LESSON PLAN

PART I

Lesson 1: Discovering Flight
Instructor: Academic Instructor
Teaching Method: Informal Lecture
Visual Aids (VA): PowerPoint Presentation
Student Preparation:
Reading Assignment: Text, Chapter 1, Lesson 1
Homework Assignment: Instructors may use any or all Student Workbook items for this lesson as homework or in-class assignment.
Date of Lesson Development: December 2006

PART IA

Lesson Objectives:
1. Know how humans tried to fly in ancient times
2. Know key aviation devices created during ancient times
3. Know why machines do not fly the way birds do

Samples of Behavior/Main Points:
1. Explain how human interest in flight preceded the Wright brothers
2. Identify ways humans tried to fly in ancient times
3. Describe Chinese kites
4. Describe Chinese rockets
5. Describe Da Vinci's parachute and model helicopter
6. Identify Leonardo Da Vinci's contributions
7. Describe gliders
8. Identify the principles of bird flight
9. Explain why machines do not fly the way birds do
10. Discuss why some ancient inventors mimicked bird flight in their attempts to fly

PART IB

Strategy: Students need to know that the invention of the airplane was not the beginning of aviation history. The Wright brothers and other inventors built on the work of many others before them. Approach this lesson by raising students' awareness of the fact that interest in flight dated back to ancient times. Emphasize that this course will introduce them to many exciting figures and events in aviation history. It will also help them appreciate the heritage of flight we have today. This includes how humans tried to fly in ancient times, key aviation devices created during ancient times, and why machines do not fly the way birds do.

PowerPoint Presentation: Information points will appear on mouse clicks.

Optional Activities: Pages 6-8, 9, 12-13, and 14.

Lesson Outline:

1. Introduction (5 min.)

2. Quick Write (5 min.)

3. Topics (35 min.)

    a. How humans tried to fly in ancient times
    b. Key aviation devices created during ancient times
    c. Why machines do not fly the way birds do

4. Conclusion/Wrap-up (5 min.)

PART II

INTRODUCTION

ATTENTION

"Look! It's a bird. It's a plane. No, it's…Superman!" While today we enjoy stories about flying super heroes such as "Superman," human fascination with flight has appeared in stories and myths since ancient times. In fact, humans have not only told stories about flight through the ages, but also tried to actually fly in ancient times. Fascination with flight is nothing new.

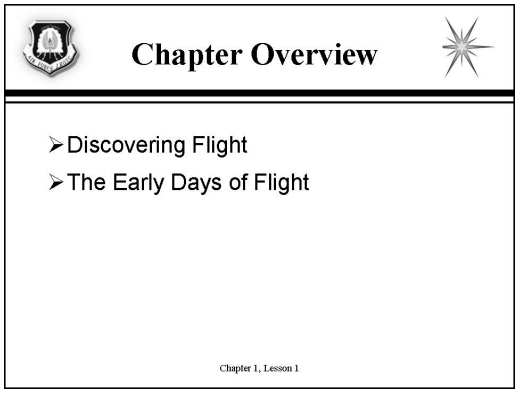
MOTIVATION

Today we'll learn about discovering flight in ancient times. It may seem that the history of flight should start with the first airplane—that is, the Wright brothers' first flight. But the Wrights' achievement was only the final step in centuries of attempts to learn how to fly. The Wright brothers built on the work of many others before them.

CHAPTER OVERVIEW

In this chapter on Ancient Flight, we'll cover the following topics (this lesson's topics are in bold):

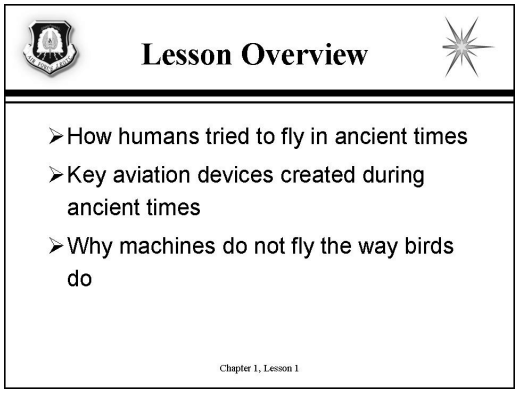
1. **Discovering Flight**
   - **a. How humans tried to fly in ancient times**
   - **b. Key aviation devices created during ancient times**
   - **c. Why machines do not fly the way birds do**
2. The Early Days of Flight
   - a. Developments in lighter-than-air flight
   - b. Ways balloons were used in the US Civil War and Spanish-American War
   - c. Developments in heavier-than-air flight



LESSON OVERVIEW

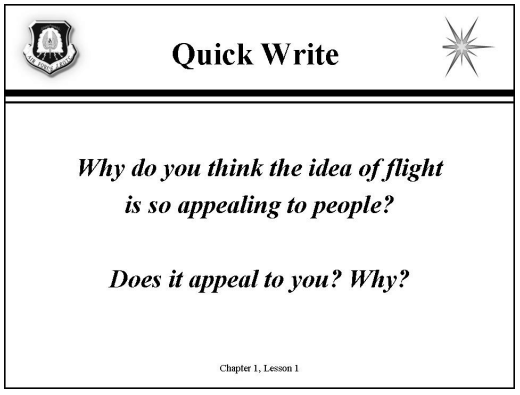
Today, we'll cover the following topics:

1. How humans tried to fly in ancient times
2. Key aviation devices created during ancient times
3. Why machines do not fly the way birds do



QUICK WRITE
Have the students read/review the opening story in the lesson. Then have them write a response to the Quick Write on a separate piece of paper.

