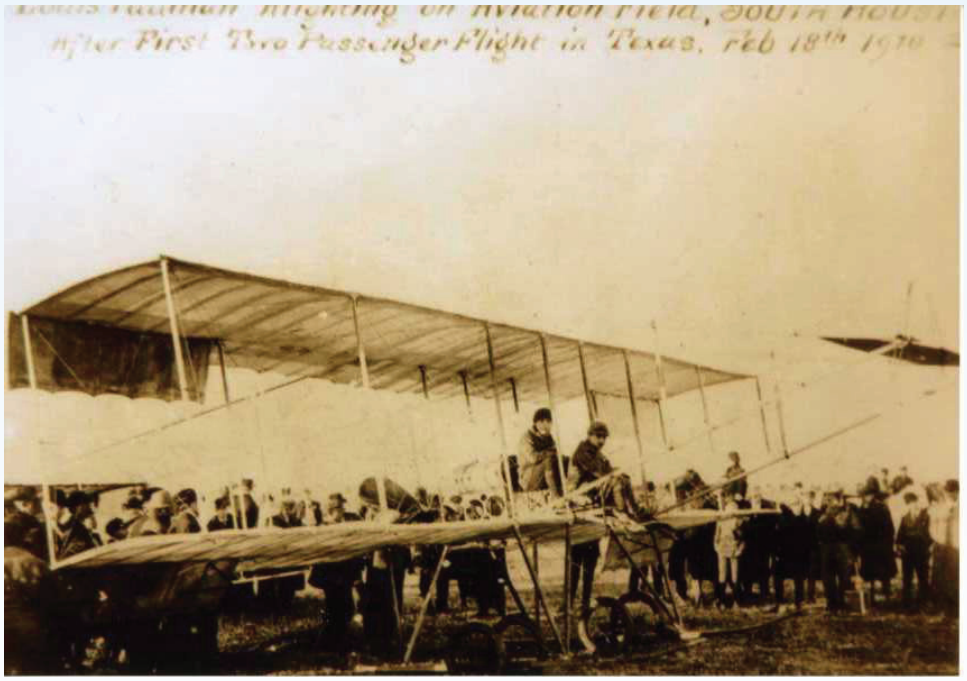
Picture of L. L. Walker - 1910

Leslie L. Walker flew a Bleriot monoplane in Houston, which he built himself.
Courtesy Houston Metropolitan Research Center, Houston Public Library, Houston

Benjamin Foulois (1911)

Lt. Benjamin Foulois and Lt. Parmalee flying Wright Model B over U.S. Army tents in camp at Fort Sam Houston, San Antonio, ca. 1911.
Courtesy National Air and Space Museum, Smithsonian Institution (SI 2003-31170), Washington, D.C.

Louis Paulhan (1910)



Frenchman Louis Paulhan flew the first flight in Texas on February 18, 1910.
Courtesy Houston Metropolitan Research Center, Houston Public Library, Houston

Air and Flight Student Page

Complete the following tasks to discover more about air.

Task 1 Does air take up space?

Procedure: Design a test using any of the materials at the station to prove that air takes up space.

Materials: balloon, baggies, paper bag, straws, bubble gum

Describe your test. _____

_____

What do you think will happen? Explain why. _____

_____

Conduct your test and explain the results. _____

_____

Illustrate what happened.

Task 2 Does air have mass?

Procedure: Design a test using the materials at the station to prove that air has mass.

Materials: balance, balloons, meter stick, string, straws

Describe your test. _____

_____

What do you think will happen? Explain why. _____

_____

Conduct your test and explain the results. _____

_____

Illustrate what happened.

Task 3 Does air move?

Procedure: Design a test using the materials at the station to prove that air can move.

Materials: paper, feather, straws, pinwheel

Describe your test.

_____

_____

What do you think will happen? Explain why. _____

_____

Conduct your test and explain the results. _____

_____

Illustrate what happened.

How do you know that air is matter?

_____

_____

_____

How do you think air is important to things that fly?

_____

_____

_____

Air Pressure and Flight Student Page

See how air flow affects different shapes of wings.

Hold one end of a strip of paper under your mouth and blow over the paper. Record what happens.

Fold a piece of legal-sized paper in half. Hold the edges together and up to your mouth. Blow over the paper. Record what happens.

Fold a piece of legal-sized paper in thirds leaving a one inch space in the middle of the paper. Hold the edges together and up to your mouth. Blow over the paper. Record what happens.

Hold the opposite ends of a piece of legal-sized paper together so that the middle of the paper is curved. Hold the edges together and up to your mouth. Blow over the paper. Record what happens.

Draw the shapes in the order from the one that lifted the most to the one that lifted the least.

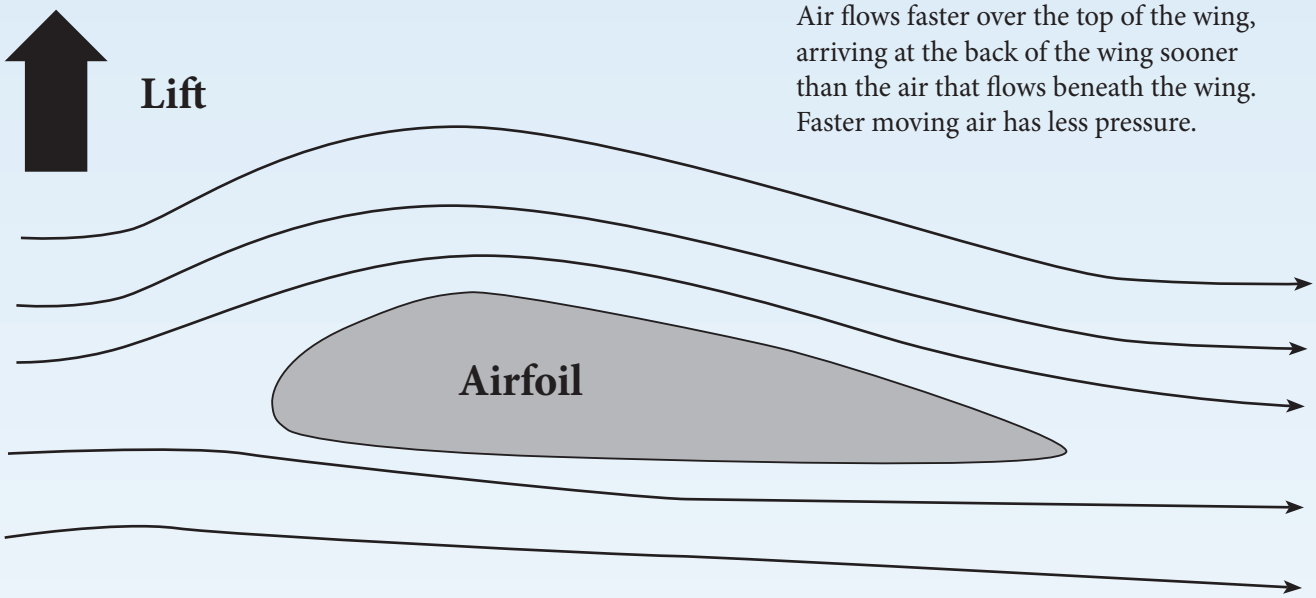
Which wing shape was the easiest to lift? Why?

Which wing shape was the hardest to lift? Why?

Draw an airfoil below and show how the air flows over and under it. Label the side with the least air pressure and the side with the most air pressure. Label the side where the air travels the fastest. Explain what lift is.

Wings and Flight Transparency
Air Flow around a wing

Airplane wings have a special shape that is called an **airfoil. Bernoulli's** principle partly explains flight.



Air flows faster over the top of the wing, arriving at the back of the wing sooner than the air that flows beneath the wing. Faster moving air has less pressure.

Air flows slower beneath the wing causing greater pressure. The air pushes harder on the bottom of the airfoil than the top. This helps produce **lift**.

Newton's third law of motion also helps explain lift. Wings push air downward (action) and the air pushes the wing upward (reaction). The angle of the wing, or angle of attack, deflects air downward. While traveling in a car, stick your hand out the window. Notice the difference between holding your hand parallel to the ground and angling your hand so that the air can push against it. Angling your hand causes it to lift.

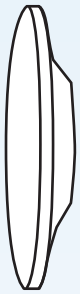
Forces of Flight Student Page

What is drag?

1. Hold a paper plate so that it is parallel to the ground.
2. Wave the paper plate through the air.
   - How does it feel?
   - Is it hard or easy to move through the air? Why?

Illustrate	Explain

3. Turn the plate so that it is perpendicular to the ground.
4. Wave it through the air.
   - How does it feel now?
   - Is it harder or easier to move through the air? Why?



Illustrate	Explain

Explain drag _____

_____

How do you think drag affects an airplane? _____

_____

How does weight affect flight?

1. Make a model of an airplane out of clay.
2. Try to make it fly in the air.
3. Make a model of an airplane out of paper.
4. Try to make it fly in the air.

- What happens when you tried to fly each airplane?
- How does weight affect flight?

Illustrate what happened to the clay airplane	Illustrate what happened to the paper airplane	Compare and explain the results

What is thrust?

1. Place two boxes of the same size on the ground. One box should be full, and the other box should be empty.
2. Push the full box across the floor.
3. Push the empty box across the floor.

- Which box requires more force, or thrust, to push across the floor?
- How is thrust important to flight?

_____

_____

_____

_____

Extend Student Learning

Design Challenge *Design a Paper Airplane*

Challenge Design a paper airplane that can remain in flight as long as possible. Use one of the templates provided or make up your own design.

Design Draw your design on a piece of graph paper. Label the parts of your airplane such as wings, tail, and fuselage.

1. What materials will you use? Why?

_____

_____

2. How will your airplane get lift?

_____

_____

3. How will the airplane's weight affect its flight?

_____

_____

4. What will you use for thrust?

_____

_____

5. What will you do to reduce drag?

_____

_____

Build Build your airplane based on the design.

Test Test your airplane by flying it three times and recording the results. Calculate the averages for each column. You may try to improve your results by adjusting the design, materials, or weight.

Flight #	Distance (m)	Time in air (seconds)	Speed (m/seconds)
Average			

6. Share your airplane with the class. How well did your airplane fly?

_____

_____

Revise

7. After seeing the designs of other airplanes, select at least one idea you can use to improve your own design. What change(s) will you make? Why?

_____

_____

8. Test your airplane by flying it three more times. Calculate the averages for each column.

Flight #	Distance (m)	Time in air (seconds)	Speed (m/seconds)
Average			

Evaluate

9. How did the changes you made affect the airplane's performance?

_____

_____

10. What could you do to improve the design further?

_____

_____

11. What was the average speed of your airplane for the first set of flights? What was the average speed of your airplane for the second set of flights?

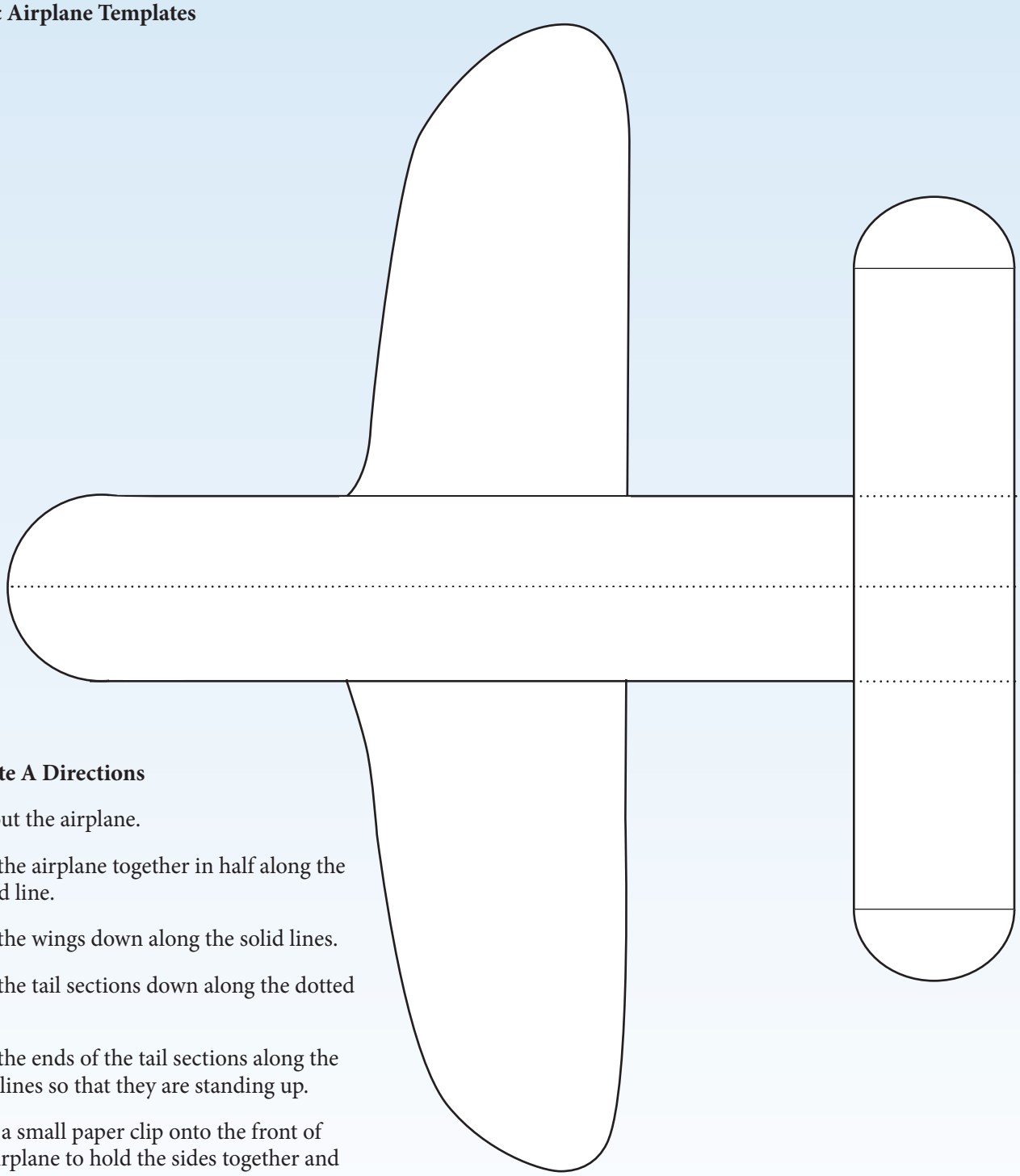
_____

_____

12. Create a graph comparing the distance the airplane flew for each flight of the final test.

Extend Student Learning

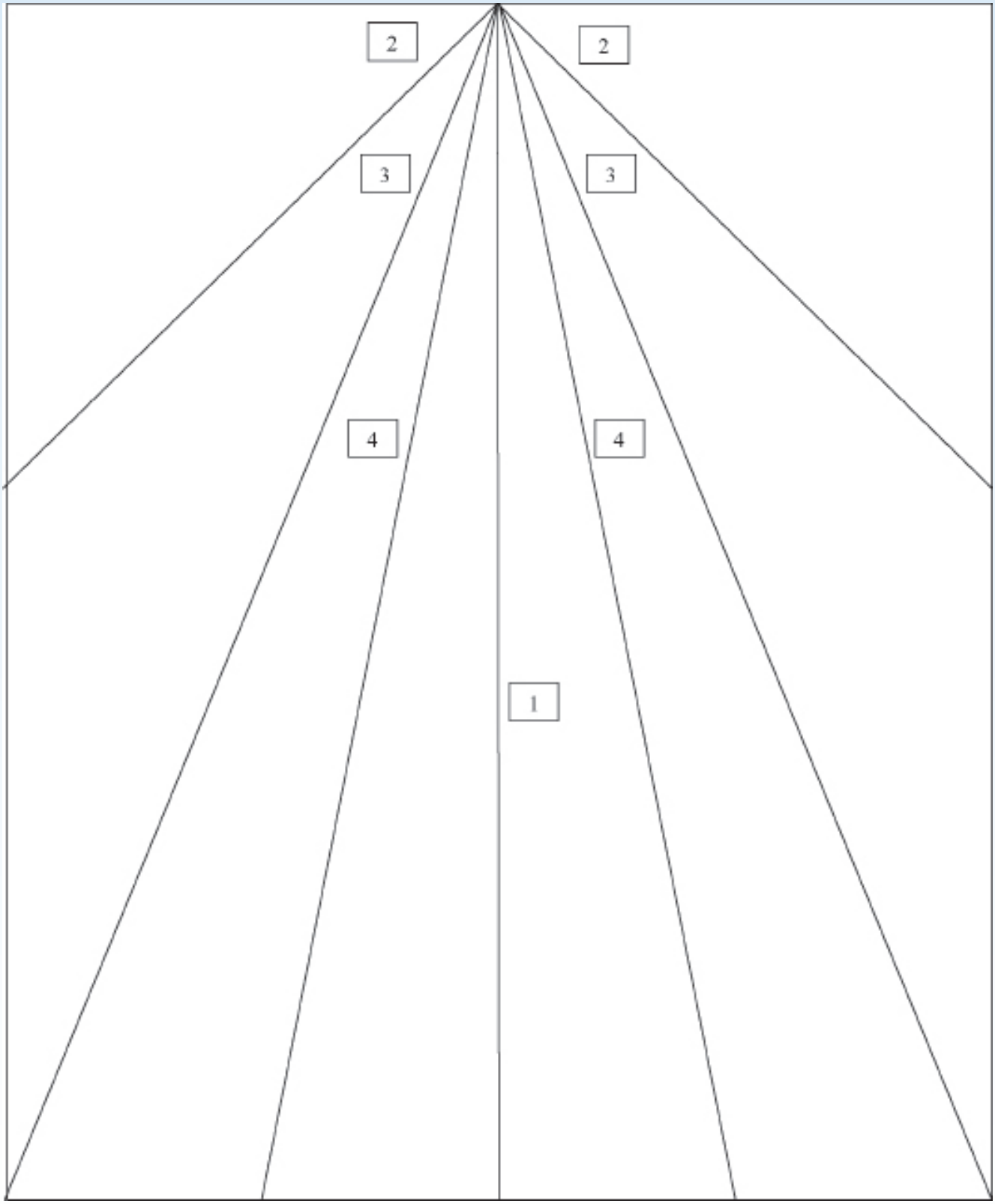
Basic Airplane Templates



Template A Directions

1. Cut out the airplane.
2. Fold the airplane together in half along the dotted line.
3. Fold the wings down along the solid lines.
4. Fold the tail sections down along the dotted lines.
5. Fold the ends of the tail sections along the solid lines so that they are standing up.
6. Push a small paper clip onto the front of the airplane to hold the sides together and provide weight.
7. Test your airplane.
8. Make changes to improve your airplane's performance such as creating ailerons, rudders, and elevators.

Template B Directions Cut the template out. Fold the paper in half along the line labeled 1. Fold the top corners down along the lines labeled 2 so that they meet the fold in the paper. Fold each side down along the lines labeled 3 so that they meet the fold in the paper. Fold each side along the lines labeled 4 so that they stick out like wings. Push a small paper clip underneath the front of the plane to hold the paper together and to give the airplane weight. Test your airplane.



WWI and the Stinson Family 1910s

Set the Stage

Katherine and **Marjorie Stinson** were among the daring, highly capable women flyers who demonstrated to a disbelieving public that women could fly during aviation's early years. Katherine Stinson performed death-defying stunts to the delight of thousands of spectators in the United States, Canada, Japan, and China. Katherine was the first woman to fly in Asia, the first female night skywriter, and the first person to carry the mail to Western Canada. Their brother, **Eddie Stinson**, became a record setter, designer, and manufacturer of Stinson aircraft. The Stinson family established the Stinson Flying School in San Antonio, Texas, to train military cadets during World War I. After the war, the flying school ended its operations and eventually became Stinson Municipal Airport, housing two flight schools, an air cargo operator, and an aviation museum. It serves as the general aviation reliever airport for San Antonio International.

Overview:
Students simulate airplane controls by using body movements to simulate yaw, pitch, and roll. Students discover how ailerons and elevators affect airplane flight by modifying a paper airplane so that it will land at different targets. Students investigate Katherine Stinson and create a scrapbook containing important events in her life.

Objectives:
- Students simulate yaw, pitch, and roll to understand how pilots can make airplanes move in different ways
- Students modify a paper airplane so that the forces applied will cause the plane to land on designated targets
- Students research Katherine Stinson and create a scrapbook that explains and illustrates her contributions to aviation

Guiding Questions:
- How did aviators in the early 1900s earn a pilot's license?
- How does a pilot control an airplane?

