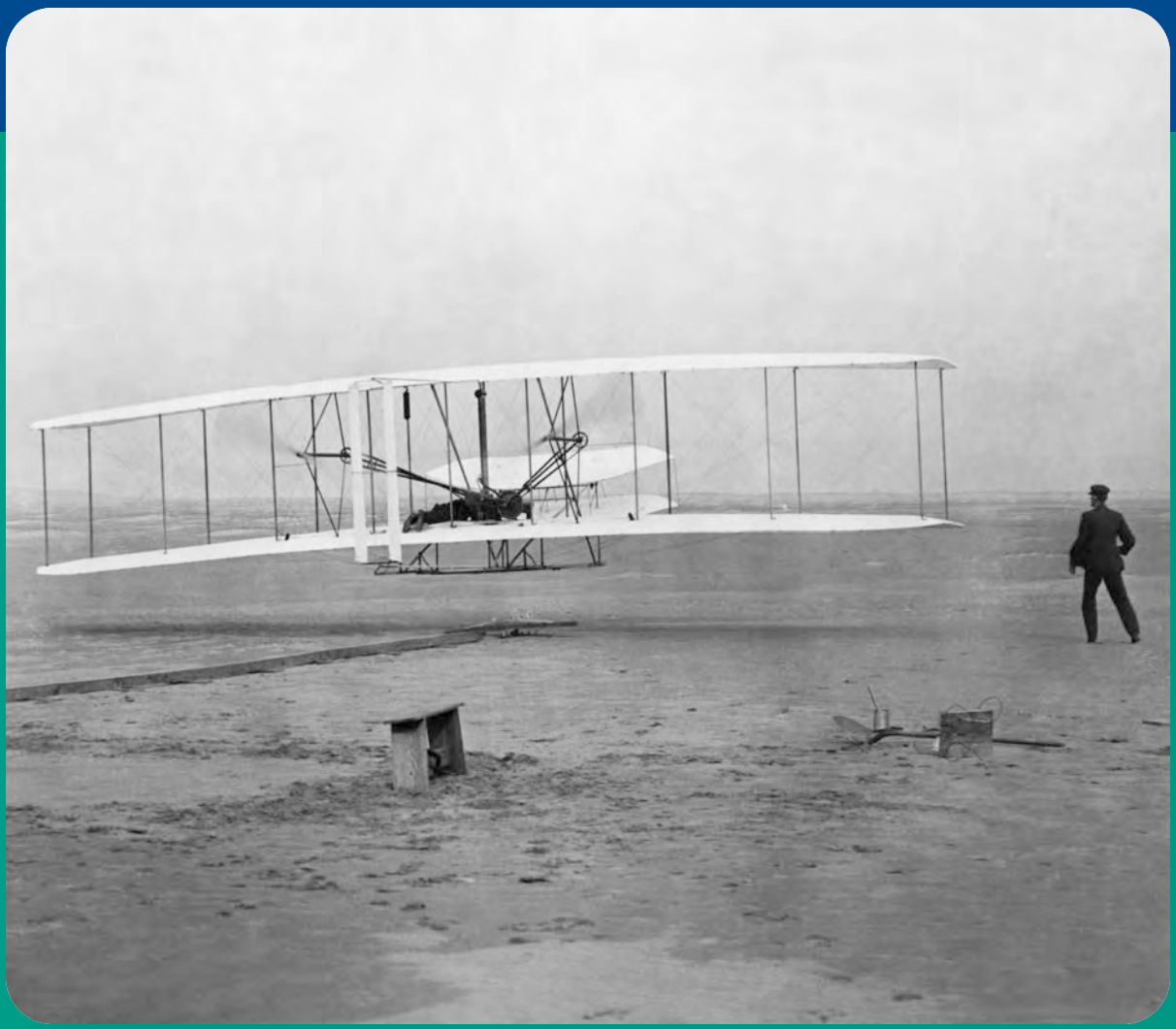
UNIT TWO

Explo



The Wright Brothers' first flight

Courtesy of Bettmann/Corbis

ring FLIGHT

Unit Chapters

CHAPTER 2

Capt Eddie Rickenbacker,
American ace in World War I

Courtesy of Bettmann/Corbis

Pioneers of Flight

Chapter Outline

"More than anything else, the sensation [of flying] is one of perfect peace mingled with an excitement that strains every nerve to the utmost—if you can conceive of such a combination."