Why do you think the idea of flight is so appealing to people? Does it appeal to you? Why?



BODY

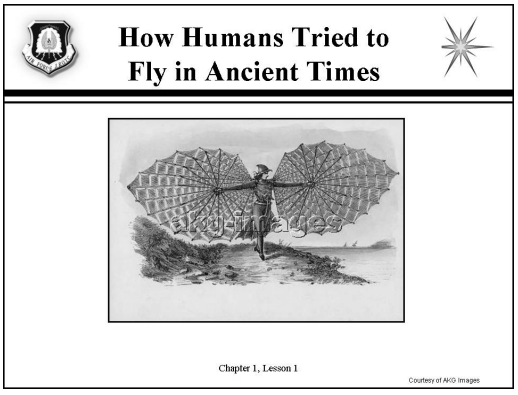
PRESENTATION

1. How humans tried to fly in ancient times

a. Humans have dreamed of taking flight for thousands of years.

(1) **Flight** is *the act of passing through the air on wings.*

(2) People told tales about flight around the fire at night. Parents in early societies handed down these stories to their children.

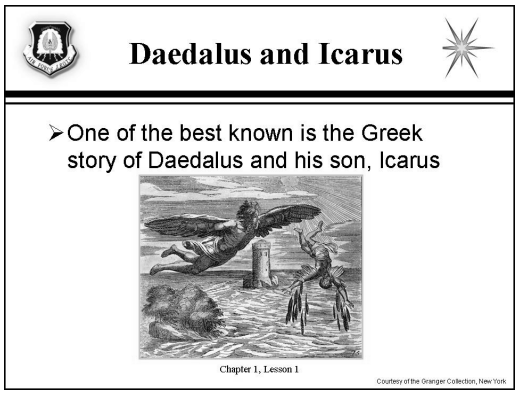


b. One of the best known is the Greek story of Daedalus and his son, Icarus.

(1) Daedalus and Icarus were imprisoned by King Minos on the island of Crete. To escape, they made wings from bird feathers and attached them to their bodies with beeswax. The wings did carry them off the island.

(2) But Icarus enjoyed his new freedom so much that he ignored his father's warning and flew too close to the sun. Its heat melted the wax. Icarus fell into the sea and drowned.

(3) The story of Icarus and Daedalus is a myth. It isn't a true story. But people still tell it today because of what it says about the human quest for freedom—and about sons who disobey their fathers. The story, however, doesn't say much about how to build a good flying machine.

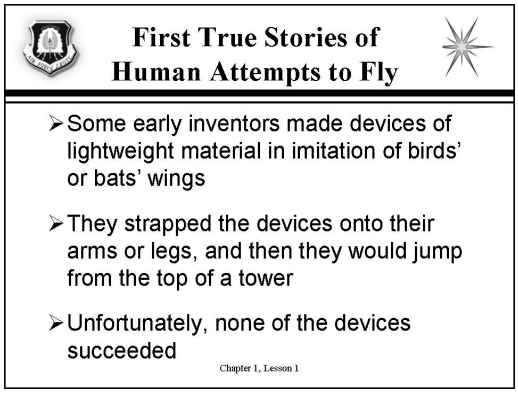


c. The first true stories of human attempts to fly, though, included things that today seem almost as strange as stick-on wings.

(1) Some of these early inventors made devices of lightweight material such as cloth or wood, in imitation of birds' or bats' wings.

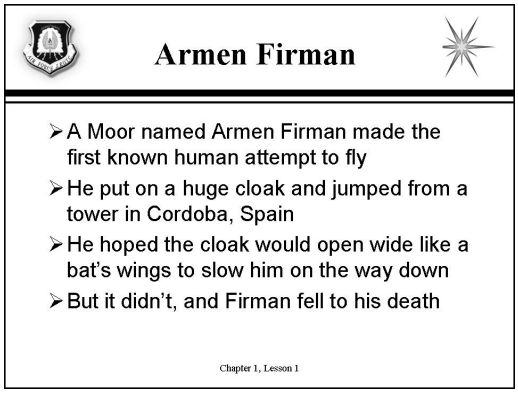
(2) They strapped the devices onto their arms or legs, or both. Then they would jump from the top of a tower or tall building, hoping to glide or flap their way gently to earth.

(3) Unfortunately, none of the devices succeeded. At best, they slowed their wearers' plunge to earth. These early inventors all made hard landings, resulting in serious injury or death.



d. History credits a Moor named Armen Firman as the first known human to attempt to fly.

(1) In the year AD 852, he put on a huge cloak and jumped from a tower in Cordoba, Spain. He hoped the cloak would open wide like a bat's wings to slow him on the way down.



(2) But it didn't, and Firman fell to his death. His unfortunate experiment might be described as an early attempt at a jump by parachute.

(3) A **parachute** is *a device intended to slow free fall from an aircraft or another high point*.