Materials

Engage
- Copies of *Parts of an Airplane Diagram and Cards* (1 set for each group – cut out cards and place in baggies ahead of time)

Explore in the Classroom
- Computers with Internet access
- Microsoft PowerPoint or other presentation software

Extend Student Learning
- *Design Process Diagram*
- 3 pieces of poster board
- Paper for paper airplanes
- Small paperclips
- Outside area

Vocabulary:

Aileron	Moveable parts of the wings that move up and down to roll the plane from side to side
Cockpit	Place where the pilot sits and flies the airplane
Elevator	Moveable, horizontal part of the tail that changes pitch to guide an airplane up and down
Fuselage	Body of the airplane that holds things together and carries cargo
Landing gear	Structure that supports an airplane on the ground and allows it to take off and land
Pitch	An up and down movement of the airplane
Propeller	Generates thrust so the airplane will move forward
Roll	Tilting movement to the left or right so that one wingtip of an airplane is higher than the other
Rudder	Moveable, vertical part of the tail that changes yaw to guide airplane from left to right
Wing	Produces lift as the airplane moves through the air
Yaw	Side-to-side movement of the airplane; turn

Suggested Literature:
Katherine Stinson: The Flying Schoolgirl by Debra L. Winegarten

Katherine Stinson Otero, High Flyer by Neila Petrick

Texas Aviation on the Web:
Refer to the following web sites during the lesson and to extend learning.

Royal Air Force Museum Aircraft Controls
rafmuseum.org.uk/cosford/learning/aircraft_controls.cfm

Young Eagles: Pitch, Yaw, and Roll
youngeagles.org/games/pyr/

The Handbook of Texas Online: Katherine Stinson
tshaonline.org/handbook/online/articles/SS/fst97.html

Centennial of Flight
centennialofflight.gov/essay/Dictionary/K_STINSON/DI158.htm

Lesson Procedure:

Engage Students

1. Pass out one set of *Parts of an Airplane Diagram and Cards* to each group.
2. Each group matches the words to the correct part of the airplane. Students match the function to each part.
3. Discuss each group's answers, allowing students to make adjustments. Students may also suggest adding additional parts.
4. Ask students to complete the activity again at the end of the lesson to compare their understanding of the parts and functions of an airplane.

Explore in the Classroom

Controlling an Airplane (K-3)

1. Ask students to describe how pilots control airplanes and the different ways airplanes move such as turning and rotating sideways.
2. Demonstrate yaw, pitch, and roll. Stand in front of the class with arms extended like an airplane.
   - To demonstrate pitch, slowly move forward while moving the torso up and down. Pitch determines whether the airplane will fly in an upward, straight, or downward direction
   - To demonstrate yaw slowly turn the body and walk in the direction the body is facing. Yaw is controlled by the rudder and turns the plane left and right
   - To demonstrate roll slowly turn one arm (wing) down while the other arm (wing) lifts upward. Roll rotates the airplane from side to side
3. Students should repeat the motions as the teacher demonstrates each movement.
4. Organize students into pairs. Students work together to write a set of directions to give another student who will simulate airplane movement, including taking off from one point and traveling to a destination. Students should complete this activity outside so they have room to complete the task. Student pairs must:
   - Select a starting and ending point. Try to include obstacles that the student airplane has to avoid
   - Write a series of directions to take the student airplane from the start to the finish point. For example:
     - Fly forward three steps
     - Angle your pitch downward for five steps
     - Level your plane and roll to the right for four steps
     - Straighten the plane and move forward eight steps
     - Yaw to the right for five steps
     - Move forward for 10 steps and stop
5. After each group has written and practiced their flight directions, they must pair up with another group. Each group should take turns calling out their directions to their partner group.
6. Younger students may enjoy creating paper wings and decorations to attach to their bodies.

7. Discuss:

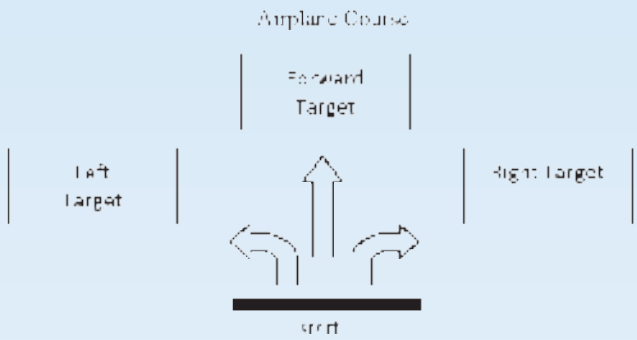
- How well each group gave and followed directions
- The difference between yaw, pitch, and roll

Controlling an Airplane (4-12)

1. Visit one of the following web sites to learn more about yaw, pitch, and roll. Introduce the web sites using an interactive white board or projector.
   - Practice changing yaw, pitch, and roll on an airplane at the *Royal Air Force Museum: Aircraft Controls* interactive web site
   - Students identify and use the controls of the airplane to control yaw, pitch, and roll at the *Young Eagles: Yaw, Pitch, and Roll* interactive web site
2. Students create their own animated PowerPoint presentation teaching about the airplane parts and controls.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Design Challenge: Hit the Target 1. Display the *Design Process Diagram* on a screen and describe the steps students will follow to complete the design challenge. 2. Review the airplanes students made from the previous lesson and how they were able to get their planes to stay in flight. 3. Now that students know how some of the parts of an airplane work, they must modify a paper airplane to fly in different directions to hit several targets. Students may design their own airplane, use the templates from the *Aviation Takes Off Lesson*, or access web sites from the Internet. 4. Set up a course requiring students to throw their airplane so that it flies in three different directions: • Straight and land on a target • Turn to the right and land on a target • Turn to the left and land on a target 5. Label three different pieces of poster board as Forward Target, Left Target, and Right Target. Spread the targets out as shown in the diagram below.	**Stinson Scrapbook** Katherine Stinson in Tokyo during tour of Asia in 1915. *Courtesy University of New Mexico, University Libraries, Center for Southwest Research, Albuquerque, New Mexico* 1. Students use the information gathered through research to create a scrapbook of Katherine Stinson's life.



6. Students stand at the start line with their airplane. They must make adjustments to their airplane before each flight to make it land on the designated target.
   - *Left Target Test* - Students test their airplane to see how many times they can make it land on the Left Target. Adjust structures (flaps, ailerons, etc.), thrust, and pitch to control where the airplane lands. Record results on the student page.
   - *Forward Target Test* - Students test their airplane to see how many times they can make it turn and land on the forward target. Stand facing the Forward Target and then throw the airplane. Students must adjust structures (flaps, ailerons, etc.), thrust, and pitch to make the airplane land on the target. Record results on the student page.
   - *Right Target Test* - Students test their airplane to see how many times they can make it turn and land on the right target. Students stand facing the Forward Target and then throw the airplane. Students must adjust structures (flaps, ailerons, etc.), thrust, and pitch to make the airplane turn to the right and land on the target. Record results on the student page.
7. Share students' results and discuss how they controlled their airplanes. Discuss how yaw, pitch, and roll were important in this activity.

2. Students gather or recreate at least five different examples of artifacts such as posters, letters, newspaper articles, and pictures that represent important events in Stinson's life.
3. Students provide explanations of the events and accomplishments that each artifact represents.
4. Scrapbooks can be made from construction paper, cardboard, or photo albums.
5. Use online resources for more information such as *Handbook of Texas: Katherine Stinson* and *Centennial of Flight*.

Engage Students

Parts of an Airplane Diagram

Engage Students

Parts of an Airplane Cards
Cut out the cards and match them to the correct part on the airplane diagram.

Parts of an airplane

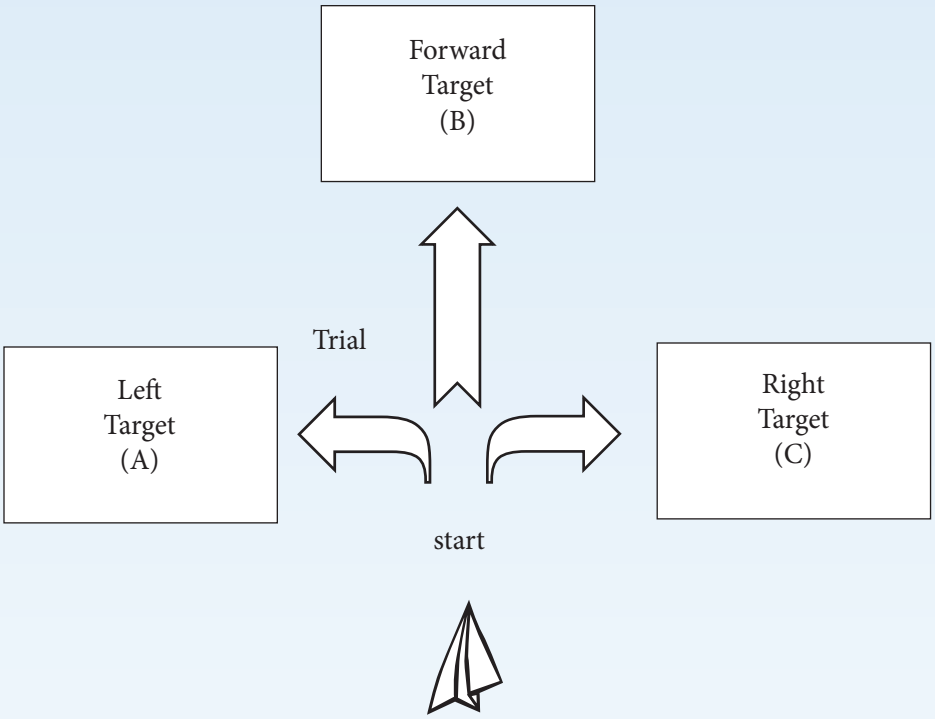
propeller	**wing**
aileron	**rudder**
landing gear	**fuselage**
cockpit	**elevator**

What the parts do

Generates thrust so the airplane will move forward	Produces lift as the airplane moves through the air
Moveable parts of the wings that move up and down to roll the plane from side to side	Moveable, vertical part of the tail that changes yaw to guide airplane from left to right
Structure that supports an airplane on the ground and allows it to take off and land	Body of the airplane that holds things together and carries cargo
Place where the pilot flies the airplane	Moveable, horizontal part of the tail that changes pitch to guide airplane up and down

Extend Student Learning

Design Challenge *Hit the Target*
Design and make a paper airplane that can fly forward to land on a target, turn to the left to land on a target, and turn to the right to land on a target. Create structures such as ailerons, elevators, flaps, and/or rudder to help control the direction your airplane flies. Test your airplane and complete the tables below to record your airplane's results.



Target A – Land on the left target.

Trial	Adjustment made (ailerons, elevators, flaps, rudder)	Result	Landed on Target Yes/No
1			
2			
3			
4			
5			
6			
7			
8			

Target B – Land on the forward target.

Trial	Adjustment made (ailerons, elevators, flaps, rudder)	Result	Landed on Target Yes/No
1			
2			
3			
4			
5			
6			
7			
8			

Target C – Land on the right target.

Trial	Adjustment made (ailerons, elevators, flaps, rudder)	Result	Landed on Target Yes/No
1			
2			
3			
4			
5			
6			
7			
8			

Calculate your airplane's accuracy.

Target	Number of times you threw airplane	Number of times the airplane landed on the target	Percentage of time the airplane hit target
A			
B			
C			

Answer the questions based on your tests.

1. How did you make the airplane turn left and right?

_____

_____

_____

2. Identify at least two forces that were acting on your airplane. Explain the adjustments you made to overcome those forces and control your airplane.

Force _____

Adjustments _____

Force _____

Adjustments _____

3. Explain how yaw, pitch, and roll were important in this activity.

_____

_____

_____

4. What do you need to do to make your airplane fly more accurately?

_____

_____

_____

Barnstormers

Set the Stage

Barnstormers were pilots and stunt people who made their living entertaining audiences with amazing aerial feats during the 1920s. Wing walkers were barnstormers who performed stunts outside the cockpit of the airplane.

On June 15, 1921, **Elizabeth "Bessie" Coleman** became the first woman from Texas to earn a pilot's license, and the first licensed African-American pilot in the United States. She was also the first African American, male or female, in the world to earn an international pilot's license from the *Federation Internationale Aeronautique* (FAI) in France. In late 1922, upon her return to New York, Bessie Coleman made parachute jumps and exhibition flights that included aerobatic loops and figure eights. She performed in various states across the country, including New York, Massachusetts, Illinois, Tennessee, Montana, Texas, California, and Florida, where she earned the nickname, "Brave Bessie."

Ormer Locklear set the standard for the extreme sport of wing walking in the United States. Locklear was the first person to transfer from one plane to another in mid-air on November 8, 1918. He was known as the "King of the Wing Walkers." Locklear performed other stunts such as handstands, grasping a trapeze or rope ladder with his teeth, and transferring from a moving vehicle onto an aircraft.

Overview:
Students learn about wing walkers by interacting with advertisements and video. To simulate wing walking, students experiment with balance as they stand in different body positions to find their center of gravity. Students create barnstorming paper airplanes that can perform stunts, and then investigate modern stunts and extreme activities that people perform for entertainment today. Students investigate and write a news report covering the achievements of Bessie Coleman and Ormer Locklear.

Objectives:
- Students discover their center of gravity by remaining balanced while holding their bodies in different positions and while a force is acting on them
- Students complete a design challenge to create a paper airplane that will generate enough lift to perform aerobatics
- Students compare barnstorming and wing walking to extreme activities of today, explaining how athletes or performers overcome forces to complete their stunts
- Students research and retell the story of a famous barnstormer by creating a multimedia news report

Guiding Questions:
- How were wing walkers able to perform on moving airplanes?
- Why were people entertained by barnstorming and wing walking?

Materials

Engage
- Note cards (1 per student)
- *Barnstorming True or False Transparency*

Explore in the Classroom
- Electric fan
- Outside area
- Paper for paper airplanes
- Stopwatch
- *Barnstorming Paper Airplane Directions*
- *Barnstorming Paper Airplane Student Page*
- *Design Process Diagram*

Extend Student Learning
- Computers
- Microsoft Photo Story

Vocabulary:

Balance	A state of equilibrium
Barnstorming	A popular form of entertainment in which stunt pilots perform tricks with airplanes
Center of gravity	The point located at an object's average position of weight
Force	A push or a pull
Gravity	The force that pulls everything towards the center of the Earth
Kinetic energy	Energy of motion
Potential energy	Stored energy
Stall	When an airplane loses lift due to the separation of the airflow from the airfoil surface
Wing walking	The act of moving on the wings of an airplane during flight

Suggested Literature:

Bessie Coleman: Daring to Fly by Sally M. Walker

Fly High! The Story of Bessie Coleman by Louise Borden

Nobody Owns the Sky: The Story of "Brave Bessie" Coleman by Reeve Lindbergh

Queen Bess: Daredevil Aviator by Doris L. Rich and Mae Jemison

Air Shows: From Barnstormers to Blue Angels by Elizabeth Van Steenwyk

Texas on the Web:

Refer to the following web sites during the lesson and to extend learning.

Hollywood Aviators and Barnstormers
youtube.com/watch?v=LwmcSRyzi2A

Centennial of Flight: Ormer Locklear
centennialofflight.gov/essay/Explorers_Record_Setters_and_Daredevils/wingwalkers/EX13.htm

Century of Flight: Ormer Locklear
century-of-flight.net/Aviation%20history/daredevils/lunatics.htm

Centennial of Flight: Bessie Coleman
centennialofflight.gov/essay/Explorers_Record_Setters_and_Daredevils/Coleman/EX11.htm

Bessie Coleman
bessiecoleman.com/default.html

PBS: Bessie Coleman
pbs.org/wgbh/amex/flygirls/peopleevents/pandeAMEX02.html

Lesson Procedure:

Engage Students

1. Give each student a note card, ask them to write the word True on one side and False on the other side.
2. Read the statements about barnstorming in the 1920s from the *Barnstorming True or False Transparency*. Students hold up True or False for each statement.
   - Some wing walkers would do handstands while the airplane was flying
   - Some wing walkers would hang from their airplane by a trapeze bar
   - Some wing walkers would jump out of an airplane and open a parachute before reaching the ground
   - Some wing walkers would hang from a rope by just their teeth
   - Some wing walkers would practice archery target practice during the flight
   - Some wing walkers would transfer from a moving car onto an airplane in flight
3. Confirm that all statements are true. Then show a series of images displaying wing walkers. Ask students to explain why they think anyone would want to perform stunts on an airplane.
4. Show the advertisement from the *Barnstorming True or False Transparency* announcing a barnstorming show. Ask:
   - What is the poster advertising?
   - What information does the advertisement provide?
   - Why would people want to watch this type of performance?
   - What are the risks involved with barnstorming and wing walking?

Explore in the Classroom

Balancing Act (K-4)

1. Take students outside. Ask students to demonstrate different body positions or acrobatics that a wing walker might use such as standing on one foot and doing a hand stand. Students must remain balanced while they are in each position. Help students locate their center of gravity.
2. Turn a large fan on high and ask students to repeat their stunt. Ask:
   - How does wind affect your ability to balance?
   - What do you have to do to remain balanced under the force of wind?
   - How would this compare to wing walking?
3. Students record how well they were able to stay balanced with and without the force of wind.
4. Discuss the terms force, balance, and center of gravity.
5. Play a video clip such as Hollywood Aviators and Barnstormers that shows barnstorming and wing walking. Discuss students' comments and questions.

Paper Airplane Barnstorming (4-12)

1. Display the *Design Process Diagram* on a screen and describe the steps students will follow to complete the design challenge.

2. Students must create a paper airplane to simulate the stunts that barnstormers performed in the 1920s.

3. Discuss the forces that barnstormers had to overcome in order to perform their stunts such as gravity, wind, and weight of the airplane. Watch a video clip showing barnstorming and wing walking such as *Hollywood Aviators and Barnstormers.*

   - Ask students to explain how the following terms can be applied to barnstorming and wing walking: kinetic and potential energy, gravity, center of gravity, speed, acceleration, velocity, and balance
   - Create a class list of terms and meanings

4. Students follow the directions provided for making a barnstorming airplane. Students will test their airplanes, observe the results, and make revisions. Record results on the *Barnstorming Paper Airplane Student Page.*

5. Share airplanes during a class air circus.

6. Encourage students to create posters advertising the stunts their airplanes can perform.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Modern Day Stunts 1. Students work in small groups to research people who perform modern day stunts or hobbies such as: • Barnstormers • Stunt men and women • Extreme sports athletes • Sky divers 2. Students assume the role of a person who participates in the extreme activity and then give an oral presentation explaining: • How the activity is done • The forces that the person must overcome in order to successfully complete the activity • The danger involved with the activity • Why the activity is entertaining to spectators • Information about people who are famous for participating in the activity 3. The presenter must: • Dress up as someone who would perform the activity • Show props the person would use in their activity • Present a visual aid based on the information students located in their research	**Barnstormer News Report** 1. Students select one of the barnstormers from the exhibit for the subject of a news report. Students may work independently or in small groups to complete the project. 2. Students create a story map retelling a barnstorming flight of the person they chose. Each stage in the story map should show a part of the aerial routine. 3. Students must take a picture of each illustration, and then upload the pictures into Microsoft Photo Story or other presentation software. 4. Students must create text and narration as if they are a reporter retelling the event from experience. Include the following: • Facts about the barnstormers life • The barnstormers accomplishments • The stunts being performed • The type of airplane the barnstormer flew • Comments from spectators that convey why they found barnstorming entertaining 5. Use online resources for information: • *Centennial of Flight: Ormer Locklear* • *Century of Flight: Ormer Locklear* • *Centennial of Flight: Bessie Coleman* • *Bessie Coleman* • *PBS: Bessie Coleman*

Engage Students

Barnstorming True or False Transparency

Identify the statements as *True* or *False*.

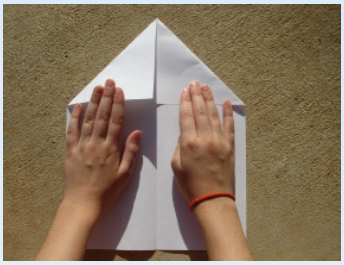
- Some wing walkers would do handstands while the airplane was flying
- Some wing walkers would hang from their airplane by a trapeze bar
- Some wing walkers would jump out of an airplane and open a parachute before reaching the ground
- Some wing walkers would hang from a rope by just their teeth
- Some wing walkers would practice archery target practice during the flight
- Some wing walkers would transfer from a moving car onto an airplane in flight

Stunt pilot Ormer Locklear, ca. 1918-1919.
Courtesy History of Aviation Collection, Special Collections Department, McDermott Library, The University of Texas at Dallas, Richardson

Barnstorming Paper Airplane Directions

Follow the directions to build an airplane that can perform aerobatics.

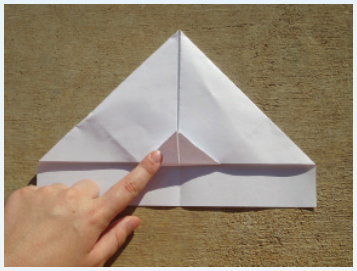
Step1:
Fold a piece of 8½ x 11 paper in half lengthwise. Unfold the paper.



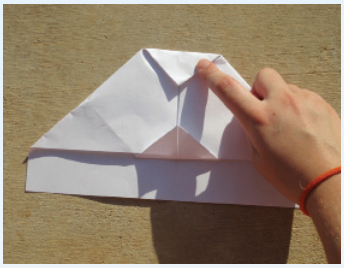
Step 2:
Fold the top corners of the paper down so that they come together at the crease in the paper.

Step 3:
Fold the top half of the paper down so that the tip touches the bottom of the paper.