WILBUR WRIGHT

LESSON 1

The Wright Brothers

Quick Write

As you read in Chapter 1, the Wright brothers were the first to conduct a manned, controlled, sustained, and powered heavier-than-air flight. Many others had tried unsuccessfully to do this. List the reasons for the Wrights' success.

Learn About...

- **how the Wright brothers succeeded in the first flight**
- **the anatomy of the *Wright Flyer***
- **the principles of airplane flight**
- **the history of the Wright brothers' involvement with the US Army**

It was 14 December 1903. Wilbur and Orville Wright stood on the sand dunes of Kill Devil Hills, North Carolina. Beside them was their aircraft, the *Wright Flyer*. It was ready for its first real test. Although their first successful manned flight of this craft would not come until three days later, on 17 December, they had high hopes. The two men had worked for years for this moment. One important question remained: who would fly the craft?

They tossed a coin. Wilbur won. He would pilot the *Flyer* on its first attempt at flight.

Choosing the pilot was a matter of chance. But it wasn't chance that brought the two brothers to this important day. It was years of work and study. Why did they succeed when others had failed?

First, they were intelligent men. They learned from the experiences of others. Second, they were also creative thinkers and great problem solvers. Third, and perhaps most important, they were patient.

A well-known proverb says, "Genius is patience." And the brothers' patience paid off. After making hundreds of flight trials between 1899 and 1903, the Wrights achieved what earlier men had only dreamed of.

How the Wright Brothers Succeeded in the First Flight

As you read in Chapter 1, all pilots face three challenges. They must *get up in the air, stay up,* and *control their craft*. The choice of craft was up to the pilot. And pilots had three choices to experiment in flight:

- manned and powered, full-size aircraft
- models
- full-size gliders.

The Wrights chose a glider as their starting point. By using a glider, they could focus first on balancing and controlling their aircraft. Power—an engine—could come later. This approach explains why they succeeded where Samuel P. Langley, who focused on power, failed.

But before they could build a full-size glider, they needed to experiment with other, smaller craft. This was a complicated process. The brothers applied what they learned at each step to make the next one go more smoothly.

Vocabulary

- **strut**
- **bracing**
- **warp**
- **lateral**
- **pitch**
- **elevator**
- **canard configuration**
- **airfoil**
- **center of pressure**
- **angle of attack**
- **relative wind**
- **spars**
- **ribs**
- **skids**
- **yaw**
- **bid**

Skynotes

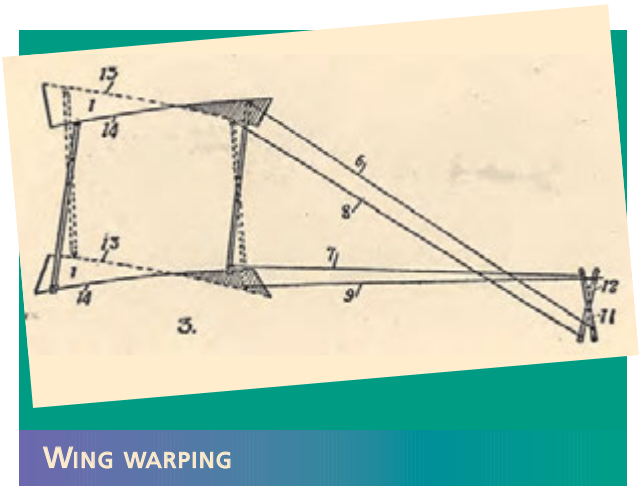
Wilbur Writes to the Smithsonian

One reason for the Wright brothers' success was their patience. Another was that they asked lots of questions. They wanted to build on what others had learned. So Wilbur went to the experts. He wrote the following letter to Smithsonian Institution in Washington, D.C., on 30 May 1899:

> Dear Sirs:
>
> I am an enthusiast, but not a crank in the sense that I have some pet theories as to the proper construction of a flying machine. I wish to avail myself of all that is already known and then if possible add my mite to help on the future worker who will attain final success.
>
> Wilbur Wright

Step One: An Unmanned Box Kite

The brothers began in July 1899 with an unmanned box kite. The kite had a five-foot wingspan and a biplane structure. It also had struts that connected the upper and lower wings. A strut *is a vertical post.* The kite also had bracing, *or support,* that was strung diagonally between the struts. The Wrights used steel for the bracing. They adapted their bracing design from a manned glider created by Octave Chanute and Augustus Herring in 1896.