2. Key aviation devices created during ancient times

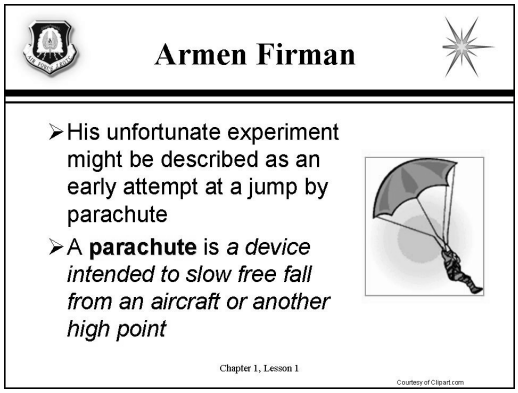
a. Chinese kites

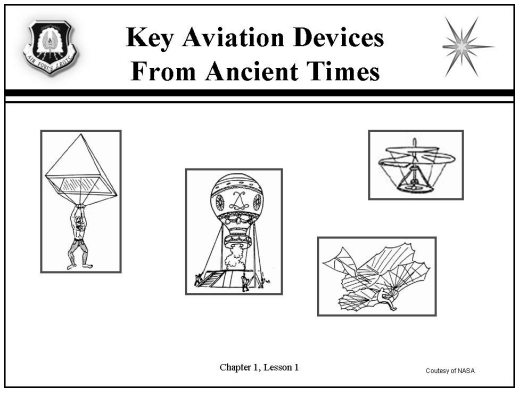
(1) A lot of ancient scientific progress took place in China. The Chinese invented the kite around 1000 BC.

(2) A **kite** is *a light framework covered with paper or cloth, provided with a balancing tail, designed to be flown in the air.*

(3) A kite may seem very different from an airplane, but kites were actually among the first man-made devices to take flight. It's not clear that these early kites actually carried people at first. Evidence suggests, though, that they were quite large and strong.

(4) Within a few hundred years, people were using them in warfare. Around AD 1300 the Italian explorer Marco Polo reportedly saw Chinese sailors attached to kites as "eyes in the sky," observing enemy actions during battle. In the seventeenth century, other Western observers reported seeing Chinese soldiers on kites serving as flying spies.





OPTIONAL ACTIVITY: Build and Fly a Kite
Instructions and diagrams are available at http://www.pbs.org/benfranklin/exp_kite_print.html. Begin with "What You'll Need." (This information is also in the SW—Lesson 1-1)

American inventor and statesman Benjamin Franklin used a kite in his scientific experiments. Follow the instructions below to build a kite like his. Then take it outside and see if you can fly and maneuver it!

Materials:

- One 24-inch wooden dowel or lightweight, straight wooden stick
- One 20-inch wooden dowel or lightweight, straight wooden stick (Hint: If you have a longer stick, get an adult to help you cut it to the right length.)
- A large piece of paper (at least 26 inches square) or a heavy-duty trash bag
- Tape
- Lightweight string, twine, or fishing line
- Craft knife (Make sure there's an adult around to supervise when you use this tool.)
- Ruler
- Pencil, pen, or marker
- Scissors
- Ribbon
- Pin, needle, or other tool with a sharp point.

Procedure:

1. With the craft knife, carve a notch into each end of each stick. Both notches must run in the same direction and be parallel to the ground.
2. Take the longer stick. Using a ruler, mark a spot 6 inches, or one-fourth of the way, from one end of the stick.
3. Take the shorter stick. With the ruler, mark off a spot 10 inches, or halfway, into the stick.
4. Place the shorter stick crosswise over the longer one, matching up the marks you just made. When the sticks are lying down, all the notches should be parallel to the ground.
5. Take the string and wrap it tightly around the center of your sticks, binding them together. You will be making an X shape with the string. Double-check that the notches remain parallel to the ground.
6. Thread the string though all the notches, creating a diamond shape. Wrap the string around twice, making sure it is tight. This is the frame of your kite.
7. Pull the end of the string back toward the center of your kite. Make sure the frame is still tight. Wrap the string tightly around both sticks (mimicking the X shape you made earlier with the string) and tie it off with a knot.
8. Cut your paper or plastic bag so that it is slightly larger than the kite frame.
9. Fold the paper over the string frame. Tape or glue it down.

10. Reinforce the top and bottom tips of your kite with tape. Using a pin or needle, punch a tiny hole through each of ehese reinforced tips.
11. Cut a two-foot piece of string. Knot one end of the string through the top hole and the other end through the bottom hole. This will form the "bridle" of your kite, the part that controls it.
12. Take the rest of the string. Attach one end to the bridle about a third of the way down. This will be your flying string.
13. Either tape or knot a two-yard-long string to the bottom tip of your kite. Then take the ribbon and tie bows around the string. The tail of your kite will add stability when the kite is in flight.
14. Now it's time to fly your kite! On a breezy day, find an open space. Make sure there are no power lines or trees nearby. Let the wind work its magic! (Hint: If your kite jerks or dips, try moving the location of the flying string knot up or down the bridle.)

(Note: end of optional activity)

b. Chinese gunpowder and rockets

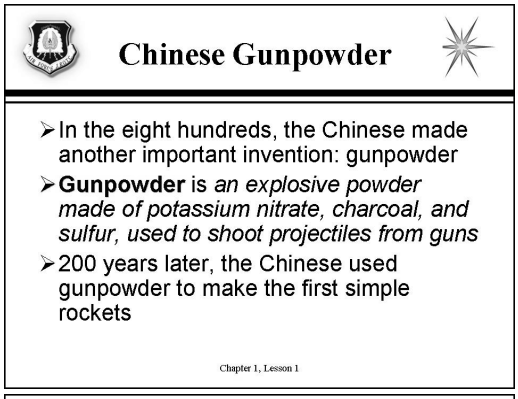
(1) In the eight hundreds, the Chinese made another important invention: gunpowder.