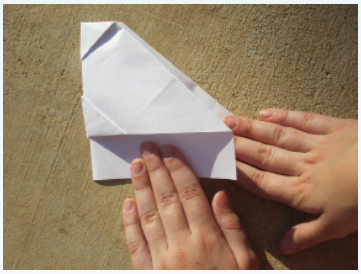
Step 4:
Fold the top corners of the paper down so that they come together at the crease in the paper.



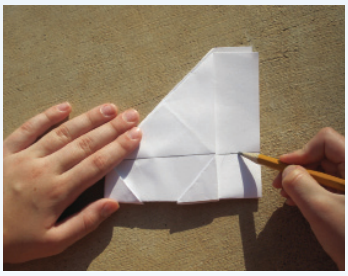
Step 5:
Fold the tip that is touching the bottom of the paper up, and fold it over the two corners from the previous step.



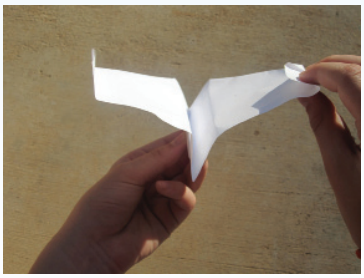
Step 6:
Fold the top tip down about one inch.



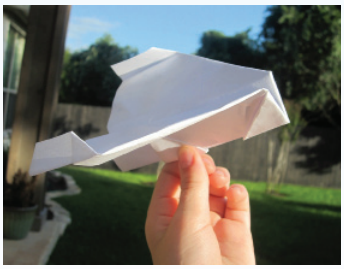
Step 7:
Fold the airplane in half so that the smooth side is together.



Step 8:
Draw a line across one side just above the tips of the triangles. Fold this side of the paper down along the line to form a wing. Repeat on the other side.



Step 9:
Fold the tips of the wings to create rudders. To create more lift, cut slits to form elevators.



Step 10:
Your airplane is ready to take flight! Throw the airplane up in the air and watch it perform aerobatic maneuvers.

Barnstorming Paper Airplane Student Page

Design Challenge *Construct and fly a paper airplane*

Design Construct and fly a paper airplane that can perform aerobatics such as fly up, stall, dive, inside loop, fly forward, roll, and land smoothly on the ground.

Step 1 Make a paper airplane using the *Barnstorming Paper Airplane Directions.*

Step 2 Make your airplane perform aerobatics. Throw your airplane straight into the air and watch what happens. Test your airplane three times to determine the amount of force you need to apply and the technique you need to use to get the airplane to do what you want it to do. Check off each movement your airplane completes.

Flight	Time in Air	Fly up	Stall	Dive	Inside Loop	Fly forward	Land smoothly
1							
2							
3							

Explain what you need to change about your airplane to help it perform better.

_____

_____

Step 3 Make adjustments to the airplane to improve its performance. Test your airplane three more times.

Flight	Time in Air	Fly up	Stall	Dive	Inside Loop	Fly forward	Land smoothly
1							
2							
3							

Step 4 Reflect on your results.

1.What was your best flight? Why?

_____

_____

Illustrate your airplane's path and aerobatics below.

2. Explain what causes the airplane to stall. What happens after it stalls? Why?

_____

_____

3. Explain what forces cause a pilot to perform an inside loop?

_____

_____

4. How does wind affect your airplane's performance?

_____

_____

5. Where did you observe the most kinetic energy? Where did you observe the most potential energy?

_____

_____

6. Create a bar or pie graph showing the total number of each type of stunt your airplane completed. Identify the most commonly completed stunts and explain why your airplane performed them more than the other types of stunts.

Record Setters 1930s

Set the Stage

In June of 1931, **Wiley Post** first set a record for flying around the world in eight days and 16 hours with the help of a navigator. Post set a second record for the first solo flight around the world in July of 1933. He flew in the *Winnie Mae* with the help of flight instruments. Post also designed the first successful pressurized flight suit that allowed him to fly into the stratosphere.

Howard Hughes was a Hollywood producer, aircraft inventor, and airline owner. He set some of the most important records during the 1930s, as well as made notable contributions to development projects during World War II and to the avionics industry in the postwar era. In July 1939, Howard Hughes and his crew set a new record by flying a Lockheed Super Electra around the world in three days and 19 hours, beating Wiley Post's record by four days. Howard Hughes built Hughes Aircraft, an important aviation manufacturing company, and was involved with aviation for most of his life.

In 1938 **Douglas Corrigan** became an instant national celebrity because of a supposed navigation error. On July 17, Corrigan flew from New York to Dublin, Ireland, when, according to the Civil Aeronautics Authority (CAA), he was supposed to fly from New York to Los Angeles for a transcontinental record. When CAA officials questioned "Wrong Way" Corrigan, he explained that he left New York en route to California but got mixed up in reading his compass and had flown the wrong way. Corrigan became a legendary aviator as a result of his misguided flight.

Overview:
After studying pictures of Wiley Post's pressure suit, students investigate how air pressure affects a pilot's ability to fly at high altitudes. Students retrace the around-the-world flights of record setters such as Wiley Post and Howard Hughes. Students research the development of the pressure suit over time, and create a newspaper similar to those that reported on record-setting aviators in the 1930s.

Objectives:
- Students use maps to retrace flight paths and calculate the distances that Wiley Post and Howard Hughes traveled around the world
- Students conduct an investigation and complete a card activity to determine how high altitudes affect a pilot's ability to fly high
- Students create a newspaper article reporting on the achievements of a famous record setter

Guiding Questions:
- How do pressure suits work, and why do pilots wear them?
- How high can airplanes fly, and why can't they fly in space?
- Why do pilots want to set aviation records?

Materials

Engage
- *Record Setters Images*

Explore in the Classroom
- Map of Howard Hughes's flight around the world
- *Layers of the Earth's Atmosphere Transparency*
- Cardboard milk carton
- Water
- Colored construction paper
- Hole-punch
- *Altitude Cards* (1 set per class or 1 set for each student pair)

Extend Student Learning
- Computers and Internet access

Vocabulary:

Air pressure	Particles of air pressing down on the Earth's surface
Altitude	Height above sea level
Atmosphere	The layer of air surrounding the Earth
Mesosphere	Located above the stratosphere; layer where meteors burn up
Navigate	To follow a planned course
Stratosphere	Located above the troposphere; many jets fly in the lower stratosphere
Pressure suit	A protective suit worn by high-altitude pilots who may fly at an altitude where the air pressure is too low for an unprotected person to survive
Thermosphere	Located above the mesosphere
Troposphere	The layer of the atmosphere closest to Earth; layer where weather occurs

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

Wiley Post
acepilots.com/post.html

Howard Hughes
acepilots.com/pioneer/hughes.html

Douglas Corrigan
centennialofflight.gov/essay/Explorers_Record_Setters_and_Daredevils/corrigan/EX16.htm

A brief history of the pressure suit
nasa.gov/centers/dryden/research/AirSci/ER-2/pshis.html#Early

Space Suits
astronautix.com/craftfam/spasuits.htm

Lesson Procedure:

Engage Students

1. Display the *Record Setters Images* onto a screen.
2. Ask students to observe and make inferences about the Wiley Post picture.
   - What do you see?
   - What do you think he is doing?
   - What is the purpose of his suit?
   - What do you think it is made of?
   - How is it different than his regular clothes?
3. Read Wiley Post's achievements and records.
4. Show a picture of Howard Hughes's airplane surrounded by a crowd. Ask students to observe and make inferences about the picture.
   - What are the people doing?
   - Why were people so interested in aviation?
5. Read Howard Hughes's accomplishments and records. Ask the students to identify obstacles that each aviator may have faced in achieving his goals.

Explore in the Classroom

Retracing Flights (3-5)

1. Ask students how long they think it would take to fly around the world. Then ask them to compare their ideas to the 1930s when technology was simpler.
2. Organize students into groups. Give each group a map showing Howard Hughes' flight around the world.
3. Give each group a blank world map. Students will draw in the Hughes path and calculate the distance he traveled. Include:
   - Countries he flew over
   - Stopping points along the way
4. Afterwards, compare each group's map and calculations to see how closely they match.

Air Pressure and Altitude (4-12)

1. Review the picture of Wiley Post with his pressure suit. Ask students why he would need to wear a pressure suit while flying.
2. Look at the *Layers of the Earth's Atmosphere Transparency*. Review the layers and the altitudes where different types of aircraft usually fly. Ask students to review what they know about air.
3. Demonstrate air pressure in the layers of the atmosphere using a milk carton and water.

- With the milk carton (cardboard is easier to handle than plastic), punch three small holes down one side. Make the first hole about one inch above the bottom of the carton. Make the second hole about three inches above the first hole. Then make third hole about three inches above the second hole. Cover each hole with a piece of duct tape
- Set the milk carton so that the holes are positioned over a sink or large bucket

4. Ask students to predict what will happen when the tape covering the lowest hole is removed. Then remove the tape and observe. Students may observe that the stream of water is coming out at a strong and steady rate.

5. Ask students to predict what will happen when the tape covering the middle hole is removed. Remove the tape and compare both streams of water. Students may observe that the water is not coming out as far as the water from the bottom hole. Ask students to explain why.

6. Ask students to predict what will happen when the tape covering the highest hole is removed. Remove the tape and compare all three streams of water flowing at the same time. Students may observe that the water coming from the top hole is not coming out as strongly or as far as the water from the other two holes. Discuss how the water at the bottom of the carton has more water pressing on it than the water at the top of the carton. More pressure on the bottom of the carton causes the water to come out stronger and farther from the lowest hole.

7. Compare the water in the carton to the air in the atmosphere. Refer back to the *Layers of the Earth's Atmosphere Transparency.* Ask students to identify where the densest air is located and where the thinnest air is located. Identify where airplanes fly.
   - How is the bottom layer of the atmosphere like the bottom layer of the milk carton?
   - What happens to the air molecules as you get higher in altitude?
   - What probably happens to oxygen molecules at high altitudes?
   - How do high altitudes affect people?
   - What might pilots who fly at high altitudes need?

8. Students create their own altitude charts.
   - Use colored construction paper punched from a hole-punch to represent the air molecules in the atmosphere
   - Add Wiley Post's airplane flying in the lower level of the stratosphere
   - Research other information to add to the diagram

Altitude (6 – 12)

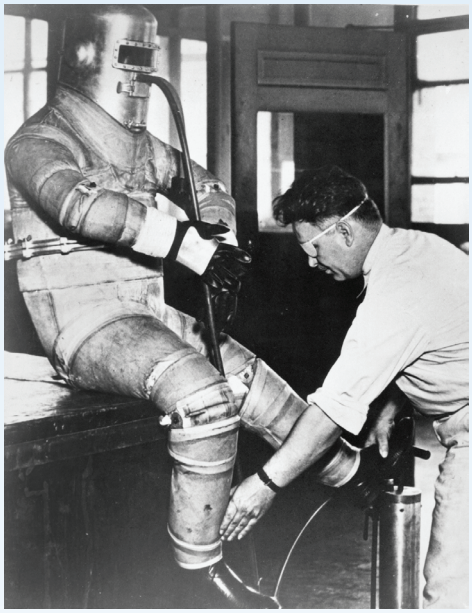
1. Students complete one of the *Altitude Card* activities.
   - Pass out one card to each student. Students find someone who has the answer or question that matches their card
   - Give pairs of students a set of question and answer cards. Students work with their partners to match the cards together
   - Pass out one card to each student. One student reads a question card aloud. The student who thinks they have the correct answer reads his or her card aloud. Continue until all questions are matched with the correct answer
2. Students use their altitude diagram to explain each answer to the class.

Extend Student Learning

Science and Math

Suiting Up

1. Research the development of pressure suits.
2. Create a timeline showing pressure suit designs, materials, and functions.
3. Students may use the following web sites:
   - A brief history of the pressure suit
   - Space Suits
4. Students present their timelines to the class.



Wiley Post examining his second full pressure suit, constructed at the BF Goodrich plant in Akron, Ohio, 1934. *Courtesy The National Air and Space Museum, Smithsonian Institution (SI 84-11901), Washington, D.C.*

Social Studies and Language Arts

Wiley Post Soars Down Home Stretch As Mollisons Hop Off for New York

Globe Circler Is Far Ahead Of Old Record

Metropolis Makes Plan to Give Oklahoma Flyer Great Reception

MARQUETTE, Mich., July 22 (AP).—An unidentified plane which observers thought might be the one flown by Wiley Post, now on the last lap of his globe-girdling flight, passed ove Ishpeming at 6:50 p. m. Saturday.

The plane, traveling a southeasterly course at a high rate of speed, was at an estimated height of 2,500 feet. Ishpeming is sixteen miles west of this city. The plane bore no distinguishing marks visible from the ground.

NEW YORK, July 22 (AP).—Wiley Post of Oklahoma, who soared away to the East in his monoplane Winnie Mae a week ago Saturday morning, flew back from the West Saturday night nearing the end of a record trip around the world.

He shot away from Edmonton, Alberta, on the last leg of his journey at 9:41 a. m. (Eastern standard time) and hoped to wing home 2,200 miles to Floyd Bennett Field within fifteen hours ahead of a tail wind.

He had ample time—until 8 p. m. Sunday (Eastern standard time)—to better the present mark of eight days, fifteen hours and fifty-one minutes he and Harold Gatty hung up in June and July in 1931. With the Winnie Mae and the weather right, the only question was as to the extent of his margin.

And he was virtually assured the distinction of being the first to fly around the world alone.

From Edmonton the flyer made good time. His white and purple ship was believed to have been sighted over McLaughlin, Alberta, at 10:50 a. m. (Eastern standard time), six miles north of North Battleford, Saskatchewan, at 11:15, Humboldt, Saskatchewan, at 1 p. m., and Winnipeg, Manitoba at 2:21.

To Let Self Be Seen.

From there his course lay over Ontario and Northern New York State. Lee Trenholm, his representative here, instructed him by wireless to let himself be seen over the cities along his route.

Hours before Post possibly could come in, Floyd Bennett Field was crowded with aviation enthusiasts, attracted not only by the prospect of hailing the latest conqueror of he world's vast skyways, but also by the twenty-four silver seaplanes of Gen.

See POST on Page 6.

Post

CONTINUED FROM FIRST PAGE.

Italo Balbo's Armada, anchored there.

The floodlights at the field were switched on after dark, and one of the greatest police concentrations ever mustered in the city was on duty.

Mrs. Post, who had said she would "have to kill Wiley if he ever tries to make another long flight," declared she was "very happy" over the prospect of a speedy reunion with her husband. She still stayed anxiously by a telephone to receive the latest reports of the airman's progress from Edmonton, but relief was eviden: in her eyes and her voice.

Oklahomans on Hand.

Trenholm was jubilant, and a group of Post's fellow-Oklahomans who flew here to greet him were likewise elated. Among them were Walter Harrison, managing editor of the Oklahoman-Times; R. T. Fredericks of the Oklahoma City News; William L. Huggins Jr., traffic manager of the St. Louis & San Francisco Railroad; Chauncey D. Nicolls, president of the Oklahoma Concrete Works; Dana Todd, president of Anderson-Todd, brokers; Thomas S. Hanna Jr. and Leslie Fain.

Gatty himself expected to be on hand to see his record shattered. He said in Washington that Post was making a great flight and that he certainly deserves the record.

Plans for the municipal reception to Post, completed Saturday, call for him to receive the traditional ticker-tape shower from the skyscrapers at noon Wednesday in the course of a para-: from the Battery to city hall, the route General Balbo rode Friday. The Winnie Mae will be in the procession, either on its own wheels or atop a truck, and Post will ride in the cockpit.

Heads for New York.

EDMONTON, Alberta, July 22 (UP).—The Winnie Mae droned across Southern Canada Saturday afternoon carrying Wiley Post on the last scheduled stage of a flight which appeared certain to set a new record for speed in encircling the globe.

He left Edmonton at 10:41 a. m. Eastern daylight time, bidding farewell, he hoped, to alien airports. He hoped to set his plane down at Floyd Bennett Airport between 1 and 3 a. m. Eastern daylight time, smashing by eighteen hours or more the mark he set with Harold Gatty in the same plane two years ago.

The speeding Winnie Mae was seldom reported in the early stages of its flight Saturday. It swept above North Battleford, Saskatchewan, at 12:15 p. m. Eastern daylight time, making the first 229 miles of the flight in the fast time of an hour and thirty-four minutes.

The tentative route was north of Winnipeg to Port Arthur, Ontario; along Northern Lake Superior, past Ste. St. Marie to Toronto and thence into the United States at about Buffalo. From there Post and his robot pilot were expected to steer a straight line course for New York City.

Twenty Hours to Good.

The flight was estimated by the route set at 2,200 miles. Post had a lead of twenty hours and twelve minutes over the Post-Gatty record when he left Edmonton and only disaster seemed likely to prevent success in his goal of smashing the old record, as well as setting the first record for a solo around-the-world flight.

To equal the record, Post must land at Floyd Bennett Field by 9 p. m. Sunday; to break it under aeronautical rules, he must arrive at least an hour earlier. But he could stop for a night's sleep en route and still establish the new mark.

Post arrived at Edmonton at 9:13 a. m. Eastern daylight time from Fairbanks after a fast flight through rain. A crowd of several hundred persons gave him an enthusiastic greeting as airport attendants sped about the task of refueling. New spark plugs were installed and 438 gallons of gasoline poured in the tanks.

The flyer, then just over a week out of New York—a week in which he had little sleep—complained of a headache from flying at high altitude to escape storms, but he exhibited full confidence that he would reach New York well before Sunday dawn.

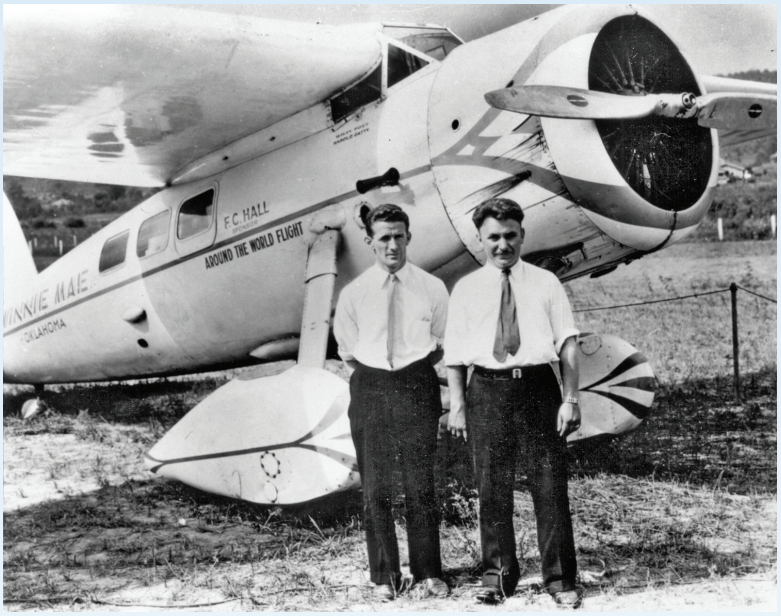
Dallas Morning News, July 23, 1933. Reprinted with permission of *The Dallas Morning News*. *Courtesy Center for American History, The University of Texas at Austin*

1. Look at an example of a newspaper reporting on one of Wiley Post's flights. Ask students to explain what type of information would be included in the report.
   - Who is the article about?
   - What is the article about?
   - Where and when did the event take place?
   - Why did the event take place?
   - How did the event take place?
2. Students write a newspaper article describing the details of one of Wiley Post, Howard Hughes, or Douglas Corrigan's flights. Students may research using the following web sites:
   - Wiley Post
   - Howard Hughes
   - Douglas Corrigan
3. Combine students' newspaper reports into one newspaper. Students may add editorials, advertisements, and other information that reflects the time period.

Engage Students

Record Setters Images

What do you observe in these pictures? What can you infer from your observations?



Courtesy The National Air and Space Museum, Smithsonian Institution (SI 89-11), Washington, D.C.

1933 First Aviator to fly solo around the world

1934 Developed the first successful pressurized flight suit

Courtesy Florida Air Museum, Lakeland, Florida

1935 Set a new speed record, of 352 mph in his H-1 Racer

1937 Set a new transcontinental air speed record of seven hours and 28 minutes

1938 Set a new record by flying around the world in three days and 19 hours

Engage Students

Altitude Cards

Questions

What happens to Earth's atmosphere as the altitude increases?	How are altitudes described?	How does friction affect airplanes?
What is air like at higher altitudes?	How is the air at higher altitudes beneficial to airplanes?	At what altitudes can pilots fly without extra oxygen?
How high do commercial jet planes and prop planes fly?	What is there less of in the air at high altitudes than at lower altitudes?	What does a pilot wear at high altitudes?