WING WARPING

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2001-9902)

The brothers also had a unique approach to controlling the kite. They discovered that they didn't need to tilt an entire wing to turn the craft: They needed to twist only the ends of the wings. They called this process "wing warping." To warp, *or twist,* the wings, they removed the bracing between the front and rear struts. They attached four cords to the top and bottom of the front outer struts. Pulling on these ropes turned the craft.

In the summer of 1899, Wilbur successfully tested the kite in a field. The first step in the experiment for aircraft control was a success. The next step: man a glider.

Skynotes

An Absentminded Invention

Wilbur Wright was talking to a customer in the bicycle shop he owned with his brother in Dayton, Ohio. As he did so, he toyed with a long, empty carton. Twisting the carton this way and that, he made a discovery: the sides of the box retained their shape and strength. Wilbur figured this same principle would apply to the wings of a biplane kite. In other words, the tip could be twisted, but the wing would remain strong. Thus the brothers' groundbreaking wing-warping theory was born.

Step Two: Manned Gliders

The box kite taught Wilbur and Orville Wright how to control lateral—*sideways*—turns. But building a successful manned glider presented other challenges. Between 1900 and 1902, the brothers built three gliders. Before putting a man aboard, they flew each glider like a kite. They wanted to test it for control and lift. Only after doing this would they put a man aboard.

The early glider experiments were successful. They taught the brothers three important things:

- how to control climb and descent
- the best design for the shape of the wing
- how large the wing area had to be to sustain lift.

The First Glider (1900)

With a man on board the craft, knowing how to move up and down was essential. Otherwise, a sudden pitch—*a movement up or down*—could be fatal. For example, the German aviator Otto Lilienthal, whom you read about in the previous lesson, died when his craft made a downward pitch and crashed.

The Wrights studied Lilienthal's data. They used it to design a device that gave them greater control of pitch. In their experiments at Kitty Hawk in 1900, they had placed an elevator—*a movable, horizontal surface that controls motion up and down*—at the front of the glider. This was a unique idea: Earlier designers had mounted elevators behind the wings. But the Wrights found it easier to control climb and descent when the elevator was placed forward. This development saved the Wrights' lives on several occasions. A canard configuration *is another name for an elevator that sits in front of the wings.* (*Canard* is the French word for *duck*—early observers thought the canard configuration resembled a flying duck.)

THE WRIGHTS FLYING ONE OF THEIR GLIDERS AS A KITE

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2003-29083)

THE WRIGHTS' 1900 GLIDER

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2002-23711)