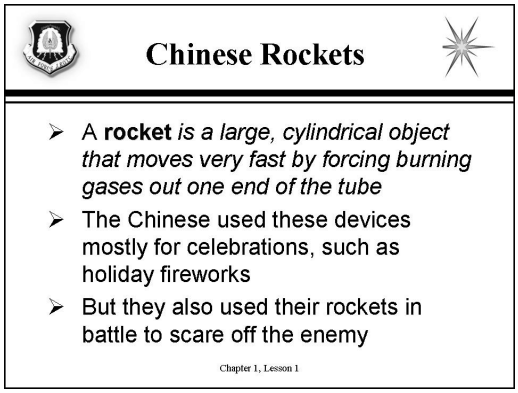
(2) **Gunpowder** is *an explosive powder made of potassium nitrate, charcoal, and sulfur, used to shoot projectiles from guns*.

(3) And just 200 years later, the Chinese were using gunpowder to make the first simple rockets.

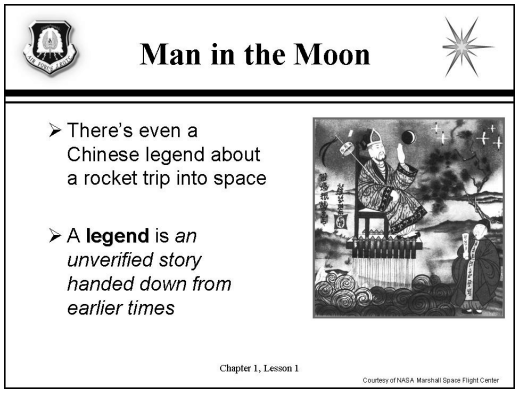
(4) A **rocket** *is a large, cylindrical object that moves very fast by forcing burning gases out one end of the tube.*

(5) The Chinese used these devices mostly for celebrations, such as holiday fireworks. But they also used their rockets in battle to scare off the enemy.





(6) There's even a Chinese legend about a rocket trip into space.



(7) A **legend** is *an unverified story handed down from earlier times.*

(8) This legend says that a man named Wan Hoo fastened 47 rockets to a chair. He hoped his invention would take him to the moon. Not surprisingly, it didn't work. He went up in a ball of fire, and, the legend suggests, perhaps became the Man in the Moon.

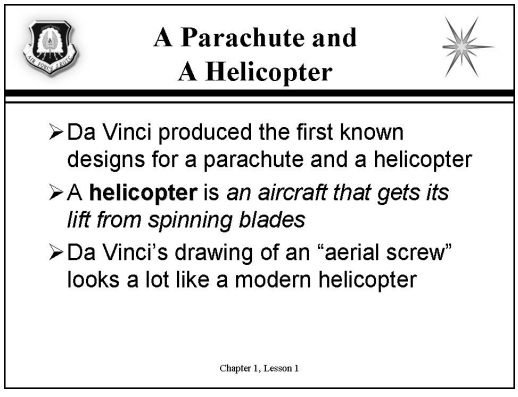
OPTIONAL ACTIVITY: Class *Jeopardy* Contest on Leonardo da Vinci

Put students in equal groups (no more than 5 students per group). Each group is a team and must write answers to the following Jeopardy *style questions about Leonardo da Vinci. Teams will be awarded five points for each correct answer. The team with the most points wins.*

1. The famous painting da Vinci is known for. (What is the *Mona Lisa*?)
2. Da Vinci was an important part of this historical movement. (What is "The Renaissance"?)
3. Another profession da Vinci was known for, besides being an artist. (What is a scientist?)
4. An aircraft that gets its lift from spinning blades that da Vinci produced the first known design and model for. (What is a helicopter?)
5. Da Vinci was fascinated with these creatures. (What are birds?)

(Note: end of optional activity)

c. A parachute and a helicopter



(1) The first person in the history of aviation who was also a real scientist was Leonardo da Vinci (1452–1519). Da Vinci produced the first known designs for a parachute and a helicopter. He apparently made models of both and may even have flown one of his helicopters.

(2) A **helicopter** is *an aircraft that gets its lift from spinning blades.*

(3) Da Vinci's drawing of an "aerial screw" looks a lot like a modern helicopter. And in fact, both devices are based on the same principle: a flat screw that, when turned, produces lift.

(4) What's more, today's parachutes are based on principles first described by da Vinci. His invention, he wrote, would allow someone to "throw himself down from any height without sustaining any injury."

(5) Da Vinci's notebooks show that he understood several key concepts in aviation, such as streamlining.

(6) **Streamlining** is *designing an aircraft to reduce resistance to motion through the air.*

d. Gliders

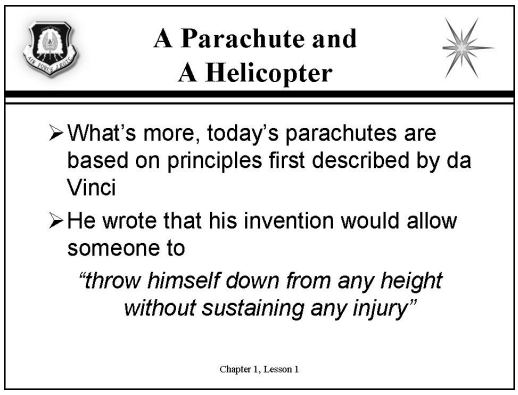
(1) Da Vinci also researched the idea of a glider.