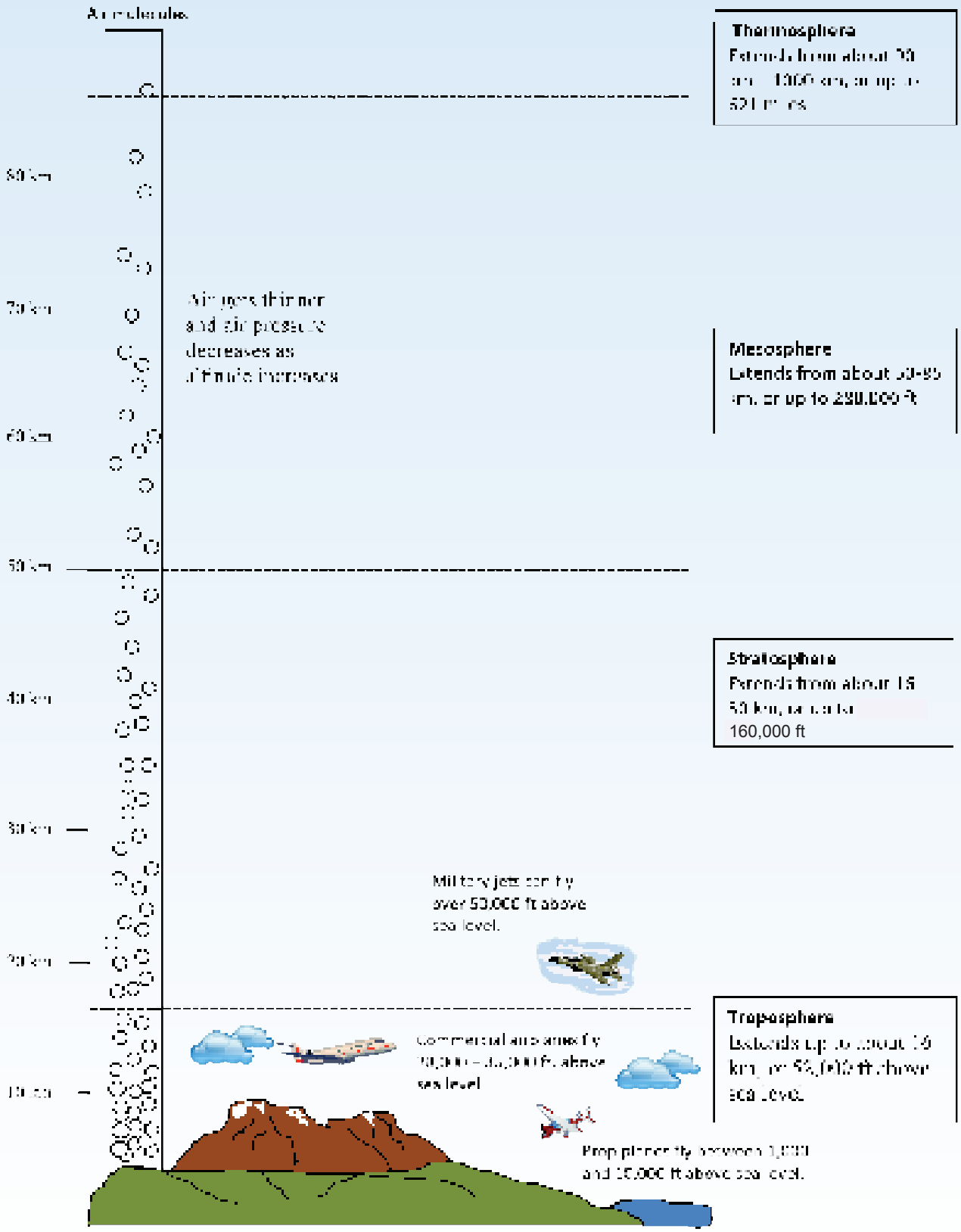
Altitude Cards

Answers

The air in the Earth's atmosphere becomes thinner as the altitude increases.	Altitudes are described by the number of feet above sea level.	There is less friction at higher altitudes. Less friction and higher air speed causes engines to burn less fuel. This allows the airplane to travel further.
Air is less dense at higher altitudes.	Thinner air at high altitudes creates less resistance.	Pilots flying between sea level and 10,000 feet usually do not require extra oxygen.
Commercial jet planes can cruise between 28,000 and 35,000 feet. Prop planes fly between 1,000 and 10,000 feet above sea level.	There is less oxygen at high altitudes than there is at lower altitudes.	At high altitudes a pilot wears a pressure suit that supplies him with a pressurized atmosphere.

Map of the World showing round-the-world flights attempted by pilots up to 1939. Given to Howard Hughes by Hollywood actress Katharine Hepburn. Created by Rand McNally and Company, New York, 1939.
Courtesy Florida Air Museum, Lakeland, Florida

Layers of Earth's Atmosphere Transparency



World War II 1940s

Set the Stage

Women's Air Force Service Pilots (WASP) were civilian auxiliary pilots whose service released qualified men for combat. They were the first women to serve as pilots and fly military aircraft for the United States Army Air Forces during World War II. The WASP were originally stationed in Houston, Texas. These civilian aviators performed a variety of duties, including ferrying aircraft, towing targets for anti-aircraft and aerial gunnery, tracking and searchlight missions, transporting military personnel, making bombing range runs to train bombardiers, giving flight instruction, and engineering and maintenance test flying. In a two-year period during World War II, the WASP altogether flew sixty million miles and delivered 12,652 airplanes domestically. The WASP proved that women were capable of flying military aircraft as well as men.

Overview:
Students learn about the WASP (Women Air Force Service Pilots) and their role in World War II by interacting with images and video. Students try to train a partner to perform a new skill and then evaluate their own ability to give and follow directions. Students locate military training bases on a Texas map and research the geography and climate that make the locations desirable places to train pilots. Students research military aircraft or research and create a documentary about the roles WASP played during World War II.

Objectives:
- Students observe video and images of the WASP to determine the role they played in World War II
- Students practice giving directions to develop their ability to train someone to master a new skill
- Students use maps to identify training fields in Texas and determine why geography and weather make Texas a desirable location for military training bases
- Students research military aircraft to understand the features that pilots needed to fight in World War II
- Students research a military group that existed during World War II, and create a documentary to illustrate and explain the role the group played in the war

Guiding Questions:
- How is training important in becoming a pilot?
- What role did the WASP play in World War II?
- Why is Texas an ideal location for flight fields and schools?

Vocabulary:

WASP	Women Air Force Service Pilots
Tuskegee Airmen	The first African American flying unit in the United States military during World War II
Flying Tigers	Group of U. S. civilian volunteer pilots recruited to fight in World War II
Royal Air Force	The British air force

Materials

Engage
- Computer with Internet access and projector
- *WASP Images*

Explore in the Classroom
- *Training Fields in Texas Map*
- Computers with Internet access

Extend Student Learning
- *WWII Documentary Story Board*
- Computers with Internet access

Literature:
Yankee Doodle Gals by Amy Nathan

The Tuskegee Airmen Story by Lynn Homan and Thomas Reilly

Red-Tail Angels: The Story of the Tuskegee Airmen of World War II by Patricia C. McKissack and Fredrick L. McKissack

The Tuskegee Airmen by Linda George and Charles George

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

A Brief History of the WASP
youtube.com/watch?v=pmEQziYmg38

WASP on the Web
wingsacrossamerica.us/wasp/video/index.htm

WASP on the Web
wingsacrossamerica.us/wasp/index.htm

WASP primary sources
pbs.org/wgbh/amex/flygirls/filmmore/reference/primary/

Women Airforce Service Pilots (WASP)
twu.edu/library/wasp.asp

Tuskegee Airmen
tuskegeeairmen.org/Tuskegee_Airmen_History.html

American Visionaries: Tuskegee Airmen
nps.gov/history/museum/exhibits/tuskegee/airoverview.htm

Flying Tigers
acepilots.com/misc_tigers.html

Royal Air Force
raf.mod.uk/history/

Royal Air Force: Online Exhibitions
rafmuseum.org.uk/online-exhibitions/

Explore Texas Regions – Primary
tpwd.state.tx.us/kids/about_texas/regions/primary/

Explore Texas Regions
tpwd.state.tx.us/kids/about_texas/regions/

WWII Airplanes and More
acepilots.com/planes/main.html

World War 2 Planes
world-war-2-planes.com/american-airplane-picture.html

Lesson Procedure:

Engage Students

1. Show a video clip of the history of the WASP (Women Air Force Service Pilots) such as *A Brief History of the WASP* or *WASP on the Web.*

2. Students make notes about the video including:
   - Comments about what they observed
   - Technology of the time
   - Clothing of the time
   - Duties
   - Aircraft they flew
   - Intended message for the viewer
   - Questions
3. Discuss students' comments and observations.

4. Show pictures of the WASP and ask students to infer what is happening in each picture.

5. Students write questions they still have on sticky notes, and then post the questions on the board or a wall. Review the questions throughout the lesson so students can post answers.

Explore in the Classroom

Pilot Training (K-5)

1. Organize students into pairs. Each student in the pair must identify a skill that they are good at and can demonstrate such as doing a cartwheel, drawing a picture, or solving a math problem.

2. Each student must teach their partner the skill, so the partner can demonstrate the new skills for the class.

3. Students record their experience by answering the following questions:
   - Trainer
     - Was your partner able to follow your directions?
     - What could you have done to help your partner learn the skill better?
     - What directions, if any, did you leave out?
     - How well did your partner perform the skill?
   - Student
     - How well were you able to perform the skill?
     - What could your partner have done differently that would have helped you to learn the skill easier or faster?
     - How well did you partner teach you the skill?
4. Discuss students' experiences with training and being trained. Relate their experiences to learning to become a pilot. What types of skills do pilots need to learn?

Air Fields in Texas (4-8)

1. Give students the *Training Fields in Texas Map* marked with locations of training fields. Students must complete the table identifying the region where each training field is located and the geography and climate for that region.

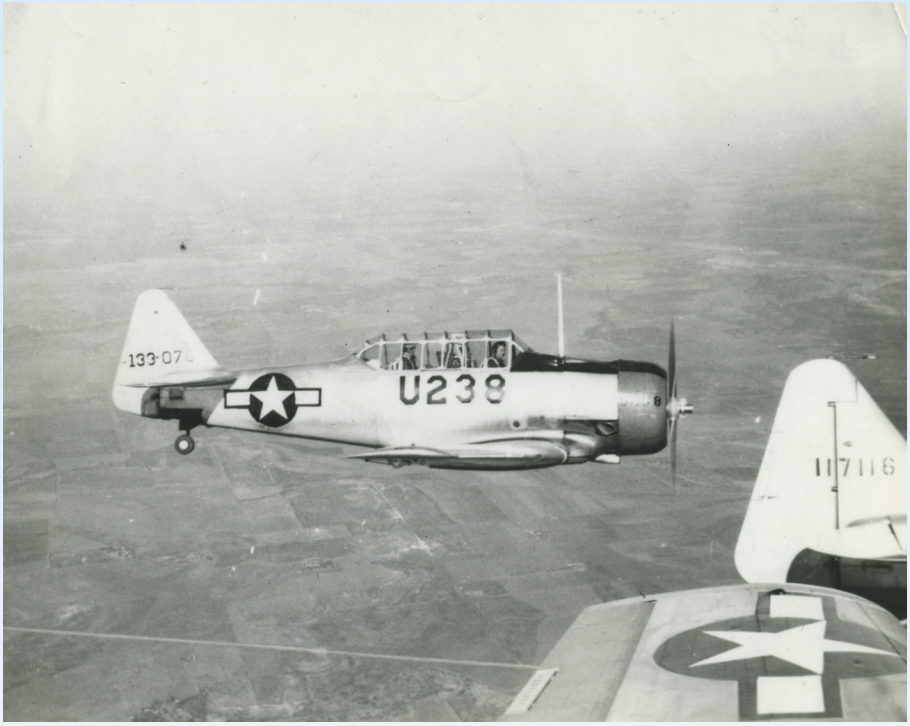
2. Students may use the following web sites:
   - *Explore Texas Regions – Primary*
   - *Explore Texas Regions*

3. Students include an explanation of how geography and climate may have played a part in establishing training bases in Texas.

Extend Student Learning

Science and Math	Social Studies and Language Arts
WWII Airplanes 1. Students research different WWII airplanes. Students must select one, and create a poster with the following: • Labeled diagram of the parts of the airplane • Purpose of the airplane • Special features that helped it to complete its missions • Success of the airplane 2. Students may use the following web sites: • WWII Airplanes and More • World War II Planes 3. Students present their WWII airplanes to the class. 	**WWII Documentary** 1. Students select one of the groups that played an important role in World War II, and conduct further research. Students must create a documentary using Photo Story or other presentation software. Include the following: • Who were the members of the group? • How did they become a part of the group? • What is their connection to Texas? • What did their flight suits and uniforms look like? • How long was the group in existence? 2. Students may use the *World War II Documentary Story Board* to plan. Students may use the following web sites: • Women Airforce Service Pilots (WASP) • WASP on the Web • Fly Girls • Tuskegee Airmen • American Visionaries: Tuskegee Airmen • Flying Tigers • Royal Air Force • Royal Air Force: Online Exhibitions 3. Students present their documentaries during a class film festival.

WASP Images



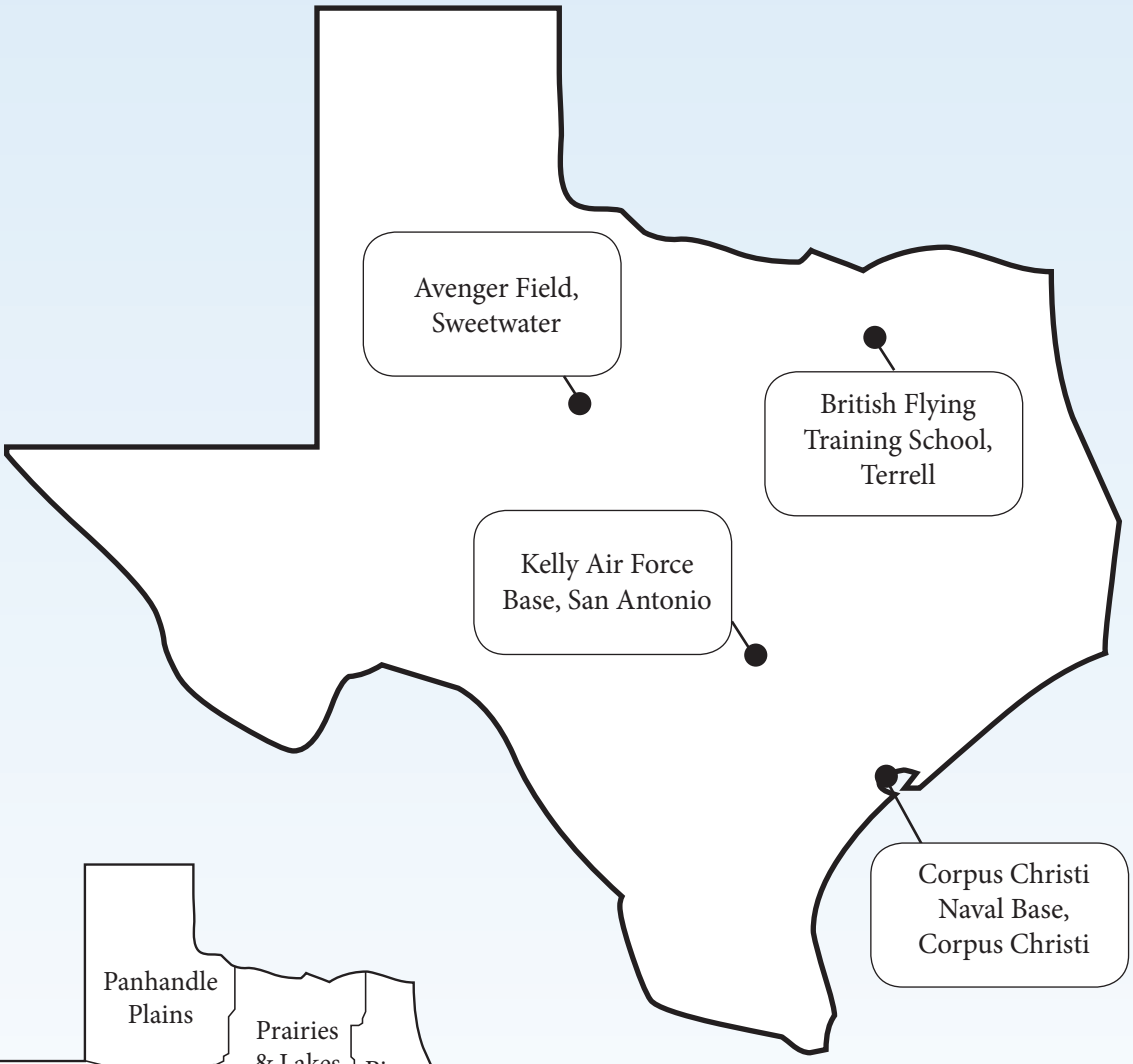
WASP flying AT-6, Avenger Field, Sweetwater, Texas, ca. 1943-44.
Courtesy Texas Women's University, Denton

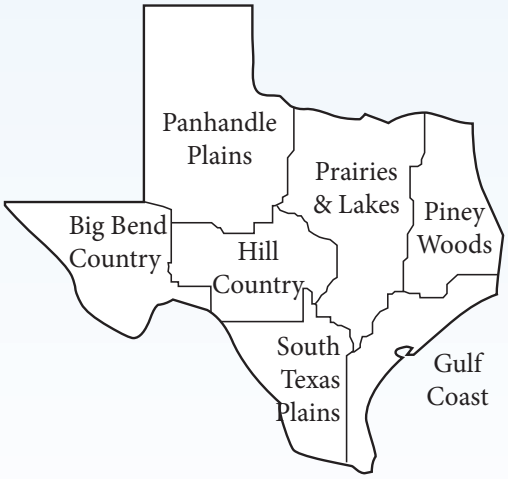
WASP training, Avenger Field, Sweetwater, Texas, ca. 1943-44.
Courtesy Texas Women's University, Denton

WASP ground school, Avenger Field, Sweetwater, Texas, ca. 1943-44.
Courtesy Texas Women's University, Denton

Training Fields in Texas Map

Use the maps and Internet resources to record information about the training fields in Texas.





Texas Training Field/ Location	Texas Region	Geography	Climate

What do you notice about the locations of the training fields? How are geography and climate important?

_____

_____

_____

_____

_____

What can you conclude about Texas as a place to locate training fields?

_____

_____

_____

_____

_____

WWII Documentary Story Board

Plan you documentary below on the story board. Then use your story board to create your Photo Story presentation. Be sure to add graphics, narration, text, and music.

Title	When and why did the group first form?	What is the group's connection to Texas?
Who were some of the members, and how did they become part of the group?	What airplanes did they fly and what did their uniforms look like?	What were some of the group's accomplishments?
How long was the group in existence?	Conclusion	

Cold War 1950-1970s

Set the Stage

The **B-36 Peacemaker**, the first intercontinental and propeller driven bomber used by the U.S. Air Force, served as a deterrent during the initial years of the Cold War. The Peacemaker was the largest mass-produced piston engine aircraft ever made. It had the longest wingspan of any combat aircraft ever built. It was capable of delivering nuclear weapons that fit inside the bomb bay without aircraft modifications. The B-36 was the nation's principal nuclear weapons carrier in the arsenal of the Strategic Air Command at Carswell Air Force Base in Fort Worth, Texas. **Beryl A. Erickson** and **Gus Green** first test flew the Convair XB-36 on August 8, 1946.

Overview:
After watching a video clip of the B-36 Peacemaker, students conduct a test to determine how wing size affects lift. Students use their new learning to explain how wing size was important in helping the B-36 fly. Students attempt to build the largest airplane that can fly. To learn more about the B-36 students research its history and present their findings by creating a mobile.

Objectives:
- Students conduct a test to determine how wing size affects lift
- Using problem-solving and critical thinking skills, students complete a design challenge to build the largest airplane that can fly
- Students research the history of the B-36 bomber to determine the impact it has had on military aviation

Guiding Questions:
- What was the purpose of the B-36 Peacemaker, and how did people feel about it as a military airplane?
- How does wing size affect an aircraft?

Vocabulary:

B -36	Known as the Peacemaker; designed to deliver a heavy bomb load to targets half way around the world
Wingspan	The distance from one wing tip to the other

Materials

Engage
- Computer with Internet access and projector

Explore in the Classroom
- Styrofoam trays or oval plates (2 pieces per student, depending on the size of the tray or plate)
- Scissors or X-Acto Knife
- Small binder clips (1 per student)
- *Which Airplane Flies Best? Student Page*
- *Wings and Lift Student Page*
- *Wing Size and Lift Airplane Template*

Extend Student Learning
- Computer with Internet access

Literature:
Convair B-36 Peacemaker by Meyers K. Jacobson

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

B-36 Bomber
en.wikipedia.org/wiki/File:B-36_bomber.ogg

Convair B-36 Peacemaker Biggest Bomber
youtube.com/watch?v=YgStI1S_rEM

1956 Featherweight B-36 Reaches New Height
youtube.com/watch?v=4oSG1TmbAB0&feature=PlayList&p=0A51A6CB7E0AF3D3&playnext=1&playnext_from=PL&index=1

Convair B-36 Peacemaker
aerospaceweb.org/aircraft/bomber/b36/

Lesson Procedure:

Engage Students

1. Introduce the B-36 Bomber by showing one of the following video clips.
   - *B-36 Bomber*
   - *Convair B-36 Peacemaker Biggest Bomber*
   - *1956 Featherweight B-36 Reaches New Height*
2. Ask students to write down three facts that made the B-36 different from other airplanes. Share notes as a class.

