An early German Zeppelin
Courtesy of Corbis Images
Unit Chapter

CHAPTER 1

Ancient Flight
Union forces prepare a balloon for use during the Civil War.
“The way in which we experience the irregularities of the wind while gliding through the air cannot be learned in any other way except by being in the air itself. . . .”

OTTO LILIENTHAL, “The Father of Modern Aviation”
A stiff, 27-mile-an-hour wind roared across the dunes at Kill Devil Hills, North Carolina. Wilbur Wright reached out to steady the wing of his experimental flying machine. His brother, Orville, lay at the controls. For years the brothers had worked for this moment—both in their bicycle shop in Dayton, Ohio, and on these same coastal dunes. They’d tested kites. They’d tested gliders. They’d even built a small wind tunnel and learned how to control their craft in the air.

Now, on 17 December 1903, they were ready to find out: Would their heavier-than-air craft leave the ground and fly on its own?

Orville gunned the engine, and Wilbur let go of a wire that held the plane in place. The Wright Flyer rolled down a set of tracks on a trolley, with Wilbur’s hand still steadying the wing. Suddenly, it happened: The Flyer lifted into the air, dropped the trolley, and flew for 12 seconds. Under Orville’s control, it landed 120 feet away from the track’s end. The Wright brothers had achieved a milestone: the first controlled, sustained, and powered heavier-than-air flight.

That flight and the three that followed on that raw December day changed the course of human history. After thousands of years of dreaming and trying, humans had mastered flight. But the Wrights’ achievement was only the final step in centuries of attempts to learn how to fly. The brothers from Dayton built on the work of hundreds of others before them.
How Humans Tried to Fly in Ancient Times

Humans have dreamed of taking flight—of escaping gravity to fly “free as a bird”—for thousands of years. People told tales about flight—the act of passing through the air on wings—around the fire at night. Parents in early societies handed down these stories to their children.

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

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.

The first true stories of human attempts to fly, though, included things that today seem almost as strange as stick-on wings. Some of these early inventors made devices of lightweight material such as cloth or wood, in imitation of birds’ or bats’ wings. 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.

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.

History credits a Moor named Armen Firman with 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 the way down. 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—a device intended to slow free fall from an aircraft or another high point.

Key Aviation Devices Created During Ancient Times

Chinese Kites

A lot of ancient scientific progress took place in China. The Chinese invented the kite around 1000 BC. A kite is a light framework covered with paper or cloth, provided with a balancing tail, designed to be flown in the air. A kite may seem very different from an airplane, but kites were actually among the first man-made devices to take flight.
flight. It's not clear that these early kites actually carried people at first. Evidence suggests, though, that they were quite large and strong. 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.

**Chinese Gunpowder and Rockets**

In the 800s AD, the Chinese made another important invention: gunpowder—an explosive powder made of potassium nitrate, charcoal, and sulfur, used to shoot projectiles from guns. And just 200 years later, the Chinese were using gunpowder to make the first simple rockets. A rocket *is a large, cylindrical object that moves very fast by forcing burning gases out one end of the tube.*

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.

There’s even a Chinese legend, or unverified story handed down from earlier times, about a rocket trip into space. 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.

It’s obvious that this is just a story. But in a way, the legend foretold history. When the Apollo astronauts traveled to the moon in the 1960s and 1970s, they were strapped into special chairs in their spacecraft and then lifted away from Earth by rockets.
A Parachute and a Helicopter

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, an aircraft that gets its lift from spinning blades. He apparently made models of both and may even have flown one of his helicopters.

Da Vinci’s drawing of an “airscrew” 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. 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.”

Leonardo da Vinci

Have you heard the term “Renaissance man?” It refers to someone who has many talents. Leonardo da Vinci was such a man. He’s best known today as an artist—for example, he painted the Mona Lisa. But he was a scientist, too. He conducted the first scientific experiments in aviation.

Like other scientists, Da Vinci observed the world closely. Also like other scientists, he kept good records. He filled the pages of his notebooks with detailed drawings of things he had actually seen, as well as things he thought up. The notebooks included 160 pages of drawings of his projects for flight. The notebooks show that Da Vinci understood several key concepts in aviation, such as streamlining, which is designing an aircraft to reduce resistance to motion through the air.

His orderly way of working did a lot for science. But it could have done much more. Tragically, his notes were lost for about 300 years following his death. He left his drawings and papers in the care of a friend, who never published them. Scientists today wonder how much sooner human flight would have developed had Da Vinci’s work been available during those “lost” years.
Giders

Da Vinci also researched the idea of a glider, a light aircraft without an engine, designed to glide after being towed aloft or launched from a catapult. Gliders were the first aircraft that had directional control.

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

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. That realization didn’t come until about 150 years after Da Vinci’s death. At that time, the Italian biologist Giovanni Alfonso Borelli (1608–1679) concluded that a man’s muscle power just wasn’t great enough to lift his weight.

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. Unfortunately, when it comes to being able to fly on their own muscle power, humans have more in common with elephants than with birds!
Why Machines Do Not Fly the Way Birds Do

The Principles of Bird Flight

A bird’s flight is similar to an airplane’s in some ways and different in others. Here’s how Dr. Paul Fortin, author of *The Fantasy and Mechanics of Flight*, explains it:

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

Dr. Fortin adds:

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

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 Isaac Newton.
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. 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 phenomenon is known as *Bernoullian lift* or *induced lift*.

Sir Isaac Newton, an Englishman who lived from 1643 to 1727, formulated three famous laws of motion. 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. This reaction provides some additional lift, known as *Newtonian or dynamic lift*. 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.

By now you’re beginning to understand that birds and airplanes don’t work exactly alike. Here’s another difference: Airplanes are fixed-wing aircraft. They don’t flap their wings as birds do. Instead, airplanes rely on their propellers or jet engines to get them off the ground.

**Timeline of Aviation History**

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<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>1000 BC</td>
<td>Chinese invent the kite.</td>
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<td>200 BC</td>
<td>Chinese General Han Hsin uses kites for military surveillance.</td>
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<td>AD 800s</td>
<td>Chinese invent gunpowder.</td>
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<td>AD 852</td>
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<td>1452–1519</td>
<td>Life span of Leonardo da Vinci, who pioneered the scientific study of</td>
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Why Ancient Inventors Tried to Mimic Bird Flight

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

CHECKPOINTS

Lesson 1 Review

Using complete sentences, answer the following questions on a sheet of paper.

1. What milestone did the Wright brothers reach in December 1903?
2. Who were Daedalus and Icarus?
3. Who was Armen Firman, and what was his role in aviation history?
4. What were some early military uses of kites?
5. Who made the first rockets? What were they first used for?
6. What kinds of flight devices did Leonardo da Vinci explore?
7. What are the two phases of bird flight?

Applying Your Learning

8. Flying squirrels don’t have wings, but they do have flaps of skin between the legs on each side of their body. These flaps allow them to “fly” from tree to tree or from a tree to the ground. To which flying device would you compare a flying squirrel and why?