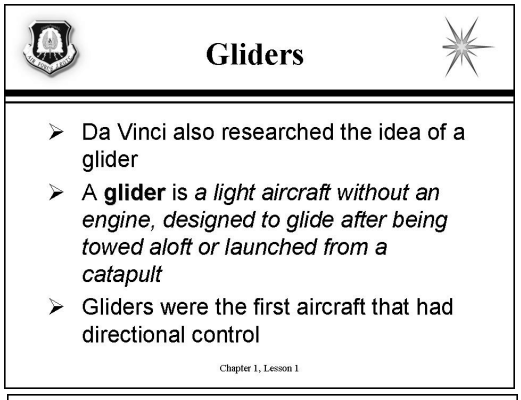
(2) A **glider** is *a light aircraft without an engine, designed to glide after being towed aloft or launched from a catapult.*

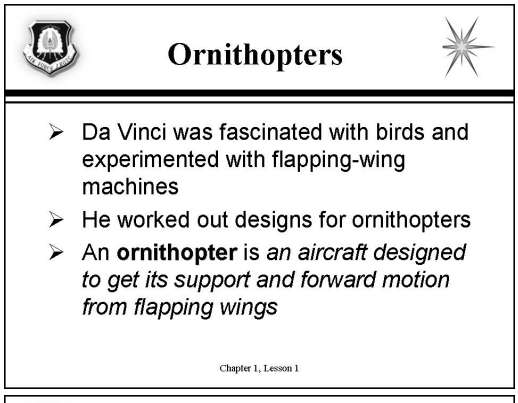
(3) Gliders were the first aircraft that had directional control.

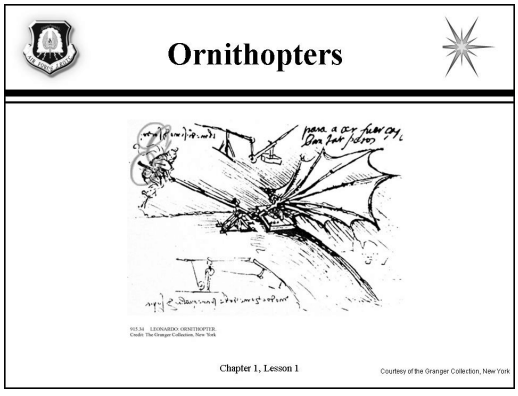
(4) Da Vinci was fascinated with birds, and he experimented with flapping-wing machines. He worked out structures and mechanisms intended to mimic the motions of a bird. These included some designs for ornithopters.

(5) An **ornithopter** is *an aircraft designed to get its support and forward motion from flapping wings.* (*Orni-* comes from a Greek word for bird.)



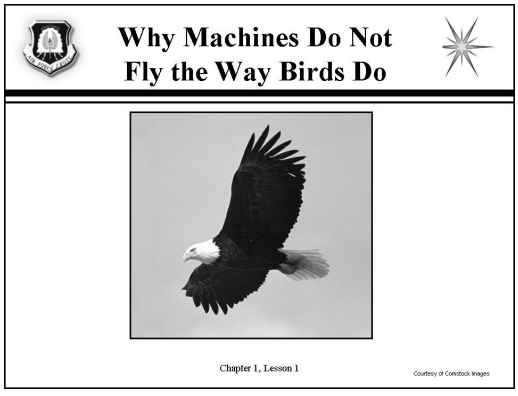






(6) Da Vinci was a careful observer. But even he didn't understand how complex the movements of a bird's wing are. He also didn't realize that human muscle power could never be powerful enough to keep a person in the air.

(7) You may think of birds as "lightweights," and in many ways, they are. But it's relative proportions that matter. Birds are very powerful for their size. Their large wing muscles and hollow bones make them well suited to flight.

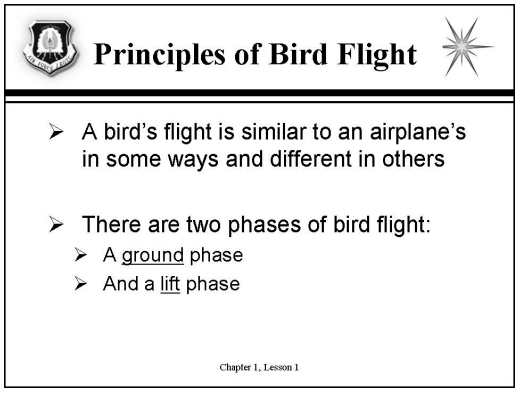


3. Why machines do not fly the way birds do

a. The principles of bird flight

(1) A bird's flight is similar to an airplane's in some ways and different in others.

(2) There are two phases of bird flight—a ground phase and a lift phase.



(3) The ground phase allows the bird to get started moving forward in order for the wings to provide the necessary lift. To be lifted by its wings, a bird . . . must be moving forward fast enough to make air pass over its wings. A bird can move forward by flapping its wings. Most of the flapping is done by the outer wing. The flight feathers work like the propeller of a plane: i.e., they push downward and backward, thereby driving the air backward and moving the bird forward.

(4) Once the bird's speed is adequate, lift over the wing is generated by the same principle as the flow of air over the wing of an airplane.

(5) Slow-motion pictures of birds in flight show that the wings move downward rapidly. The wing tips trace a figure eight as they move though the air. The downward beat of the wings moves the bird forward as the outer tips push against the air.

(6) Wing feathers are arranged much like shingles on a roof. They change position when the bird is flapping. On the downbeat of the wing, the feathers are pressed together so little air can pass through them. On the up stroke the feathers open.