Explore in the Classroom

Which Airplane Flies Best? (K-3)

1. Students build airplanes with two sizes of wings using the *Wing Size and Lift Airplane Template*.
2. Hold up two airplanes with different sizes of wings constructed from the *Wing Size and Lift Airplane Template*. Ask students to predict which one will fly farther, higher, and longer?
3. Organize students into small groups. Give each group airplanes with both sizes of wings.
4. Students test each airplane and record how well each one flies on the *Which Airplane Flies Best? Student Page*.
5. Display the student page onto a screen and record each group's response to the questions.
6. Ask students to explain the results.

Wing Size and Lift (4-12)

1. Explain that the B-36 was known as the Peacemaker. It was the largest mass-produced piston engine aircraft ever made. The B-36 had the longest wingspan of any combat aircraft ever built. It was designed to deliver a heavy bomb load to targets half way around the world. The B-36 Bomber had a very long wingspan. How was the wing size important to its success?
2. Explain that students must create and build an airplane with two different wings to determine how the wing size affects the airplane's ability to fly.
3. Students may work alone or in groups to build their airplanes. Give each student or group one to two Styrofoam trays or oval plates and a *Wing Size and Lift Airplane Template*.
   - Cut out the airplane template and trace the parts on a Styrofoam tray or oval plate. Then cut out the Styrofoam pieces. If using scissors, students should be sure not to bend the Styrofoam. If using an X-Acto knife, an adult should do the cutting.
   - Cut out the two slots on the fuselage. Slide wing A into the slot located toward the front of the fuselage. Slide the elevator through the slot in the back section of the fuselage.
   - Place a binder clip under the nose of the airplane to add weight and balance. Students will need to test their airplanes to determine the proper placement of the binder clip. Students can move the binder clip forward and backwards until the airplane flies the best.

Wide wings

Narrow wings

4. Students test both sets of airplane wings to determine how size affects how the airplane flies.
   - Give each student a *Wing Size and Lift Student Page*. Students follow the directions to test both sets of wings and then record their results
5. Discuss students' results. Students may find that the wider wings provide more lift for the airplane. Ask students to explain how the B-36's wing size helped it to fly.

Extend Student Learning

Science and Math

Design Challenge Build your own B-36

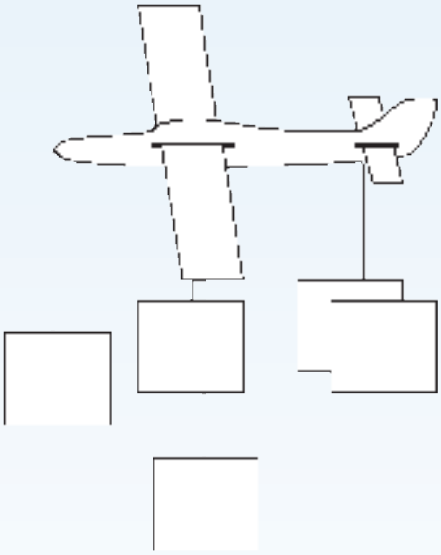
1. Display the *Design Process Diagram* onto a screen and describe the steps students will follow to complete the design challenge.
2. Students design and build the largest airplane that can fly.
3. Students draw their design on graph paper. They may use ideas from past activities or use other ideas from books or the Internet.
4. Students then construct, test, and revise their airplanes.
5. Students present their airplanes to the class.
6. Make a list of each student's airplane and include the distance that it flies.
7. After identifying the airplane(s) that fly the longest, study the construction to decide what helps them stay in flight.

Student	Time in air

Social Studies and Language Arts

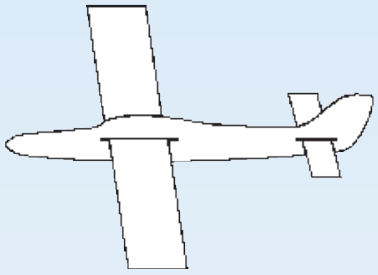
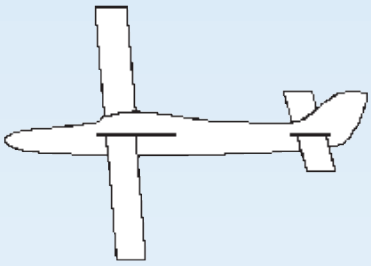
History of the B-36

1. Students learn more about the history of the B-36 Bomber. Use video and web sites to create a mobile that teaches about the following:
   - Development
   - Related models
   - Design
   - Records set
   - Roles
   - Reason for retirement
2. Refer to video and web sites for information such as *Convair B-36 Peacemaker*.
3. Students create a model of the B-36 airplane to hang in the middle of the mobile, and then hang information about each topic underneath. Students must make sure the mobile is balanced.



Which Airplane Flies Best? Student Page

Put a check under the airplane that best answers the question.

	 Wide wings	 Thin wings
Which airplane flew higher?		
Which airplane flew farther?		
Which airplane flew longer?		

Explain which airplane you think flies the best and why.

_____

_____

_____

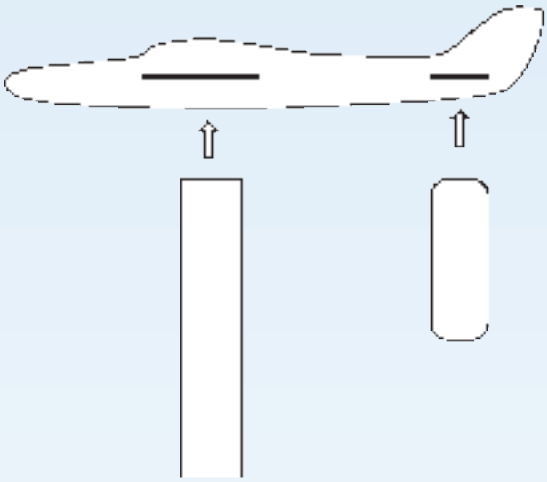
_____

_____

Wing Size and Lift Student Page

Step 1: Cut out the airplane template and trace the parts on a Styrofoam tray or oval plate. Then cut out the Styrofoam pieces. If using scissors, be sure not to bend the Styrofoam. If using an X-Acto knife, an adult should do the cutting.

Step 2: Cut out the two slots on the fuselage. Slide wing A into the slot located toward the front of the fuselage. Slide the elevator through the slot in the back section of the fuselage.



Step 3: Place a binder clip under the nose of the airplane to add weight and balance. You will need to test the airplane to determine the proper placement of the binder clip. Move the binder clip forward and backwards until the airplane flies the best.

Attach a binder clip under the nose of the airplane. Move the clip forward or backward until the airplane's weight is balanced. The airplane is balanced when it flies smoothly.

Step 4: Follow the directions to test the airplane using Wing A. Then repeat the test using Wing B. Record your results.

1. Prediction. Which set of wings will provide the most lift, and will allow the airplane to fly the farthest and longest? Why?

_____

_____

_____

2. Measure the width of each wing and the wingspan (distance from the tip of one wing to the tip of the other wing). Calculate the area of each wing (Multiply length x width). Test the airplane using each set of wings, and record your results in the tables below.

Airplane with Wing A

Width of Wing _____ Wingspan _____ Area of Wing _____

Trial	Distance traveled
1	
2	
3	
Average	

Airplane with Wing B

Width of Wing _____ Wingspan _____ Area of Wing _____

Trial	Distance traveled
1	
2	
3	
Average	

Observations _____

_____

_____

3. Which airplane flew the farthest? Why?

_____

_____

_____

4. Which airplane flew the longest? Why?

_____

_____

_____

5. How does the wing size affect the airplane?

_____

_____

_____

What do you think now?

6. What else could you change about the wing that would affect the way the airplane flies?

_____

_____

_____

_____

7. Plan and conduct an investigation to test your idea. Record what you do below.

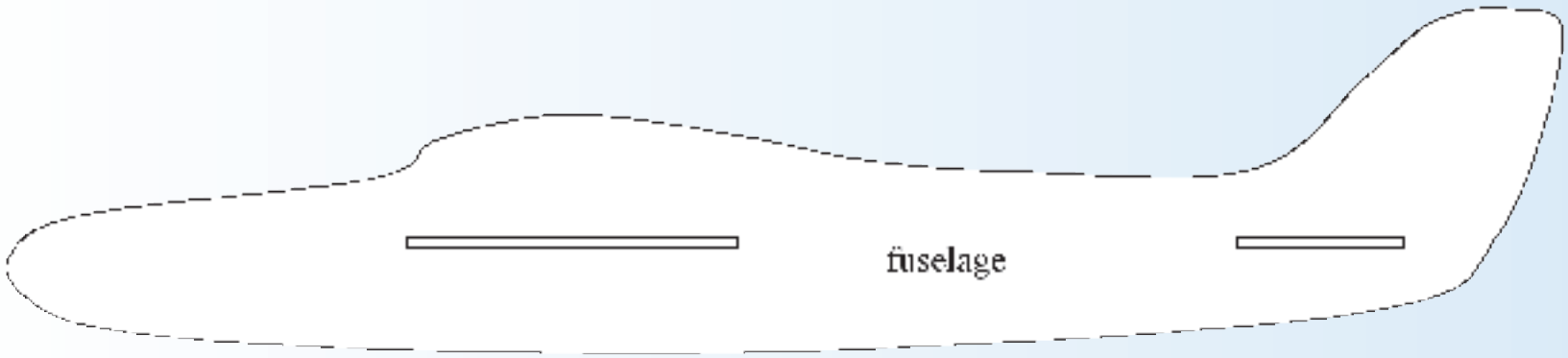
_____

_____

_____

_____

Wing Size and Lift Airplane Template



Wing A

Wing B

Elevator

Extend Student Learning

Design Challenge *Build Your Own B-36*

Design Challenge Design and build the largest airplane that can fly.

Design Design your airplane on graph paper.

Build Build your airplane based on your design.

Test Test your airplane several times and record your results below in a table.

Revise Explain the improvements you need to make to your airplane.

_____

_____

_____

Explain how your airplane performed after you made the improvements.

_____

_____

_____

Present Present your airplane to the class and discuss the results.

Evaluate Reflect on your results.

How did the changes you made affect the airplane's performance?

_____

_____

_____

_____

What could you do to improve the design further?

_____

_____

_____

_____

What did you learn from this experience?

_____

_____

_____

_____

1980s, 1990s, and Today

Set the Stage

On December 23, 1986, *Voyager* completed the first non-stop, non-refueling flight around the world. The pilot, **Dick Rutan**, and co-pilot, **Jeana Yeager**, flew this unique aircraft constructed almost entirely of a lightweight graphite honeycomb composite material. It took them nine days, three minutes, and 44 seconds to travel 26,358 miles at an average speed of 116 miles per hour.

In 1982, **H. Ross Perot Jr.** completed the first helicopter flight around the world in his aircraft the *Spirit of Texas*. The 26,000 mile trip was completed in less than 30 days, crossing 26 countries, and 17 seas and oceans.

Overview:
Students compare the tasks that helicopters and airplanes can complete. Students test their knowledge over the parts of a helicopter, and then create a paper helicopter to test different factors that affect lift. Students research how a helicopter flies and present their new learning in a multimedia presentation and remote control helicopter demonstration. Students identify the details of world record flights around the world, and then develop a proposal for their own transcontinental flight.

Objectives:
- Students compare and contrast helicopters and airplanes to determine the roles they each play in aviation
- Students explore the parts of a helicopter and determine how the parts of the helicopter system help it to fly
- Students complete a card activity to distinguish between the record-setting, around the world flights of the *Voyager* and the *Spirit of Texas*
- Students learn about the advances in technology that provide opportunities for around-the-world flight

Guiding Questions:
- How are helicopters and airplanes similar and different?
- Why do people continue to set aviation records for traveling around the world?
- Besides airplanes, what type of aircraft do people use to fly around the world?

Materials

Engage
- Large Venn diagram

Explore in the Classroom
- *Parts of a Helicopter Diagram and Cards* (1 set per student group)
- *Helicopter Template*
- *Helicopter Flight Test Student Page*
- *Design Process Diagram*
- *Around the World Cards* (1 set per student group)

Extend Student Learning
- *Around the World Student Directions*
- *Design Challenge Helicopter Flight Test*

Vocabulary:

Cockpit	Where the pilot sits and controls the helicopter
Drive shaft	Attaches to the main rotor and spins the blades
Engine	Provides the power to spin the shaft so the helicopter can lift off of the ground
Helicopter	An aircraft that gets its lift from blades that rotate around a vertical, central axis
Landing skids	Structure that supports the helicopter so it can land and sit on the ground
Main rotor	Includes rotor blades that spin and give the helicopter lift
Mechanical energy	The energy of motion used to perform work
Tail rotor	Produces sideways thrust and keeps the helicopter from spinning

Literature:
Dick Rutan and Jeana Yeager Flying Non-Stop Around the World by Laurie E. Rozakis

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

How Stuff Works: Special Capabilities of Helicopters
science.howstuffworks.com/helicopter2.htm

Future Flight Design Center
futureflight.arc.nasa.gov/liftSize.html

How Stuff Works: Helicopters
science.howstuffworks.com/helicopter3.htm

Start Flying
start-flying.com/new%20site/heli1.htm

Centennial of Flight
centennialofflight.gov/essay/Dictionary/helicopter/DI27.htm

Lesson Procedure:

Engage Students

1. Ask students what they would rather fly: an airplane or helicopter. Then ask students to explain why.
   - Is one type of aircraft better than another?
   - Is one type better for certain tasks than another?
2. On a wall in the room create a large Venn diagram. Label one side helicopters and the other side airplanes. Organize students into groups to discuss what they know about each type of aircraft.
   - Students write how helicopters and airplanes are alike and different on sticky notes or note cards to place in the Venn diagram. Students should describe structures, how the two aircrafts fly, and the types of jobs each one performs
   - Students should be sure not to duplicate answers they see
   - As a class, discuss whether students think one type of aircraft is better or more important than another. Students may conclude that each can serve specific purposes that the other cannot accomplish such as a helicopter can fly lower into smaller spaces to pick up or drop off a passenger. Airplanes can hold many more people than a helicopter can

Explore in the Classroom

Parts of a Helicopter (K-8)

1. Pass out one set of *Parts of a Helicopter Diagram* and cards to each group.
2. Each group matches the words to the correct part of the helicopter. Then students match the function to each part.
3. Discuss each group's answers. Students may add other parts.
4. Students may complete the activity again at the end of the lesson to compare their understanding of the concepts.

Helicopter Flight Test (K-8)

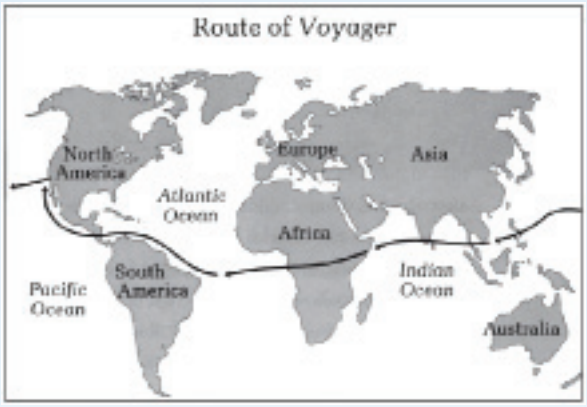
1. Review what students know about airplanes and flying. Investigate how helicopters fly.
2. Display the *Design Process Diagram* onto a screen and describe the steps students must follow to complete the design challenge.
3. Give each student the *Helicopter Template* and *Helicopter Flight Test Student Page.*
4. Students cut the helicopter out and follow the directions included.
5. Once the helicopter is assembled, students test it three times and record the results.
6. Students then try to find a way to make the helicopter stay in the air longer. Students may try using a different type of paper or change the size of the rotors. Students record the modifications they make to the design, retest their helicopter three more times, and then record the results.
7. Discuss what makes the helicopter work. When the helicopter falls, air pushes up, bending the rotors slightly. When air continues to push up on the slanted rotors, the result is a push. Since both rotors are being pushed, the helicopter spins. Use the diagram of a helicopter to show the thrust and motion of the helicopter.

8. Ask students to describe other ways a helicopter might move.
   - What are the benefits of each type of movement?
   - How is mechanical energy important in helicopters?
9. Show the video clips from *How Stuff Works* to see a helicopter hover, stop quickly in mid-air, and fly in reverse.
   - *How Stuff Works: Special Capabilities of Helicopters*
10. Students may practice using different rotors and blades at the *NASA: Future Flight Design Center.*

Around the World Records (4-12)

1. Organize students into groups. Give each group a set of *Around the World Cards*. Explain that both aircraft set records for flying around the world. Students study the pictures and match the facts to the aircraft being described.
2. Once students have matched all cards, check answers with the class. Ask students to give evidence to support their answers.

Extend Student Learning

Science and Math	Social Studies and Language Arts
How does a Helicopter fly? 1. Students research how helicopters fly and maneuver. Use web sites to locate information. • *How Stuff Works: Helicopters* • Start Flying • Centennial of Flight 2. Students create a multimedia presentation, and present it to the class. 3. Bring in a remote controlled helicopter to help demonstrate.	**Plan Your Flight Around the World** Jeana Yeager and Dick Rutan flew the first, non-stop, non-refueling flight around the world. It took them nine days, three minutes, and 44 seconds. They traveled 26,358 miles at an average speed of 116 miles per hour. Plan your own trip around the world.  1. Give students the *Around the World Student Directions* to help them plan their trip around the world. 2. Students may work in groups or individually to create their proposal and display. 3. Students must present their proposals to a panel of judges who will evaluate their plans and give them a score.

Parts of a Helicopter Diagram

Parts of a Helicopter Cards

Cut out the cards and match them to the correct part on the *Parts of a Helicopter Diagram.*

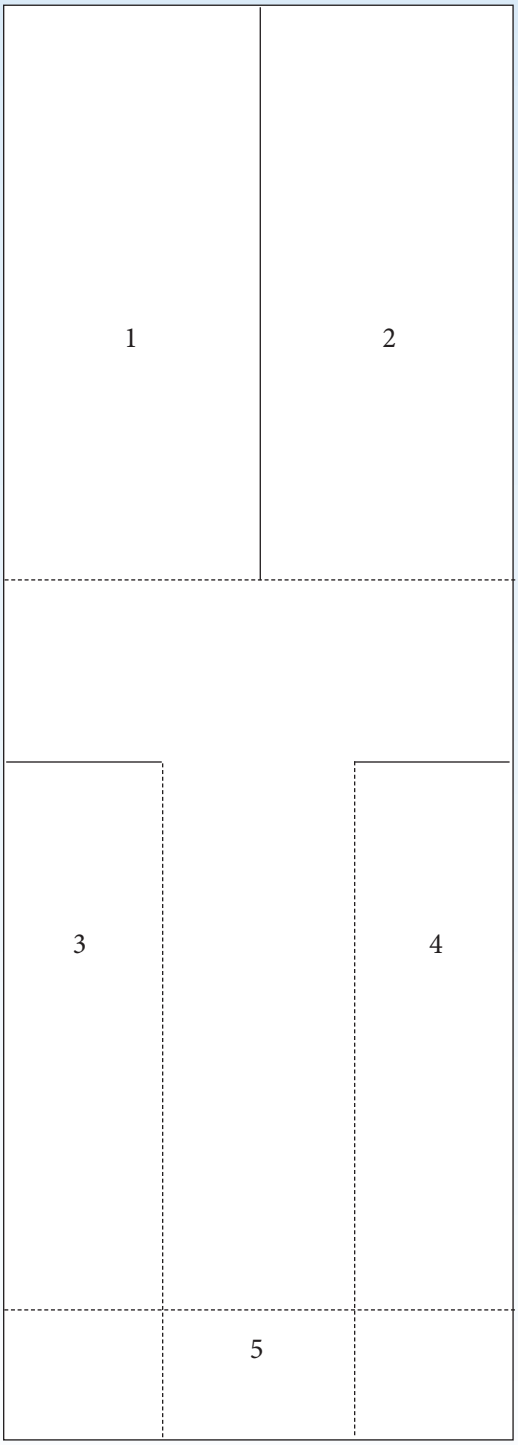
Parts of a helicopter

Tail Rotor	**Main Rotor**	**Drive Shaft**
Engine	**Landing Skids**	**Cockpit**

What the parts do

Produces sideways thrust and keeps the helicopter from spinning	Includes rotor blades that spin and give the helicopter lift	Attaches to the main rotor and spins the blades
Provides the power to spin the shaft so the helicopter can lift off of the ground	Structure that supports the helicopter so it can land and sit on the ground	Where the pilot sits and controls the helicopter

Helicopter Template



Directions:

1. Cut the helicopter out along the outer solid line.
2. Cut along the interior solid lines.
3. Fold flap 1 down along the dotted line. Fold flap 2 along the dotted line, but in the opposite direction.
4. Fold flap 3 and 4 in so that they overlap.
5. Fold the bottom labeled 5 up and hold together with a paper clip.
6. Decorate your helicopter.
7. You can test your helicopter two different ways.
   - Hold the helicopter high off of the ground and drop
   - Hold the helicopter by the paper clip, throw it into the air, and observe

Modification suggestions:

- Use different weights of paper
- Use different sizes and numbers of paper clips
- Make longer or shorter rotors
- Use different rotor shapes
- Make a larger or smaller helicopter
- Combine two rotors to make a 4-propeller helicopter

Design Challenge Helicopter Flight Test

Design Challenge *Build and test a helicopter that will fly as long as possible.*

Design and Build Cut the helicopter out from the template, and follow the directions included.