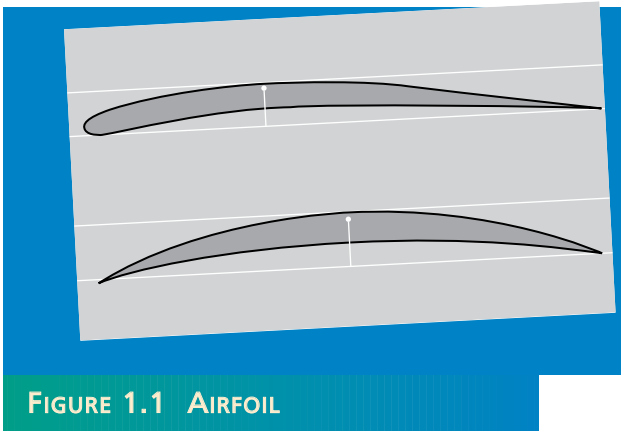


FIGURE 1.1 AIRFOIL

Courtesy of the National Air and Space Museum, Smithsonian Institution

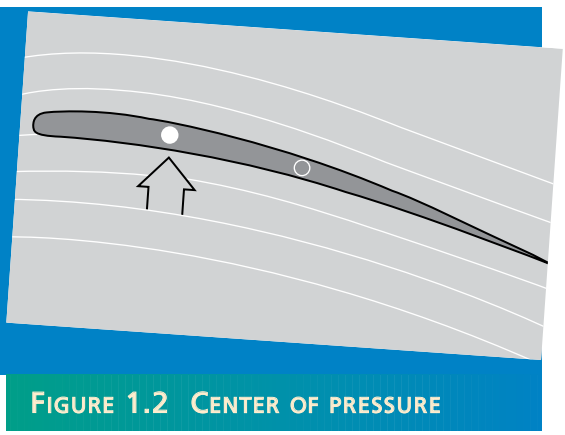


FIGURE 1.2 CENTER OF PRESSURE

Courtesy of the National Air and Space Museum, Smithsonian Institution

Next, the Wrights tackled the challenge of how to shape the glider's wing. This took a couple years to figure out. In 1900 they focused on airfoil—*a wing's profile*. In particular, they zeroed in on the curve of a wing.

Wings have a lot to do with lift, which, as you've learned, is the upward force on an aircraft. The center of pressure *is the focal point of lift*. The Wrights tried to design a wing that shifted the center of pressure toward the front edge of the wing—the wing edge nearest the front of the aircraft. Earlier designers thought that the center of pressure should be in the middle of the wing. The Wrights placed the highest point of the wing's arc closer to the outer edge than to its center. They believed this would create greater stability and control.

The brothers test-flew their glider at Kill Devil Hills in 1900. It didn't crash. But clearly improvements were necessary. The Wrights left North Carolina and headed back to Ohio. During the winter, they would tinker with their craft and build the next version of their glider.

Skynotes

A Stitch in Time

A glider's wings need to be strong but not heavy. They need to be stiff but not inflexible. In 1900 Wilbur and Orville Wright hit on a way to get all of this: fabric. They covered the top of the glider's wings with French sateen. Pieces of the wings' framework slid into "pockets" sewn on the underside of the fabric. These skeleton-like pieces of the wings "floated" inside the pockets. The fabric took the role that heavier wires and bracing would otherwise have taken. The Wrights attached the fabric to the wing's frame on the bias, which is a 45-degree angle. This made the wing stronger.

The Second Glider (1901)

The Wrights' first glider had a wing area of 165 square feet. That glider didn't have nearly enough lift. So for their 1901 glider, the brothers increased the wing area to 290 square feet. This glider was also a big disappointment. The brothers couldn't control it well when they tested it at Kill Devil Hills. It flew less than 300 feet. Time to return to Dayton.

Wilbur and Orville built a wind tunnel in their bicycle shop in Ohio to test model-size wings. These wings came in many shapes—squares, rectangles, and semicircles. They ranged from perfect curves to arcs with their highest points at the outer edges. The Wrights made them of sheet steel. Over the winter, the brothers cut more than 200 model wings of different shapes.