(7) Bird flight and the flight of human-made aircraft rely on two kinds of lift, each named for a famous scientist who never flew, but who made significant contributions to aeronautical science: Daniel Bernoulli and Sir Isaac Newton.

b. Daniel Bernoulli

(1) The Dutch-born scientist Daniel Bernoulli (1700–1782) made an important discovery about the relationship between pressure and fluids (liquids or gases) in motion. A fluid has a constant pressure, he found, but when a fluid starts to move faster, the pressure drops.

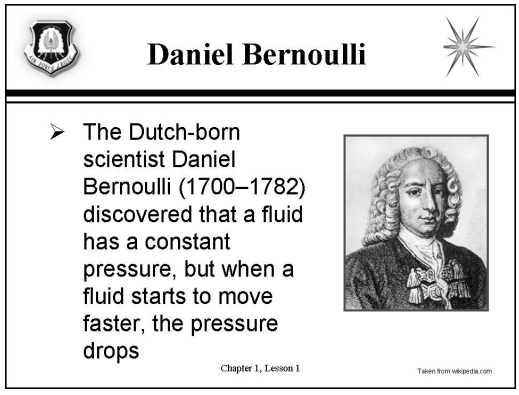
(2) Wings are designed to make air flow faster over their tops. This makes the pressure drop and the wings move upward, defying the force of gravity.

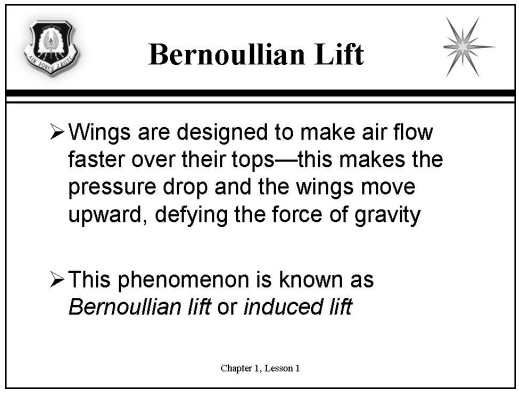
(3) This phenomenon is known as *Bernoullian lift* or *induced lift*.

OPTIONAL ACTIVITY: Is Bernoulli's Principle Worth Two Cents?
Adapted from Civil Air Patrol: AEX II, Volume One, Activity 12. (This information is also in the SW—Lesson 1-1)

The objective of this activity is to create an airfoil out of a piece of file folder and then make it "fly" with a source of high velocity wind. A file folder, shaped like a wing, will fly when the wind of a hair dryer is directed toward it. The force is strong enough even to lift a few pennies!

Materials:
- One, or more, filing folders cut to about the size of a sheet of paper
- One hair dryer
- Masking or Scotch-type tape
- Two pennies.





Procedure:
1. Tape the file folder piece to the edge of a smooth table.
2. Fold so that it eventually has the shape of an elongated tear drop.
3. Point the hair dryer toward the leading edge and experiment with wind flow.
4. After a few tries, the "wing" will lift right off the table.
5. Next, tape a penny to the underside of the wing.
6. Try the air flow again…and if you've done it correctly, it will lift 2, sometimes 3 pennies.

This is a fun way to teach Bernoulli's Principle. In the example of our wing, air flows faster over the upper curved surface. As the air going over the upper surface accelerates, the pressure drops. The air on the underside, relative to the upper surface, has a higher pressure. The difference in pressure causes the wing to react by rising toward to the area of lower pressure. If the air is flowing fast enough and the surface of the wing is curved enough, it will fly!
(Note: end of optional activity)

c. Sir Isaac Newton

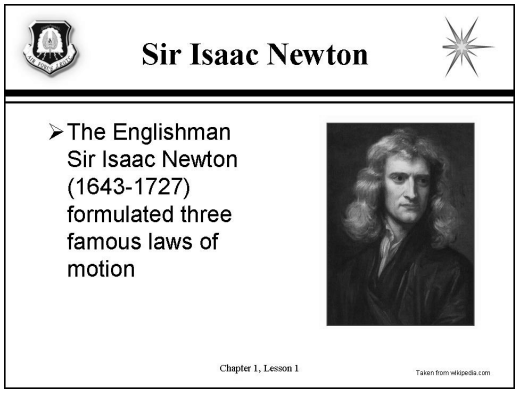
(1) Sir Isaac Newton, an Englishman who lived from 1643 to 1727, formulated three famous laws of motion.

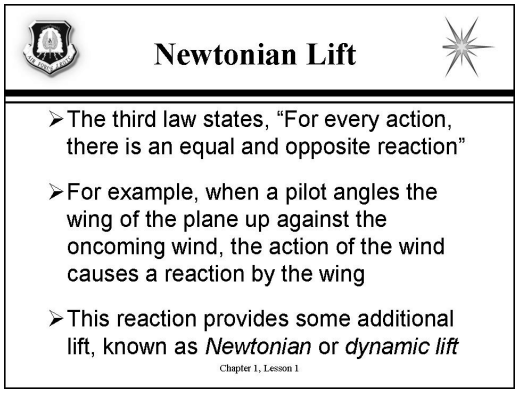
(2) The third law states, "For every action, there is an equal and opposite reaction." This principle comes into play when an airplane is ascending, or flying higher. When a pilot angles the wing of the plane up against the oncoming wind, the action of the wind causes a reaction by the wing.