Test Test your helicopter three times and record the results. Be sure to drop your helicopter from the **same height each time.**

Trial	Drop Height	Time in air (s)	Speed
1			
2			
3			
Average			

1. Illustrate your helicopter, and explain how it works. How do the rotors generate lift? Draw arrows to show the direction of the air's force and the direction of the helicopter's motion.

_____

_____

_____

_____

_____

Revise How can you make the helicopter stay in flight longer? Try using a different type of paper, changing the size of the rotors, or any other modification to improve your helicopter's performance. Retest your helicopter three more times. Be sure to drop the helicopter from the same height each time.

I modified my helicopter by _____

Trial	Drop Height	Time in air (s)	Speed
1			
2			
3			
Average			

Present Demonstrate your helicopter to the class. Discuss the results.

Evaluate Reflect on your experience.

2. Explain what you have learned from your investigation.

_____

_____

_____

_____

_____

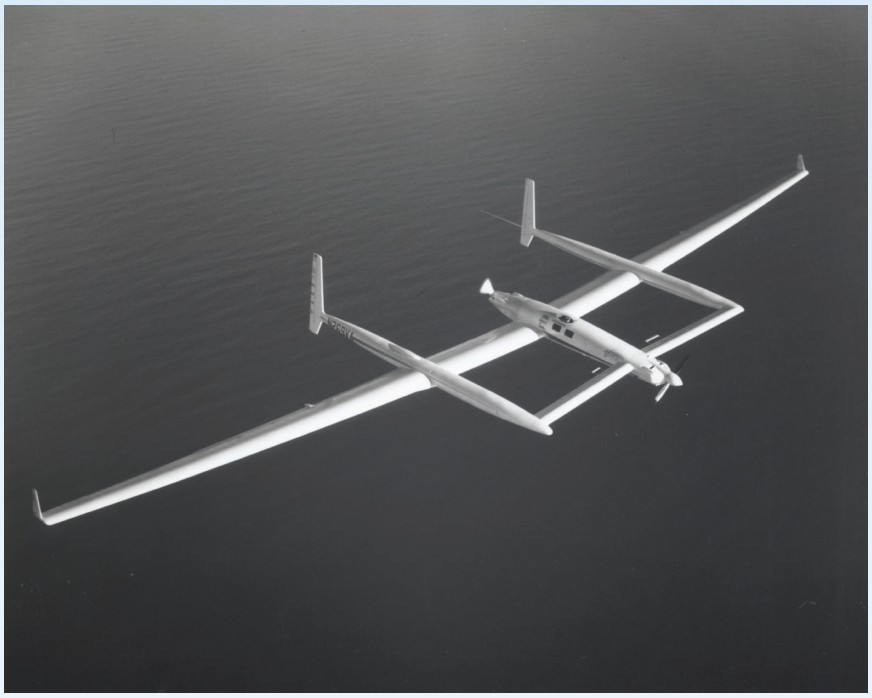
3. Make a double bar graph showing how your helicopter performed before and after your modifications.

_____

(title)

Around the World Cards

Cut out the pictures and cards. Then match the cards to the aircraft being described.



The *Voyager* during a test flight, ca. 1986.
Courtesy Texas A&M University-Commerce Special Collections, Commerce

Pilots Jay Coburn and H. Ross Perot Jr. with the Bell Lone Ranger II *Spirit of Texas* helicopter they flew around the world, ca. 1982.
Courtesy Bell Helicopter, Hurst

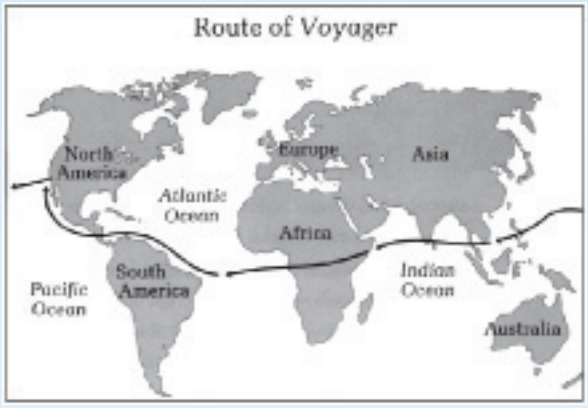
Around the World Cards

First helicopter to fly around the world	Completed the first non-stop, non-refueling flight around the world
Flew around the world in 29 days, three hours, and eight minutes in 1982	Flew around the world in nine days, three minutes, and 44 seconds in 1986
Aircraft was painted with bright colors and designs so it could be easily seen	Aircraft was built using graphite and was half the weight of steel and five times as strong
Flew an average of 8 ½ hours a day	Weighed only 939 pounds when empty and 9694.5 pounds when full of fuel, pilots, and supplies
Refueled 56 times	Average altitude flown was 11,000 feet
A special fuel tank was added to the aircraft, along with special safety, communication, and navigation equipment	One of the pilots cut hair to reduce weight

Answers: The 1st column describes the *Spirit of Texas*. The 2nd column describes *Voyager*.

Around the World Student Directions

Jeana Yeager and Dick Rutan flew the first, non-stop, non-refueled flight around the world. It took them nine days, three minutes, and 44 seconds. They traveled 26,358 miles at an average speed of 116 miles per hour.



You have been approached by the *World Travels Company* to create a travel package that will take passengers on an around-the-world flight. In order to be selected for this honor, you must create a proposal that details your plan. Then you will present your proposal to the company for consideration.

Your proposal must be in the form of a display and must include the following:

- ❑ **Type of aircraft** – It must be able to hold up to four passengers.
- ❑ **Fuel** – Research information about the aircraft you choose and determine how much fuel and weight it can carry. How far can the aircraft travel before refueling? How much fuel will you need for the trip?
- ❑ **Flight Path** – Where will the aircraft travel? Are there areas you will want to avoid flying over? How will you determine where to fly? Where will the aircraft land for refueling?
- ❑ **Altitude** – What will be the average altitude the aircraft will fly?
- ❑ **Distance** – What will be the total distance traveled?
- ❑ **Stops**– Describe the countries and geography of the places you will stop for refueling.
- ❑ **Time** – How long will the entire trip take?
- ❑ **Map** – Create a map showing the path of the flight around the world.

Present your proposal to a panel of judges.

Early 1930s and World War II Manufacturers

Set the Stage

On June 24, 1930, **William C. Ocker**, the "father of instrument flying," successfully piloted the first cross-country flight with only his instruments as his guide. Ocker worked to convince aviators that their senses when flying blind were not only of no help, but were actually a constant threat against mishaps, injuries, and fatalities. He convinced them that their flight instruments, and not their senses, were telling the truth and to move their hands and feet in accordance with what they saw on the instrument panel instead of what they saw outside the cockpit. To give instrument instruction, Captain Ocker used a whirling chair and a lighted instrument panel mounted in a box. By 1926 Ocker had developed a solution to counter the effects of vertigo, a disorienting spatial illusion, by adopting the bank and turn instrument for use with his "Ocker Box." He attached his invention to the whirling Jones-Barany Chair, which became the world's first blind flying trainer.

Overview:
Students complete tasks by listening to directions instead of using their sense of sight, and then fly an airplane using the controls in the *Google Earth Flight Simulator.* Students learn about manufacturing by creating their own company, designing and producing an aircraft in large quantities, and distributing their product to other students. Students research women's roles in manufacturing during World War II, and create a video interview of the experience.

Objectives:
- Students simulate blind flying by relying on senses other than sight to accomplish a task
- Students fly an airplane by using the navigation controls in a flight simulator
- Students simulate the manufacturing process by building mass quantities of an item using an assembly line
- Students research and report on the roles of women in manufacturing during World War II

Guiding Questions:
- How is relying on flight instruments instead of senses important to pilots?
- How did manufacturing in the United States change during World War II?
- What role did women play in manufacturing during World War II?

Materials

Engage
- *Blind Flying Images*
- Blindfold

Explore in the Classroom
- *Google Earth*
- Computers
- *Flying in Google Earth Directions*
- *Women and Manufacturing during World War II Images*
- Items to build in assembly lines

Extend Student Learning
- *Starting a Manufacturing Company Student Directions*

Vocabulary:

Assembly line	An arrangement of workers, machines, and equipment in which the product being assembled passes consecutively from task to task until completed
Blind flying	Relying on flight sensors rather than on pilot senses to navigate
Flight instruments	Instruments in the cockpit of an aircraft that provide the pilot with information about the flight status of the aircraft
Manufacturing	Any industry that makes products from raw materials by the use of manual labor or machines and that is usually carried out systematically with a division of tasks.
Produce	To create

Suggested Literature:

Rosie the Riveter by Christine Petersen

Rosie the Riveter: Women Working on the Home Front in World War II by Penny Colman

Texas on the Web:

Refer to the following web site during the lesson and to extend learning.

World War II: American Manufacturing Mobilizes for War
videos.howstuffworks.com/hsw/21690-world-war-ii-american-manufacturing-mobilizes-for-war-video.htm

Lesson Procedure:

Engage Students

Option 1: Blindfold Obstacle Course

1. Set up an obstacle course for students to navigate.
2. Organize students into pairs. Blindfold one student and place them at the start of the obstacle course. Place the partner at the end of the obstacle course.
3. The partner who is not blindfolded calls out directions to the partner to help him or her travel to the finish line.
4. Once the blindfolded partner reaches the finish line, the students switch places and repeat the activity.

Option 2: Can You Draw It?

1. Organize students into pairs.
2. Ask one student to draw a picture.
3. The student then calls out directions to a partner so he or she will draw the exact same picture.
4. Students compare pictures and see how similar they are.
5. Students repeat the activity. The student who followed directions earlier draws a picture and calls out directions to the partner.
6. Discuss the students' experiences.
   - What was it like to not be able to see what you were doing?
   - What senses do you depend on when you cannot use your sense of sight?
   - How good was your partner at giving directions?
   - What is important to do in giving directions to someone who cannot see what they are doing?
7. Show a picture of a pilot using an Ocker Box from the *Blind Flying Images*. Explain that the Ocker Box was an important part of early flight training. William Ocker demonstrated that using flight instruments was more accurate than relying on human senses, which could sometimes become confused by disorientation and poor visibility. "Blind flying" refers to relying on flight sensors rather than on pilot senses to navigate. William Ocker became known as the "father of blind flying." Show the diagram of the airplane instrument panel, and explain that pilots must depend on their instruments to know where to fly.

Explore in the Classroom

Flying in Google Earth (K-12)

1. Take students to the computer lab or acquire a set of lap tops. Group students into pairs.
2. Launch *Google Earth* on a computer that is attached to a projector.
3. Press Ctrl + Alt + A to enter Flight Simulator mode.
4. Use the *Flying in Google Earth Directions* to demonstrate how to fly in *Google Earth.*
5. Give students a set of directions for them to use. Students must work together to take off, fly, and land their airplane. For younger students, consider flying as a class.

Manufacturing during World War II (9-12)

1. Show the *Women in Manufacturing during World War II Images* to students. Ask students to explain what they think the advertisement and images represent.
2. Explain that aircraft were mass produced during World War II to help fight in the war. Because the men were off fighting the war, women had to step in to work at the factories to produce the aircraft. Show *World War II: American Manufacturing Mobilizes for War*. Discuss the jobs that women held and the type of work students observed them doing in the factories.
3. Explain that students will work in an assembly line to produce a product. Select several items that can be easily assembled such as a ballpoint pen, toy, or artwork. Gather 5-10 of each item.
   - Organize students into groups and assign each group one of the products to assemble
   - Each student is responsible for adding only one part of the group's product, so that by the time each group member has completed their task, the entire product will be assembled
   - Give groups a designated amount of time to build all of their items. Once time is called, make all groups stop working. Each group presents the item they were in charge of assembling and the job that each group member had to complete
   - Discuss the students' experience:
     - How is working on an assembly line helpful in building the product?
     - What are the challenges of working on an assembly line?
     - How were assembly lines important in manufacturing during World War II?
4. Students complete a written reflection about their experience.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Become a Manufacturer Factories were an important part of mass producing aircraft during World War II. Students create their own manufacturing company to produce an airplane that they design. Finished products will be distributed to another classroom of students. Each group competes with other companies for business, so they must make sure their aircrafts function correctly. Students should also decorate their products to attract customers. 1. Organize students into groups. Give each group a *Starting a Manufacturing Company* student directions page. 2. Each group must create a manufacturing company and decide on a name for their company. 3. Each group must determine the jobs that need to be done, and who will do them. 4. Students must make a list of materials, and then gather them. 5. Students construct their aircraft using an assembly line. Set a limited amount of time to simulate real world time-constraints. 6. Students develop an advertising campaign and customer satisfaction survey. 7. Host a class Aircraft Fair and invite students from other classrooms to come and select an aircraft from one of the companies. Students try out their aircrafts and complete and return the customer satisfaction survey. 8. Each group evaluates the success of their company and product. 9. Students share their experiences, what they learned, and how they would improve in the future.	**Women and Manufacturing during World War II** 1. Students find out what role women played in the manufacturing of aircraft. Use Internet sites for further information. 2. Students imagine that they worked in manufacturing during World War II, and tell their story in a video biography. 3. Students may work in teams to accomplish the following tasks. • Write the script • Film the interview • Participate in the interview • Record background music • Transfer the video into a movie format 4. Interviews should include the following information. • Jobs in manufacturing • Training provided • Salary • Recruiting • Life after the war 5. Students present their video biographies to the class.

Engage Students

Blind Flying Images

Col. William Ocker (center) demonstrates his blind flying invention called the Ocker Vertigo Stopper Box, ca. 1926. He created the tool in 1926 to show how the value of a rudimentary flight instrument device could help pilots navigate while flying in bad weather.
Courtesy United States Air Force

Instrument panel from a Mooney plane, ca. 1960s-70s.
Courtesy Mooney Airplane Company, Inc., Kerrville

Flying in Google Earth Directions

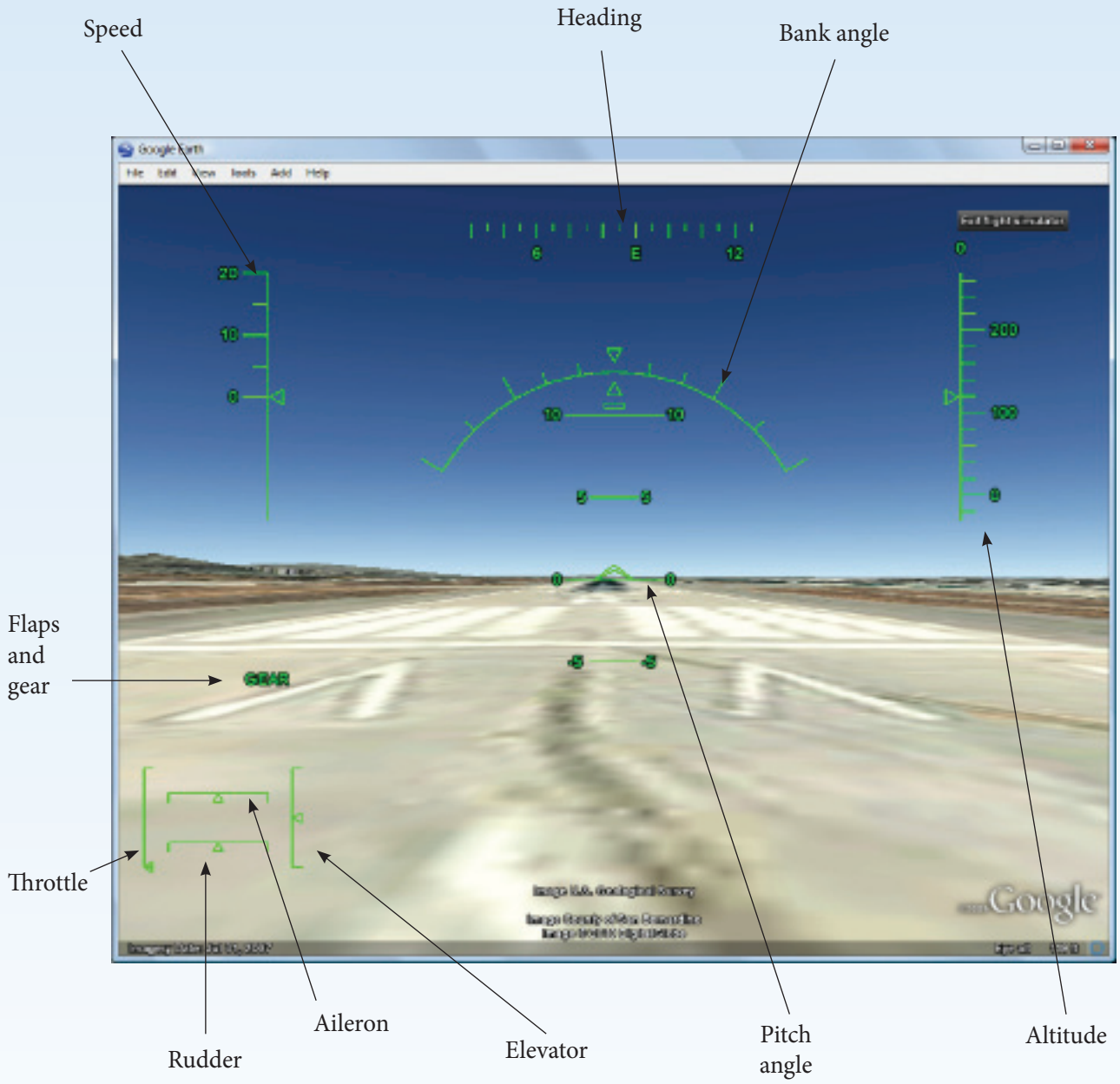
1. Launch *Google Earth* on the computer.
2. Press Ctrl + Alt + A to enter *Flight Simulator* mode.
3. Use the keystrokes in the table below to control navigation. You can also control the aircraft with a mouse or joystick. Left click to enable or disable mouse controls. Once mouse controls are active, the pointer shape changes to a cross on your screen.

Command	Windows/Linux Keystroke(s)	Mac Keystroke(s)
Exit flight simulator	Ctrl + Alt + A, Escape	⌘ + Option + A, Escape
Open flight simulator options	Ctrl + Alt + A	⌘ + Option + A
Rotate pilot viewpoint	Arrow keys + Alt (slow) or Ctrl (fast)	Arrow keys + Alt (slow) or Ctrl (fast)
Display flight simulator help	Ctrl + H	-
Increase thrust	Page Up	Page Up
Reduce thrust	Page Down	Page Down
Aileron left	Left arrow	Left arrow
Aileron right	Right arrow	Right arrow
Elevator push	Up arrow	Up arrow
Elevator pull	Down arrow	Down arrow down
Rudder left	Insert	Shift + left arrow
Rudder right	Enter (numeric keypad)	Enter (numeric keypad)
Rudder left	Shift + left arrow	Shift + left arrow
Rudder right	Shift + right arrow	Shift + right arrow
Elevator trim nose down	Home	Home
Elevator trim nose up	End	End
Elevator trim nose down	Shift + up arrow	Shift + up arrow
Elevator trim nose up	Shift + down arrow	Shift + down arrow
Reduce flap setting	Left bracket	Left bracket
Increase flap setting	Right bracket	Right bracket
Reduce flap setting	Shift + F	Shift + F
Increase flap setting	F	F
Center aileron and rudder	5	5
Center aileron and rudder	C	C
Extend/retract landing gear	G	G
Left wheel brake	, (comma)	, (comma)
Right wheel brake	. (period)	. (period)
Pause simulation	Space	Space

Taking Off

1. Press the **Page Up** key to increase thrust and move the aircraft down the runway.
2. Once your plane is moving, move the mouse or joystick back slightly down. You will take off once you build up enough speed.
3. Use the mouse to change direction or bank the aircraft.
4. Be sure to make small movements.
5. Once the wings are level, center the mouse. To look around, press the arrow keys + Alt (slow) or CTRL (fast).

Refer to the diagram to help you learn the parts of the display.



Landing

1. Approach the appropriate airstrip or flat area.
2. Press Page Down to reduce thrust and slow down the aircraft.
3. Press G to extend the landing gear.
4. Press F to increase the flap setting. This slows the aircraft.
5. Once you have touched down, use wheel brakes to slow the aircraft. Press the comma key to apply the left wheel brake. Then press the period key to apply the right wheel brake.

Extend Student Learning

Women and Manufacturing during World War II Images

Rosie the Riveter is a cultural icon of the United States. She represents the American women who worked in factories during World War II while men were fighting in the war. Even though women were encouraged to take on male dominated trades, they were expected to return to their everyday housework once the men returned home.