A REPLICA OF THE WRIGHT BROTHERS' WIND TUNNEL

Courtesy of the Air Force Museum Foundation

MODEL AIRPLANE WINGS

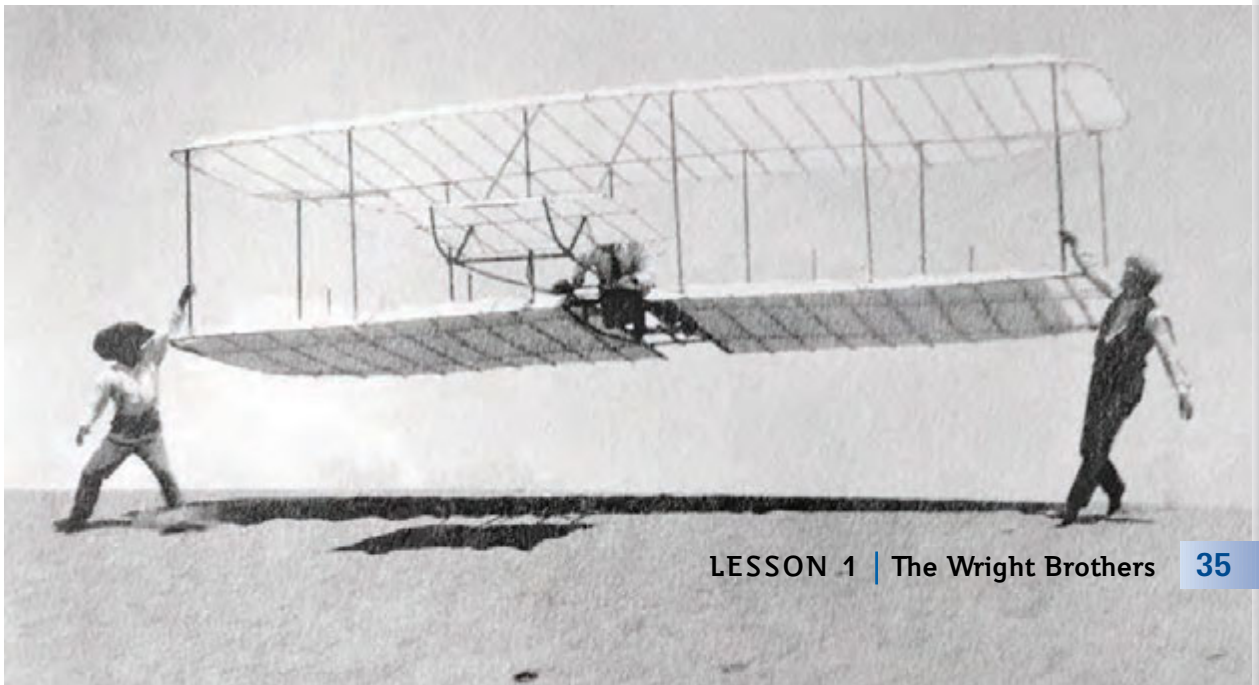
The various model wing shapes the Wrights tested

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2005-3452)

THE 1901 GLIDER

Wilbur Wright tries to fly the 1901 glider, as William and Dan Tate help.

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-86-3018)



THE WRIGHTS' 1902 GLIDER
Courtesy of the Library of Congress

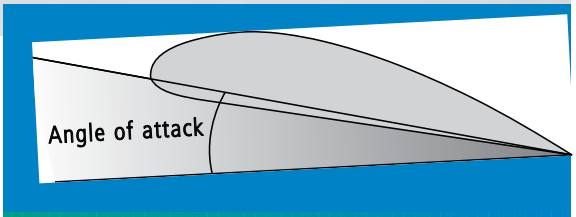


FIGURE 1.3 ANGLE OF ATTACK

The Third Glider (1902)

At this point, the brothers could have been tempted to try powered flight. After all, their model-wing tests had answered many questions. But remember—these two men were patient. They didn't want to rush the process. So in preparation for 1902, they applied what they'd learned to build a third glider.

This glider had two fixed, vertical rudders behind the wings. Test flights showed that this resulted in erratic behavior during turns. So the Wrights tried a single, movable, vertical rudder. This improved control. This aircraft, too, had a forward elevator, but it had a more elliptical shape, and longer, skinnier wings. Wing area was 305 square feet. In addition, the glider had a low angle of attack—*the angle between the* relative wind *(the flow of air) and the airfoil*. This also made the glider more stable and easier to control.

This design was a success. The brothers took to the air in the North Carolina dunes more than 700 times in the fall of 1902.

Winter arrived. It was time to head back to Ohio. It was also finally time to put an engine on the glider.

Step Three: A Manned, Powered Aircraft

One key to the Wright brothers' success was their countless test flights. Another was sticking with a core design. Their kites and gliders evolved from a single design into the manned, powered aircraft they eventually flew in 1903. They tinkered with the details, but didn't get distracted. For instance, they didn't attempt powered flight until they'd perfected other elements, such as the wings.

Once they'd resolved questions about control and lift, the brothers set out to fit their plane with an engine. They hoped they might buy one ready made. They sent out queries to a number of firms. But no one met their needs or price. So the brothers had their bicycle mechanic, Charles E. Taylor, build them a four-cylinder, 12-horsepower engine.