(3) This reaction provides some additional lift, known as *Newtonian* or *dynamic lift*.

(4) So with Bernoullian lift pulling from above and Newtonian lift pushing from below, a wing has no choice. It can only go up—whether it's attached to a bird or to an airplane.

d. But by now you're beginning to understand that birds and airplanes don't work exactly alike.





(1) Here's another difference: Airplanes are fixed-wing aircraft. They don't flap their wings as birds do.

(2) Instead, airplanes rely on their propellers or jet engines to get them off the ground.

e. Why some ancient inventors tried to mimic bird flight

(1) At the beginning of aviation history, flapping wings seemed to be what flight was all about. People observed birds, bats, and insects flying this way. As you've now learned, some early inventors thought feathers might possess some lifting power of their own.

(2) And even a thinker as brilliant as Da Vinci got stuck on birds as the model for human flight. Some scientists think that if Da Vinci had focused on fixed-wing gliders, instead of ornithopters, he might have done even more for the progress of aviation than he actually did.

(3) Only when people stopped trying to fly as birds do did the way open for the Wright brothers' success on the North Carolina dunes.

OPTIONAL ACTIVITY: Writing and Reflecting
In a journal or on a sheet of paper, ask students to reflect and write on today's lesson. Some possible writing topics:

1. Imagine you were an aviation inventor in an age before the Wright brothers made the first flight in 1903. What kind of device would you have worked on? Would you have tried to mimic bird flight? Why or why not?

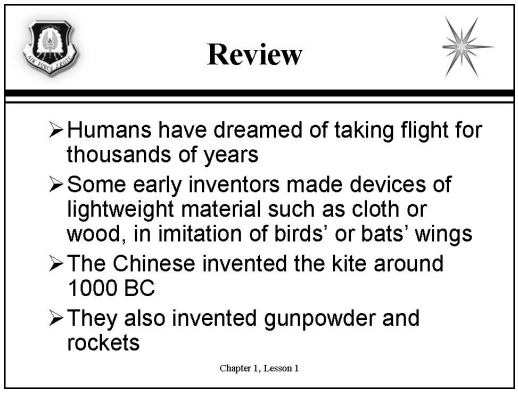
2. Explain the principles of bird flight and reflect on how humans and machines are different from birds.

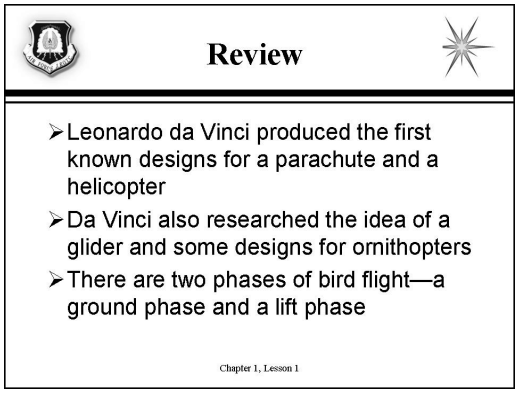
3. What do we owe to great scientists like Leonardo da Vinci, Daniel Bernoulli, and/or Sir Isaac Newton? Imagine you were a friend to one of these individuals.

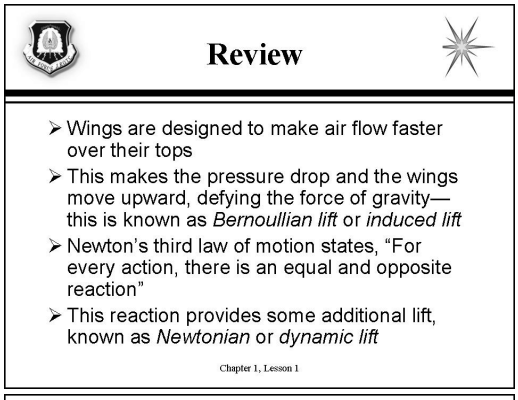
4. Expand on what you wrote during the "Quick Write" activity. If you had lived in ancient times would the concept of flight have been appealing to you?
(Note: end of optional activity)

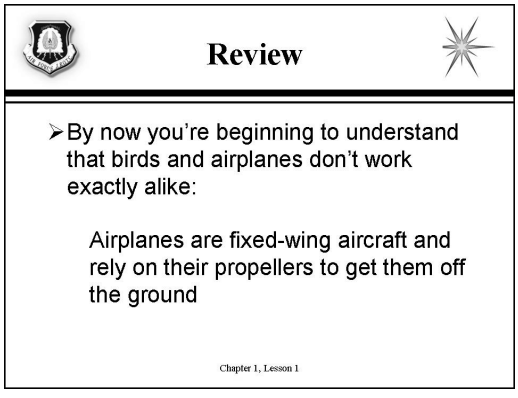
REVIEW

- Humans have dreamed of taking flight for thousands of years.
- Some early inventors made devices of lightweight material such as cloth or wood, in imitation of birds' or bats' wings.
- The Chinese invented the kite around 1000 BC; they also invented gunpowder and rockets.
- Leonardo da Vinci produced the first known designs for a parachute and a helicopter.
- Da Vinci also researched the idea of a glider and designs for ornithopters.
- There are two phases of bird flight—a ground phase and a lift phase.
- Wings are designed to make air flow faster over their tops. This makes the pressure drop and the wings move upward, defying the force of gravity—this is known as *Bernoullian lift* or *induced lift.*
- Newton's third law of motion states, "For every action, there is an equal and opposite reaction"—this reaction provides some additional lift, known as *Newtonian* or *dynamic lift.*
- By now you're beginning to understand that birds and airplanes don't work exactly alike: Airplanes are fixed-wing aircraft and rely on their propellers or jet engines to get them off the ground.