Real life Rosie the Riveters working on the B-24 bomber at the Consolidated Aircraft Corporation's "Bomber Plant" in Fort Worth, ca. 1942.
Courtesy History of Aviation Collection, Special Collections Department, McDermott Library, The University of Texas at Dallas, Richardson

Extend Student Learning

Starting a Manufacturing Company

Factories were an important part of mass producing aircraft during World War II. Create your own manufacturing company and produce an aircraft that your group designs. Your products will be distributed to another classroom of students. You will be competing with other companies for business, so make sure your product functions correctly. Be sure to decorate your product to attract customers.

1. Decide on a name for your company and record below.

   Company name _____

2. Decide on an aircraft design that your company will produce.

3. Decide on the jobs your company will need to produce the aircraft. Write those jobs below and who will perform them:

Job	Name

4. List the materials you will need to create your aircraft. Gather the materials for the first work session.

_____

_____

_____

_____

_____

_____

5. Construct the aircraft using an assembly line. Test and improve the design of the aircraft. Produce enough to meet the demand of potential customers. Be sure to decorate your product so that other students will select it.

6. Decide on a name for your aircraft _____

7. Create advertising for your group's product. Include important information such as special features, durability, and capabilities. Draw your advertising campaign below.

8. Create a customer satisfaction survey to get feedback on your product. Distribute the survey as you distribute your group's aircraft.

9. Distribute your aircraft to students during a class Aircraft Fair.

10. Evaluate your company. Place a check in the column that best fits your group's experience.

	Yes	Needs improvement
Members of the company worked well together.		
The aircraft design was well thought out.		
The aircraft was well built and performed as expected.		
The advertising campaign was clear and represented the group's product creatively.		
Based on the customer survey, customers were satisfied with our product.		

What were the strengths of your company and product?

_____

_____

_____

What improvements does your company need to make?

_____

_____

_____

Today's Manufacturers

Set the Stage

Bell Helicopter was founded by Larry Bell in 1935 as Bell Aircraft Corporation. In the early years of Bell, the company specialized in the design and production of fighter aircraft. Bell was the first to obtain certification for a commercial helicopter, and also invented tilt rotor aircraft. A tilt rotor aircraft lifts like a helicopter, and then flies like an airplane with twice the speed. Bell Helicopter is headquartered in Fort Worth, Texas.

Mooney Aircraft was founded in 1929 and is recognized in general aviation for building aircraft that are known for speed and safety. There has never been a fatal crash in a Mooney as a result of structural or airframe failure. Mooney is located in Kerrville, Texas.

In 1969 Eurocopter introduced its first helicopter to the American market. **American Eurocopter - An EADS North American Company**, aircraft are used in airborne law enforcement, border control, air medical services, oil and gas missions in the Gulf of Mexico, Alaska, and other locations worldwide, and select military purposes of the U.S. Army and the U.S. Coast Guard. American Eurocopter is headquartered in Grand Prairie, Texas.

Overview:
Students compare and contrast tilt rotor and a rotary aircraft to determine how their structures are important to the aircrafts' movements. Students identify the types of jobs people perform with helicopters and then attempt to fly using an online helicopter simulator. Students build a model of an actual helicopter and then create their own aircraft manufacturing company.

Objectives:
- Students identify how mechanical energy is used in two types of aircraft by observing images, video, and completing a graphic organizer
- Students identify the roles that helicopters play in their daily lives by completing a card matching activity
- Students control the movements of a helicopter using a flight simulator
- Students examine the needs that aircraft companies serve in our daily lives and then design their own aircraft manufacturing company

Guiding Question:
- How are helicopters important to our daily lives?

Vocabulary:

Rotorcraft	A flying machine that gets its lift and thrust from rotor blades
Rotary aircraft	Aircraft with one or more power-driven horizontal rotors that enable it to take off and land vertically, or to hover in the air
Mechanical energy	The energy of motion used to perform work
Tilt rotor aircraft	Utilizes a pair of powered rotors that can angle to generate the vertical lift of a helicopter and can also tilt forward to provide the thrust of an airplane.

Materials

Engage
- *Types of Helicopters Images*

Explore in the Classroom
- *Helicopter Jobs Cards*
- Computers with Internet access

Extend Student Learning
- Computers with Internet access

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

The Bell/Agusta BA-609 Tiltrotor
youtube.com/watch?v=EDZ8KXNxkVk&feature=related

Robin Whirlybird on her Rotorcraft Adventure
rotored.arc.nasa.gov/index.html

Helicopter Flight Simulation
eurocopter.com/flightsimulator/

Mooney
mooney.com/index.php

Bell Helicopter
bellhelicopter.com/en/

Eurocopter
eurocopter.com

Build an EC-175
eurocopter.com/site/en/ref/Papercraft_1064-1071.html

Lesson Procedure

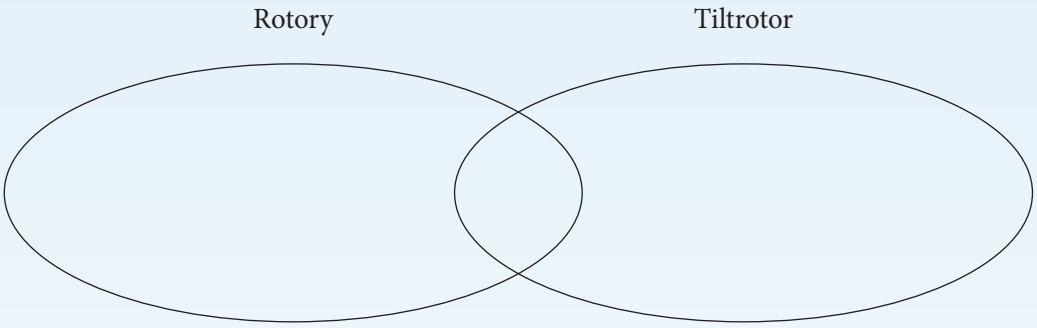
Engage Students

1. Show students the *Types of Helicopters Images*. Also show a video of a tilt rotor aircraft such as The Bell/Agusta BA-609 Tilt rotor.

2. Students compare the two types of helicopters using a Venn diagram. Ask students to compare and contrast rotors, fuselage shape, blade lengths, and direction of flight.

3. Discuss students' ideas about each type of helicopter:

   - How are the structures of the rotors important to the movements of the aircraft?
   - How is mechanical energy used in each aircraft?
   - What jobs might people perform on each type of aircraft?
   - Is one aircraft more useful than another?



Explore in the Classroom

A Helicopter Story (K-3)

1. Explain that students will read a story about a visit to NASA to see different types of helicopters.

2. Read the story *Robin Whirlybird on her Rotorcraft Adventure*.
   - The teacher may read the story aloud to students. Older students may read the story with a partner or alone. Students may also listen to a narrator by selecting "Listen" from the story menu
   - Students may click on vocabulary terms throughout to learn their meanings
   - Students make a diagram of at least one type of rotorcraft. Students label the parts and explain what the rotorcraft is used for

Helicopter Jobs (4-12)

1. Give each student one of the *Helicopter Jobs Cards*. Students must spread out in the room and find the student that matches their card.

2. Once students have found their partner, they must illustrate their helicopter performing its job on paper. Students may attach the cards to the illustration to identify what the helicopter is doing.

3. Students must then share their helicopter illustration with the class.

Flight Simulator (4-12)

1. Ask students how flying a helicopter might be different from flying an airplane.
2. Explain to students that they will fly a helicopter during a helicopter flight simulation at the Eurocopter Flight Simulator.
3. Students write about the results of their mission. Share experiences with the class.
   - How were you able to control the helicopter?
   - What was challenging about flying and landing the helicopter?
   - How did you overcome the challenges?
   - Were you able to complete the mission? Why or why not?

Science and Math	Social Studies and Language Arts
Build a model of a Eurocopter EC175 Visit the Eurocopter web site and download the pattern and directions to build an EC175.	**Aircraft Manufacturers** 1. Students research the history of one of the aircraft manufacturers located in Texas. 2. Students then design a new company, and create a brochure to advertise the aircraft and services that it provides. • Mooney • Bell Helicopter • Eurocopter

Engage Student

Types of Helicopters Images

HU-1A "Huey" helicopter in use by the U.S. Army, ca. 1950s.

Courtesy Bell Helicopter, Hurst

Rotary Aircraft

Bell V-22 Marine helicopter in airplane mode over ocean, ca. 2010.

Courtesy Bell Helicopter, Hurst

Tiltrotor Aircraft

Helicopter Jobs Cards

Copy and cut out the cards. Give each student one card. Students will spread out in the room and find the student that matches their card. Once students have found their partner, they will illustrate their helicopter performing its job on paper. Students may attach the cards to the illustration to identify what the helicopter is doing.

law enforcement helicopter	used for traffic control, search and rescue, high-speed car chases, observations, and air transportation
military helicopter	used to transport troops, combat, search and rescue, medical evacuation, observations, and attacks
medical services helicopter	used for emergency medical assistance to transport people to hospitals; serves as an air ambulance such as Life Flight
forest service helicopter	used to transport personnel and cargo to a fire; equipped to drop water and chemicals to fight fires; can remove injured fire fighters from the fire and deliver them to emergency medical facilities
off shore oil helicopter	used to rotate crews and transport workers to oil and gas fields
ranching helicopter	used to herd cattle, survey animals and capture wildlife
television station helicopter	used to monitor news stories and report on vehicle traffic

Materials of Flight

Set the Stage

Victor and **Joseph Stanzel** were two farm boys who turned their passion for airplanes into a highly successful model airplane business in Schulenburg, Texas. Victor designed model airplanes with precision and attention to detail. Joseph possessed unique mechanical capabilities. Joseph made 14 different solid model kits. Victor designed a full sized electric powered airplane modified to serve as an amusement park attraction. Together, in 1939, they produced the *Tiger Shark*, the first control line gas powered commercial kit in the world. By the 1940s, Victor and Joseph realized that children had less interest in building their own kits, so the brothers made a series of toy airplanes that were attached to the end of a cable and flown in a circular fashion overhead. Victor and Joseph Stanzel engaged children's curiosity and imagination with their models, toys, and amusement park rides.

Leo Windecker was a dentist and an innovator in flight technology. He began constructing sample aircraft wings from Styrofoam and fiberglass. In 1960 he closed his dental practice and opened a research and development facility in Texas. One of his major achievements was the *Windecker Eagle*, the first FAA certified all-composite airplane. Windecker was also a pioneer in stealth technology. He learned that composite materials reduced the likelihood of radar detection and he worked with the U.S. Army and Air Force to incorporate stealth technology into aircraft design.

Overview:
Students determine the strength of materials by testing how well each can withstand different forces. Students explore a virtual jet engine to learn how the parts work together to power a jet airplane. Students design their own model airplane and research how composite materials are used in aircraft today.

Objective:
- Students test the effects of different forces on materials to determine each material's strength
- Students explain how a jet engine works by interacting with a virtual jet engine and creating a diagram showing how all of the parts work together
- Students use measurement skills to design and build a scale model of an airplane
- Students research and explain how composite materials are used in aircraft by creating a diagram of a plane and a graphic organizer showing the advantages and disadvantages of using composite materials

Guiding Questions:
- What materials are best to use in building airplanes?
- How are jet engines better than piston engines?

Materials

Engage
- 8½ x 11 pieces of paper

Explore in the Classroom
- Computers with Internet access
- *Materials Testing Student Page*
- Balsa wood (1 piece per group)
- Paper plates (2 per group)
- Styrofoam plates (2 per group)
- Plastic plates (2 per group)
- Aluminum pie pan (2 per group)
- Cardboard cut into discs (2 per group)

Extend Student Learning
- Computers with Internet access
- Graph paper

Vocabulary:

Bending	The forming of a material, by force, into a curved shape
Combustion	The process of burning
Composites	A strong, lightweight material made from carbon fibers; materials that are combinations of two or more organic or inorganic components
Compression	A pushing and squeezing force
Jet engine	An engine that develops thrust by discharging a jet of fast moving fluid or combustion products
Shear	A tearing force
Strength	Measure of a material's ability to withstand strain or stress
Tension	A pulling force
Torsion	A twisting force

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

NASA Future of Flight Design
futureflight.arc.nasa.gov/fuseMaterials.html

NASA Future of Flight – Materials
futureflight.arc.nasa.gov/fuseMaterials.html

Flying Heavy Metal: Jet Race 2
videos.howstuffworks.com/science/jet-engine-videos-playlist.htm#video-7087

How Does a Jet Engine Work?
ueet.nasa.gov/StudentSite/engines.html

Engines 101
geae.com/education/engines101/

Timeline of the Stanzels and the Stanzel Company
stanzelmuseum.org/history.html

Centennial of Flight: Composites and Advanced Materials
centennialofflight.gov/essay/Evolution_of_Technology/composites/Tech40.htm

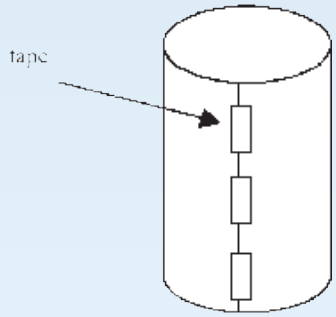
Composites and Advanced Materials in Aircraft
century-of-flight.net/Aviation%20history/evolution%20of%20technology/Composites%20and%20Advanced%20Materials.htm

Lesson Procedure:

Engage Students

1. Ask students to explain what they think aircraft are made of and why?

2. Show students a piece of paper and ask them if it is strong. Tell them that you think it is strong enough to hold a stack of books, and ask them if they agree. Then ask student to predict how many books they think a piece of paper can hold.



3. Carefully roll a piece of 8½ x 11 paper into a cylinder. Overlap the edges a little and apply plastic tape along the seam. Be sure to tape the paper so that it does not crease and will stand straight once it is set on a table.

4. Gather a stack of books with similar widths. Carefully center a book over the paper cylinder. Wait a moment to make sure the cylinder and book are stable. Ask students if they think it will hold another book. Slowly add books until the cylinder buckles and falls. Record how many books the cylinder held.

5. Ask students why they think a piece of paper can be strong enough to hold a stack of books. Discuss how the shape of the paper gives it more strength than when it is stretched out. Look for cylinders around the school that provide support, such as columns in buildings.

6. Allow time for students to try the activity on their own using different widths and lengths of cylinders.

Explore in the Classroom

NASA Future Flight Design: Materials (3-12)

1. Review students' ideas about the strength of materials.

2. Students visit the *NASA Future of Flight Design Center: Materials* to learn more about the materials used to build aircraft.

3. Students record what they learn.

Materials Testing (5-12)

1. Give groups of two to three students the *Materials Testing Student Page*.

2. Explain that students must create a flying disc that will have enough lift to fly as long as possible while withstanding forces that may be applied to it.

3. Review students' ideas about strength. Strength is a measure of a material's ability to withstand strain or stress. Students test each material to determine its strength. They must write YES or NO in the table to identify whether the materials resist each type of force.

4. Students then select the material they think will be best, create their flying disc, and then test it.

Jet Engines (6-12)

1. Ask students if pilots can fly an airplane into space. Investigate jet engines to answer this question. Explain that by the 1940s and 50s, the jet engine was in use.

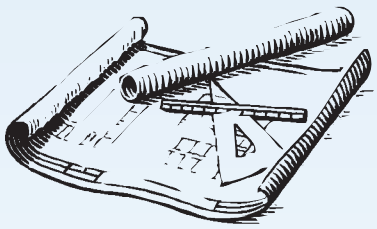
2. To learn how jet engines work, show *Flying Heavy Metal: Jet Race 2* or *How does a jet engine work?*

3. Students may also build, test, and fly a virtual jet engine at *GE Engines 101*.

4. Students create a diagram on paper or on the computer showing the parts of a jet engine. Students should identify the main parts and how they work. Include a description of how Newton's third law of motion and Boyle's Law explain how a jet engine works.

5. After learning about the parts of a jet engine, remind students of the question asked earlier: "Is it possible to fly a jet plane into space?" Refer to the *Layers of the Atmosphere Diagram* from a previous lesson. Students should explain that jet engines rely on air to work and there is very little air at high altitudes. Therefore jets cannot fly into space. Astronauts traveling into space have to generate thrust a different way.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Create Your Own Model **Design your own model aircraft.** 1. Students use graph paper to create a blueprint of a scale model of an airplane. The blueprint should include: • Measurements • Labels of parts and materials 2. Students build the model using their blueprint. 3. Students decorate their aircraft, and give it a name. Decide how the aircraft will be used.  4. Students research the strongest materials used today to build aircraft and similar products. Students must then decide on the materials they would use to build their aircraft. 5. Students design a sales plan that explains the materials that would be used to build their aircraft, approximate costs, and potential companies that could manufacture the aircraft.	**Composites in Aircraft** **Are composite materials the best materials to use in aircraft?** 1. Students create a labeled diagram of an aircraft, showing where composite materials are used. 2. Students create a graphic organizer showing the advantages and disadvantages of using composite materials in aircraft. Use web sites for information: • *Centennial of Flight: Composites and Advanced Materials* • *Composites and Advanced Materials in Aircraft* 3. Students form two groups: one group supporting the use of composite materials and one group not supporting the use of composite materials in aircraft. 4. Students hold a debate to present their positions.

NASA Future Flight Design: Materials

Complete the following information as you step through the *Future Flight Design: Materials* lesson.

1. How do composites, aluminum, and wood compare?

_____

_____

2. What materials did the Wright Brothers use to build their aircraft?

_____

_____

Advantages _____

Disadvantages _____

3. What materials was the XV-15 made with?

_____

_____

Advantages _____

Disadvantages_____

4. What materials are used to build aircraft today?

_____

_____

Advantages _____

Disadvantages _____

5. What materials will be used to build aircraft in the future?

_____

_____

Materials Testing Student Page

Design Challenge *Create a flying disc*

Design You must create a flying disc that will have enough lift to fly as long as possible while withstanding forces that may be applied to it.

1. Strength is a measure of a material's ability to withstand strain or stress. Test each material to determine its strength. Write YES or NO to identify whether the material resists each type of force.

	Type of Strength				
Material	Tensile: Resists pulling forces	Compressive: Resists pushing and squeezing forces	Torsion: Resists twisting	Shear: Resists tearing	Bending: Resists formation into a curved shape
Wood (balsa wood)					
Foam (foam plate)					
Paper (paper plate)					
Plastic (plastic plate)					
Cardboard (cardboard disc)					
Aluminum (aluminum pie pan)					

2. List the materials from weakest to strongest based on your test.

_____

_____

_____

_____

3. What forces will act on the disc when it is thrown, while it is flying, and when it is landing?

Thrown _____

Flying _____

Landing _____

4. Which material(s) do you think will make the best flying disc? Why?

_____

_____

_____

5. Create a flying disc out of the material(s) you chose. Test your disc by throwing it to make it fly, and record the results.

Material _____

Trial	Distance Traveled	Observations
1		
2		
3		

6. Did the material you chose make a successful flying disc? Why or why not?

_____

_____

_____

7. What do you need to change to improve your flying disc?

_____

_____

_____

Commercial Airlines

Set the Stage

Braniff began commercial services in 1928, transporting passengers out of Oklahoma City. Braniff's slogan was, "The World's Fastest Airline." The airline moved its operations to Dallas, Texas, after World War II. It was the first airline to use an automatic pilot in most of its aircraft, and one of the first to use commercial aircraft radar for navigation. Braniff ended in 1982. It was 54 years old when it shut down.

American Airlines, Inc started in 1934. By the end of the 1930s, American was the nation's number one domestic air carrier. In 1942 it entered the airline catering business, providing food service to its passengers. The world's first facility for flight attendant training, the American Airlines Stewardess College, was built in Ft. Worth, Texas, in 1957. Class sizes averaged between 50 and 60 trainees.

Southwest Airlines, headquartered in Dallas, Texas, began transporting customers in 1971. The airline's strategy of offering low fares has connected families, friends, and business people across the country by making it possible for everyone to fly. It is now a major leader in the airline industry and serves as a model for other airlines to follow.

Overview:
Students compare advertisements of commercial airlines from the past and present and discuss how people have come to depend on airlines in their daily lives. Students use the *Aviation Alphabet* to communicate with each other. Students match pictures of flight attendants to the decade they represent and make observations about each time period. Students plan a round trip on a commercial airline beginning from a location in Texas to a destination in another state. Students learn about their nearest airport and create a guide for a first-time flyer.

Objectives:
- Students compare advertisements from the past and present to understand how companies use advertising to persuade consumers to use their services
- Students talk to each other using the *Aviation Alphabet* to learn how pilots communicate
- Students sequence and research changes in commercial aviation over time
- Students calculate distance, airfare, and time to create an itinerary for a round trip flight to a destination in another state
- Students learn how an airport works by creating a direction guide for a first-time flyer

Guiding Questions:
- How has commercial flight changed over time?
- How have flight attendants clothing and responsibilities changed over time?
- Why do pilots use the *Aviation Alphabet*?

Materials

Engage
- *Commercial Airlines Advertisements Transparency*

Explore in the Classroom
- *Aviation Alphabet*
- *Flight Attendants Through Time Cards*

Extend Student Learning
- Computers and Internet access

Vocabulary:

Commercial airline	A business providing a system of scheduled air transport
Flight attendant	Members of an aircrew employed by airlines to ensure the safety and comfort of passengers aboard commercial flights and business aircraft
Flight plan	Specific information about the intended flight of an aircraft that is communicated to the air traffic control

Texas on the Web:
Refer to the following web sites during the lesson and to extend learning.