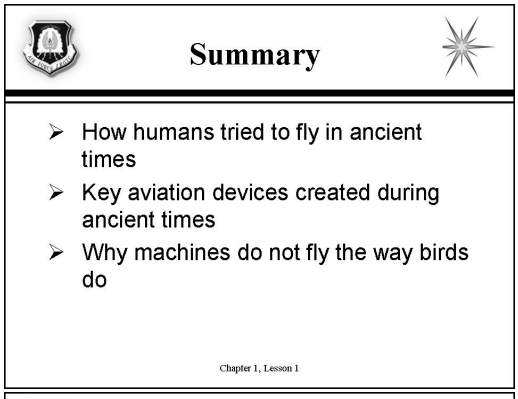


CONCLUSION

SUMMARY

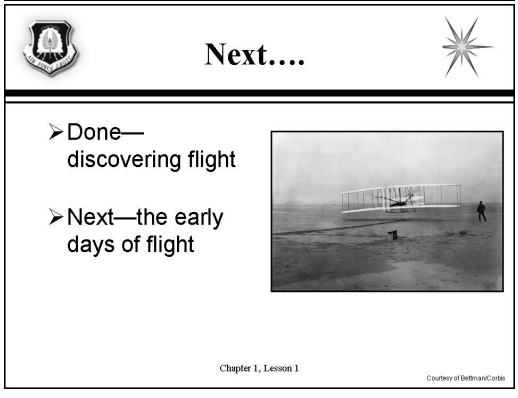
In this lesson we discussed the following:

1. How humans tried to fly in ancient times
2. Key aviation devices created during ancient times
3. Why machines do not fly the way birds do



REMOTIVATION

Humans have attempted to fly for centuries. Although some of the failed experiments we learned about seem strange to us today, inventors such as the Wright brothers built on the failures of others before them. By the 20th century, humans knew better than to try to fly "free as a bird!"



CLOSURE

We've learned about discovering flight. Next, we'll learn about the early days of flight.

Checkpoints

Below are the answers to the items listed at the end of the lesson in the student textbook edition of *Aerospace Science: A Journey Into Aviation History*. These end-of-lesson items are not assigned in the lesson plans or student workbooks. The answers are provided here in case you want to assign any of them in your classes, for homework, or if your students ask you about them. They are in the same order as listed in the student textbook.

1. The Wright brothers reached a milestone in December 1903 by achieving the first controlled, sustained, and powered heavier-than-air flight. (p. 6)

2. Daedalus and Icarus were Greek mythical characters who made wings from bird feathers and attached them to their bodies with beeswax. The wings carried them into the air, but Icarus enjoyed his new freedom so much that he ignored his father's warning and flew too close to the sun. Its heat melted the wax. Icarus fell into the sea and drowned. (p. 7)

3. Armen Firman was a Moor who made the first known human attempt to fly. In the year AD 852, he put on a huge cloak and jumped from a tower in Cordoba, Spain. He hoped the cloak would open wide like a bat's wings to slow him on his way down. But it didn't, and Firman fell to his death. (p. 7)

4. The Chinese made some early military uses of kites by flying them to scout the enemy's position and movements by air. In 200 BC, soldiers let the wind carry their kites to a position over the enemy camp. By determining how much rope had been let out, the Chinese soldiers could figure out how far away the enemy was. Around AD 1300 the Italian explorer Marco Polo reportedly saw Chinese sailors attached to kites as "eyes in the sky," observing enemy actions during battle. (p. 8)

5. The Chinese made the first rockets (around AD 1000) and used these devices mostly for celebrations, such as holiday fireworks. But they also used their rockets in battle to scare off the enemy. (p. 8)

6. Leonardo da Vinci produced the first known designs for a parachute and a helicopter. He also researched the idea of a glider, and worked out some designs for ornihopters. (pp. 9-10)

7. The two phases of bird flight are a ground phase and a lift phase. According to Dr. Paul Fortin:

   > The ground phase allows the bird to get started moving forward in order for the wings to provide the necessary lift. To be lifted by its wings, a bird . . . must be moving forward fast enough to make air pass over its wings. A bird can move forward by flapping its wings. Most of the flapping is done by the outer wing. The flight feathers work like the propeller of a plane: i.e., they push downward and backward, thereby driving the air backward and moving the bird forward. Once the bird's speed is adequate, lift over the wing is generated by the same principle as the flow of air over the wing of an airplane. (p. 11)

Applying Your Learning

8. Answers will vary. One example of a flying device to compare to a flying squirrel is a glider. Flying squirrels don't have wings like birds that give them the necessary lift to fly. Their flaps of skin could be compared to the wings of a glider, though. Launching from tree to tree is an action similar to launching a glider from a catapult. (p. 10)

References

Millspaugh, Ben P. (n.d.). *AEX II Activity Booklet for Secondary (6-12) Educators and Civil Air Patrol Aerospace Education Officers* (Vol. I). Maxwell AFB, AL: Civil Air Patrol Aerospace Education and Professional Development Directorate.

Public Broadcasting Station (PBS). "Make a Kite" activity, *Benjamin Franklin* program. From: http://www.pbs.org/benfranklin/exp_kite_print.html.