American Airlines
aa.com

Southwest Airlines
southwest.com/flight/

Expedia
expedia.com

Travelocity
travelocity.com

Lesson Procedure:

Engage Students

1. Look at the advertisement of the flying peanuts using the *Commercial Airlines Advertisements Transparency.*
2. Ask students to explain why they think this image was used as an advertisement. Ask:
   - What do you think is being advertised?
   - What message does the advertiser want people to understand?
   - Why were peanuts chosen for the picture?
   - Who were the airlines trying to appeal to?
3. Show Braniff commercial airline advertisement. Compare the advertisements and the messages that each is communicating to customers.
4. List the airlines that students have used or seen on commercials. If possible, show examples of advertisements.

Explore in the Classroom

Aviation Alphabet (K-12)

1. Pass out the *Aviation Alphabet* to students and discuss how to read the chart.
2. Practice using the alphabet and translating the meanings. Pair students together to complete several tasks.
   - Spell your name using the *Aviation Alphabet*. Introduce yourself to a friend
   - Write a message, and read it to a partner. Ask your partner to explain what you said
3. Ask students to explain who they think would use the *Aviation Alphabet* and why. Explain that the aviation alphabet is used by pilots and air traffic controllers to communicate with one another. It is also known as the International Civil Aviation Organization alphabet (ICAO), and assigns words to letters of the English alphabet to prevent people from confusing letters that have similar sounds.

Flight Attendants (6-12)

1. Give groups of students the *Flight Attendants Through Time Cards* representing the 1930s to the 1960s.
2. Ask students to match the pictures to the correct decade they represent. Students should also record the evidence that supports their decisions such as clothing, hairstyles, and environmental settings.
3. Check answers as a class and ask groups to share their evidence and reasoning. Discuss how commercial flying and the role of the flight attendant has changed over time. Students may want to research the role of flight attendants from different commercial airlines that exist today.

Extend Student Learning

Science and Math	Social Studies and Language Arts
Plan a Trip Students work in groups to plan a round trip flight from a location in Texas to a destination in another state. 1. Students research different airlines and determine the following: • Airfares • In-flight food services • Special services • Motto • Advertisements 2. Students compare the different flights and decide on the shortest flight. Students must account for transfers and layovers. Students may use the following web sites for information: • American Airlines • Southwest Airlines • Expedia • Travelocity 3. Students write a flight itinerary for their round trip that includes departure and arrival times, distances traveled, airfares, and time spent on the trip. 4. Students present their itineraries to the class.	**Create an Airport Guide** Students locate the nearest airport and find out about its services and operations. Students create an Airport Guide that someone could use to help them on their first airplane flight. 1. Locate the local airport's web site. 2. Research and include the following information in the Airport Guide: • Map of the airport • Airlines that fly in and out of the airport • Steps to follow from checking baggage to boarding the airplane • Places to eat • Security checks • Items you cannot carry on the plane • Any other information a first time flyer might need to know 3. Present the Airport Guide to the class.

Commercial Airlines Advertisements Transparency

Texas International ticket jacket, ca. 1977-1980. Texas International's "flying for peanuts" promotion began in early 1977 and continued until 1980.
Courtesy Troy Kimmel Jr., Austin

Salute To Houston!

From Texas' Own Airline

On the dedication of your wonderful new air terminal, we raise a toast to the vision and energy of a great city's leadership. We of Braniff Airways are proud to have a stake in your thrilling achievement. As pioneers of your air lanes, your progressive *Texas* spirit impelled us to establish our huge base here in Texas. Today our luxurious 21-passenger Super-B-Liners are a part of the mighty air armada which joins Houston day and night with the far corners of the continent.

Over the years, our schedules have increased more than tenfold, and our payrolls twenty-fold. We now employ the heads of more than four hundred Texas families and our total expenditures in Texas are expressed in millions rather than thousands of dollars.

Your airport, and its splendid new terminal, are an indispensable part of National Defense and of today's commercial life. You have built well. Accept our sincere congratulations!

T. E. Braniff, President.

Salute to Houston, Advertisement for Braniff Airlines, ca. 1940.
Courtesy The University of Texas at Dallas, History of Aviation Collection, Richardson

Aviation Alphabet

When pilots talk on the radio, they want to make sure their message is understood. Because some letters of the alphabet sound the same (such as M and N or B, C, D, E,G, P, T and V), they sometimes use an *Aviation Alphabet* to make sure the person to whom they are talking hears them correctly.

The pilot of the Boeing 247 pictured here, for instance, would call the control tower at Dallas' Love Field by saying "Love tower, this is November-Three-Niner-Seven-Seven-Charlie." Notice the pilot said "niner" instead of "nine." Pilots do this because "nine" might sound like "five" over the radio. The number nine is the only number that is spoken differently.

"…November-Three-Niner-Seven-Seven-Charlie."

A	Alpha	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Foxtrot	S	Sierra
G	Golf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whiskey
K	Kilo	X	X-Ray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

- Spell your name using the *Aviation Alphabet*. Introduce yourself to a friend
- Write a message, and read it to a partner. Ask your partner to explain what you said

Adapted from the San Diego Aerospace Museum
aerospacemuseum.org

Flight Attendants Through Time Cards

Copy and cut out the cards. Students will match the pictures to the correct decade. Students should record the evidence that supports their decision.

1930s	
1940s	
1950s	
1960s	

Flight attendant photos courtesy The University of Texas at Dallas, History of Aviation Collection, Richardson

TANGO ★ ALPHA ★ CHARLIE

Texas Aviation Celebration

Assessment and TEKS

WASP ground school, Avenger Field,
Sweetwater, Texas, ca. 1943-44.
Courtesy Texas Women's University, Denton

Time Flies Assessment

Overview:
Students demonstrate their understanding of the people who made important contributions to the development of aviation by creating an illustrated timeline from the early 1900s to the present.

Objective:
- Students sequence milestones in aviation history by creating and illustrating a timeline
- Students present the people they feel contributed most to advancements in aviation and support their opinions with evidence

Guiding Questions:
- What were the most important events in aviation history?
- Who made the most important contributions to the advancement of aviation?

Assessment:
Time Flies (K-4)
1. Give each student a card set containing a name with a matching date and description.
2. Students illustrate their event and glue their cards on their illustration.
3. Create a classroom Time Flies timeline. Each student must place their illustration in the correct place on the timeline.

Time Flies (5-12)
1. Organize students into groups (two to four students).
2. Give each group a set of cards. Students match each name with the correct year and description.
3. Students organize their card matches on a large piece of butcher paper to create a Time Flies timeline.
4. Students must illustrate each date to complete the timeline.
5. Students decide on the people who they think made the most important achievements or contributions to aviation, and then make a presentation to the class. Students must support their opinions with facts and evidence.

Living Museum (K-12)
1. Students select one of the people they feel made important contributions to aviation history.
2. Students prepare a speech to deliver during a Living Museum Exhibit for their school.
3. Students may dress up and use props to give their presentation.

Materials
- *Time Flies Cards*
- Paper for mounting timeline

Time Flies Cards

Sequence the events to create a timeline of the history of aviation in Texas.

Louis Paulhan	**1910** First person to fly a powered, heavier-than-air aircraft in Texas
Benjamin Foulois	**1916** Made the first reconnaissance flight by the U. S. military over foreign territory
Katherine Stinson	**1916** First woman to fly in Asia
Bessie Coleman	**1921** First woman in Texas to earn a pilot's license; first African American in the world to earn an international pilot's license

Time Flies Cards

Sequence the events to create a timeline of the history of aviation in Texas.

Ormer Locklear	**1918** First person to transfer from one moving airplane to another
Wiley Post	**1934** Designed the first successful pressurized flight suit
Howard Hughes	**1939** Set a record by flying around the world in three days and 19 hours
WASP	**1943** Women Airforce Service Pilots formed

Time Flies Cards

Sequence the events to create a timeline of the history of aviation in Texas.

B-36	**1946** Beryl Erickson and Gus Green test fly the Peacemaker
Voyager	**1986** Dick Rutan and Jeana Yeager complete the first nonstop, non-refueling flight around the world
H. Ross Perot Jr.	**1982** Complete the first helicopter flight around the world in the *Spirit of Texas*
William Ocker	**1930** Successfully piloted the first cross-country flight with only instruments as the guide

Time Flies Cards

Sequence the events to create a timeline of the history of aviation in Texas.

Bell Helicopter	**1941** Invented the tilt rotor aircraft
Mooney	**1929** Known for building fast and safe aircraft
Stanzel Brothers	**1939** Produced the Tiger Shark, the first control line gas powered commercial kit in the world
Leo Windecker	**1960** Opened a research and development facility to develop composite aircraft

Time Flies Cards

Sequence the events to create a timeline of the history of aviation in Texas.

American Airlines	**1957** Built the world's first facility for flight attendant training
Dr. William Bussey	**1995** Set world records for distance in balloon flights
Tuskegee Airmen	**1941** All African-American squadron forms
Douglas Corrigan	**1938** Became a celebrity for flying the "wrong way" and landing in Ireland instead of Los Angeles

Tango Alpha Charlie: Texas Aviation Celebration
Texas Ties to the Texas Essential Knowledge and Skills (TEKS) Grades K-5

		Aviation Takes Off 1910-1911	WWI and the Stinson Family 1910s	Barnstormers	Record Setters 1930s	World War II 1940s	Cold War 1950-1970s	1980s, 1990s, and Today	Early 1930s and World War II Manufacturers	Today's Manufacturers	Materials of Flight	Commercial Airlines	Time Flies Assessment
Science	**Scientific Investigation and Reasoning**. The student uses scientific methods during laboratory and outdoor investigations. (5.2), (4.2), (3.2), (2.2), (1.2), (K.2)	*	*	*	*		*	*			*		
Science	**Scientific Investigation and Reasoning**. The student uses critical thinking and scientific problem solving to make informed decisions. (5.3), (4.3), (3.3), (2.3), (1.3), (K.3)	*	*	*	*		*	*		*	*		*
Science	**Scientific Investigation and Reasoning.** The student knows how to use a variety of tools and methods to conduct science inquiry. (5.4), (4.4), (3.4), (2.4), (1.4), (K.4)	*		*			*	*			*		
Science	**Matter and Energy.** The Student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. (5.5), (4.5), (3.5), (2.5), (1.5), (K.5)	*			*								
Science	**Force, motion, and energy.** The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. (5.6), (4.6), (3.6), (2.6), (1.6), (K.6)	*	*	*			*	*	*	*	*		
Science	**Earth and Space.** The student knows that there are recognizable patterns in the natural world and among the Sun, Earth, and Moon system. (5.8)					*							
Math	**Number, operation, and quantitative reasoning.** The student adds, subtracts, multiplies, and divides to solve meaningful problems. (5.3), (4.3), (3.3), (2.3), (1,3)	*	*		*		*	*				*	
Math	**Number, operation, and quantitative reasoning.** The student multiplies and divides to solve meaningful problems involving whole numbers. (4.4), (3.4), (2.4)	*	*		*		*	*				*	
Math	**Measurement.** The student applies measurement concepts involving length, area, capacity/volume, and weight/mass to solve problems. (5.10), (4.11), (3.11), (2.9), (1.7), (K.10)	*	*		*		*	*			*		
Math	**Measurement.** The student applies measurement concepts. The student measures time and temperature. (5.11), (4.12), (3.12), (2.10), (1.8), (K.11)	*		*			*	*			*		
Math	**Probability and Statistics.** The student solves problems by collecting, organizing, displaying, and interpreting sets of data. (5.13), (4.13), (3.13), (2.11), (1.9), (K,12)		*	*			*	*			*		
Math	**Underlying processes and mathematical tools.** The student applies grade level mathematics to solve problems connected to everyday experiences and activities in and outside of school. (5.14), (4.14), (3.14), (2.12), (1.11), (K.13)	*	*	*	*		*	*	*	*	*	*	
Math	**Underlying processes and mathematical tools.** The student communicates about grade level mathematics using informal language. (5.15), (4.15), (3.15), (2.13), (1.12), (K.14)	*	*	*	*		*	*	*	*	*	*	
Social Studies	**History.** The student understands the concepts of time and chronology. (3.3), (2.2), (1.3), (K.3)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**History.** The student understands how various sources provide information about the past. (2.3)	*	*	*	*	*	*	*	*	*	*	*	*

	Aviation Takes Off 1910-1911	WWI and the Stinson Family 1910s	Barnstormers	Record Setters 1930s	World War II 1940s	Cold War 1950-1970s	1980s, 1990s, and Today	Early 1930s and World War II Manufacturers	Today's Manufacturers	Materials of Flight	Commercial Airlines	Time Flies Assessment
Social Studies												
History. The student understands important issues, events, and individuals of the 20th century in the United States. (5.5), (4.5), (3.1), (2.4), (1.1), (K.2)	*	*	*	*	*	*	*	*	*	*	*	*
Geography. The student understands the location and patterns of settlement and the geographic factors that influence where people live. (5.8), (4.8), (3.4), (2.7)					*							
Geography. The student uses geographic tools to collect, analyze, and interpret data. (5.6), (4.6), (3.5), (2.5), (1.4, 1.5), (K.4)				*	*		*	*			*	
Geography. The student understands the concept of regions. (5.7), (4.7), (2.6), (1.6), (K.5)					*							
Economics. The student understands patterns of work and economic activities in the United States. (5.14), (4.13), (3.8), (2.10), (1.9), (K.7)	*	*	*	*	*	*	*	*	*	*	*	*
Science, technology, and society. The student understands the impact of science and technology on life in the United States. (5.24), (5.21), (3.15), (2.16), (1.16), (K.14)	*	*	*	*	*	*	*	*	*	*	*	*
Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. (5.25), (4.22), (3.16), (2.17), (1.17), (K.15)	*	*	*	*	*	*	*	*	*	*	*	*
Social studies skills. The student communicates in written, oral, and visual form. (5.26), (4.23), (3.17), (2.18), (1.18), (K.16)	*	*	*	*	*	*	*	*	*	*	*	*
Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. (5.27), (4.24), (3.18), (2.19), (1.19), (K.17)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts												
Writing/Expository and Procedural Texts. Students write expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes. (5.18), (4.18), (3.20), (2.19), (1.19), (K.15)	*	*	*	*	*	*	*	*	*	*	*	*
Research/Gathering Sources. Students determine, locate, and explore the full range of relevant sources addressing a research question and systematically record the information they gather. (5.24), (4.24), (3.26), (2.25), (1.24), (K.20)	*	*	*	*	*	*	*	*	*	*	*	*
Research/Synthesizing Information. Students clarify research questions and evaluate and synthesize collected information. (5.25), (4.25), (3.27), (2.26), (1.25)	*	*	*	*	*	*	*	*	*	*	*	*
Research/Organizing and Presenting Ideas. Students organize and present their ideas and information according to the purpose of the research and their audience. (5.26), (4.26), (3.28), (2.27), (1.26)	*	*	*	*	*	*	*	*	*	*	*	*
Listening and Speaking/Listening. Students use comprehension skills to listen attentively to others in formal and informal settings. (5.27), (4.27), (3.29), (2.28), (1.27), (K.21)	*	*	*	*	*	*	*	*	*	*	*	*
Listening and Speaking /Speaking. Students speak clearly and to the point, using conventions of language. (5.28), (4.28), (3.30), (2.29), (1.28), (K.22)	*	*	*	*	*	*	*	*	*	*	*	*
Listening and Speaking /Teamwork. Students work productively with others in teams. (5.29), (4.29), (3.31), (2.30), (1.29), (K.23)	*	*	*	*	*	*	*	*	*	*	*	*

		Aviation Takes Off 1910-1911	WWI and the Stinson Family 1910s	Barnstormers	Record Setters 1930s	World War II 1940s	Cold War 1950-1970s	1980s, 1990s, and Today	Early 1930s and World War II Manufacturers	Today's Manufacturers	Materials of Flight	Commercial Airlines	Time Flies Assessment
Science	**Scientific investigation and reasoning**. The student uses scientific inquiry methods during laboratory and field investigations. (IPC.2), (Physics.2), (8.2), (7.2), (6.2)	*	*	*	*		*	*			*		
Science	**Scientific investigation and reasoning.** The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. (IPC.3), (Physics.3), (8.3), (7.3), (6.3)	*	*	*	*		*	*		*	*		*
Science	**Scientific investigation and reasoning.** The student knows how to use a variety of tools and safety equipment to conduct science inquiry. (8.4), (7.4), (6.4)	*		*			*	*			*		
Science	**Force, motion, and energy.** The student knows that there is a relationship among force, motion, and energy. (8.6), (7.7), (6.8)	*	*	*			*	*	*	*	*		
Science	**Science concepts.** The student knows concepts of force and motion evident in everyday life. (IPC.4)	*	*	*			*	*	*	*	*		
Science	**Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. (Physics.6)			*									
Math	**Number, operation, and quantitative reasoning.** The student selects and uses appropriate operations to solve problems and justify solutions. (8.2), (7.2), (6.2)	*	*		*		*	*				*	
Math	**Measurement**. The student solves application problems involving estimation and measurement. (7.9), (6.8)	*	*		*		*	*			*		
Math	**Probability and statistics.** The student uses statistical procedures to describe data. (8.12), (7.12), (6.10)	*	*	*			*	*			*		
Math	**Underlying processes and mathematical tools**. The student applies grade level mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities inside and outside of school. (8.14), (7.13), (6.11)	*	*	*	*		*	*	*	*	*	*	
Math	**Underlying processes and mathematical tools.** The student communicates about grade level mathematics through informal and mathematical language, representations, and models. (8.15), (7.14), (6.12)	*	*	*	*		*	*	*	*	*	*	
Social Studies	**History**. The student understands significant individuals, events, and issues of the 1920s. (U.S. History.5)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**History**. The student understands how individuals, events, and issues shaped the history of Texas during the 20th century. (7.7)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**Economics.** The student understands the economic effects of World War II, the Cold War, and increased worldwide competition on contemporary society. (U.S. History.14)					*	*		*				

Tango Alpha Charlie, Texas Aviation Celebration
Texas Ties to the Texas Essential Knowledge and Skills (TEKS) Grades 6-12

		Aviation Takes Off 1910-1911	WWI and the Stinson Family 1910s	Barnstormers	Record Setters 1930s	World War II 1940s	Cold War 1950-1970s	1980s, 1990s, and Today	Early 1930s and World War II Manufacturers	Today's Manufacturers	Materials of Flight	Commercial Airlines	Time Flies Assessment
Social Studies	**Geography**. The student uses geographic tools to collect, analyze, and interpret data. (8.10), (7.8), (6.3)				*	*		*	*			*	
Social Studies	**Geography.** The student understands the location and characteristics of places and regions of the United States, past and present. (8.11), (7.9), (6.4)					*							
Social Studies	**Culture**. The student understands the relationships between and among people from various groups, including racial, ethnic, and religious groups, during the 17th, 18th, and 19th centuries. (8.24)			*		*			*				
Social Studies	**Science, technology, and society.** The student understands the influence of scientific discoveries and technological innovations on daily life in the United States. (U.S. History.23), (8.29), (7.20), (6.20)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**Social studies skills.** The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. (U.S. History.24), (8.30), (7.21), (6.21)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**Social studies skills**. The student communicates in written, oral, and visual forms. (U.S. History.25), (8.31), (7.22), (6.22)	*	*	*	*	*	*	*	*	*	*	*	*
Social Studies	**Social studies skills.** The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. (U.S. History.26), (8.32), (7.23), (6.23)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Writing/Expository and Procedural Texts.** Students write expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes. (English 1,2,3,4.15), (8.17), (7.17), (6.17)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Research/Gathering Sources.** Students determine, locate, and explore the full range of relevant sources addressing a research question and systematically record the information they gather. (English 1,2,3,4.21), (8.23), (7.23), (6.23)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Research/Synthesizing Information.** Students clarify research questions and evaluate and synthesize collected information. (English 1,2,3,4.22), (8.24), (7.24), (6.24)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Research/Organizing and Presenting Ideas**. Students organize and present their ideas and information according to the purpose of the research and their audience. (English 1,2,3,4.23), (8.25), (7.25), (6.25)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Listening and Speaking/Listening**. Students will use comprehension skills to listen attentively to others in formal and informal settings. Students will continue to apply earlier standards with greater complexity. (English 1,2,3,4.24), (8.26), (7.26), (6.26)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Listening and Speaking/Speaking.** Students speak clearly and to the point, using the conventions of language. (English 1,2,3,4.25), (8.27), (7.27), (6.27)	*	*	*	*	*	*	*	*	*	*	*	*
Language Arts	**Listening and Speaking/Teamwork.** Students work productively with others in teams. (English 1,2,3,4.26), (8.28), (7.28), (6.28)	*	*	*	*	*	*	*	*	*	*	*	*

Credits

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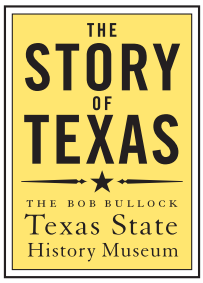

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