In September 1903 they returned to Kitty Hawk and Kill Devil Hills. The aircraft was ready. But they couldn't take to the skies quite yet. They had to build a trolley track to give their powered aircraft a running start. Bad weather also caused delays. So the first test flight of the *Wright Flyer* didn't take place until 14 December.

The brothers tossed a coin. Wilbur won the toss. He took the pilot's seat for the initial powered flight. He rolled down the trolley, launched into the air, and—crashed. That flight lasted only 3.5 seconds. The crash damaged the elevator. But the brothers were not discouraged. Quite the opposite—in a note to home, Wilbur wrote, "There is now no question of final success."

It took three days to repair the damaged craft. Then, on 17 December, Orville took the controls for this day's first flight. It was 10:35 a.m. The *Flyer* rose into the air. It stayed aloft for 12 seconds and traveled 120 feet. He had made the first controlled, sustained, heavier-than-air human flight with a powered aircraft.

On that momentous day, the brothers took turns piloting the *Flyer* for three more flights. Each launch was more impressive than the last. The fourth and final launch lasted 59 seconds. The craft traveled 852 feet.

The Wright brothers' triumph at Kitty Hawk
Courtesy of Bettmann/Corbis

The Anatomy of the *Wright Flyer*

Equipped with an engine and propellers, the *Wright Flyer* was larger than the aircraft the brothers built earlier. The biplane had a wingspan of 40 feet, 4 inches, and a wing area of 510 square feet. The *Flyer* was 21 feet, 1 inch long. It stood 9 feet, 4 inches tall. It weighed 605 pounds without a pilot and about 750 with a pilot on board.

The Parts of the Wright Flyer

The *Flyer's* wings had two main parts. The spars *were the main, lengthwise pieces of the wing*. Attached to the spars were ribs. The ribs *gave shape to the wings*. Muslin, a lightweight fabric, covered the wings. It reduced wind resistance and added strength as the wings warped during turns. Struts and bracing between the top and bottom wings further reinforced the plane.

Flight Paths

Orville (left) and Wilbur Wright

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-90-9558)

Orville Wright (1871–1948)

Orville Wright was the scientist of the family. He loved science and technology. He was also quite shy, although he was never timid about playing practical jokes on his family and friends. Later, he wrote about the support he and his siblings found at home:

> We were lucky enough to grow up in an environment where there was always much encouragement to children to pursue intellectual interests; to investigate whatever aroused curiosity. In a different kind of environment, our curiosity might have been nipped long before it could have borne fruit.

Wilbur Wright (1867–1912)

Wilbur, four years older than Orville, was outgoing. He excelled at writing and public speaking. He loved to read. Both Wilbur and Orville liked to tinker as children. When they had questions about anything mechanical, they would go to their mother, Susan. She was good at inventing. She made toys for her children and basic appliances for herself. Originally, Wilbur hoped to attend Yale University, but he was needed at home to help care for his mother. So he taught himself by reading a lot.

Two propellers sat behind the wings. They rotated in opposite directions and were made of two layers of spruce wood. Their job was to help move the craft forward. The plane also had a front elevator, which was covered by fabric. A rudder at the rear was also wrapped in fabric. The other important part of this plane was, of course, the engine. The *Flyer's* engine was water cooled like a car engine and fueled by gasoline. The engine and the propellers together weighed about 200 pounds.

Before the *Flyer*, two assistants hand-launched the brothers' gliders. Each assistant would hold a wing and help lift the craft in the air. But the new, powered *Flyer* was too heavy for that. Rather than the wheels that are so common on the airplanes you see today, the brothers used skids—*long, thin runners, like a pair of skis*. Before takeoff, the plane sat on a trolley that rolled along wooden rails.

How the Flyer Worked

The brothers controlled their craft through three main means they developed in their glider experiments: the forward elevator, the use of wing warping, and a single, movable rear rudder.

Surprisingly, the pilot did not sit upright. Instead, he lay on his stomach in a padded cradle on the lower wing. Because the engine was somewhat right of center, the pilot was placed slightly left of center to balance the weight.

To the pilot's left was a lever that he used to control the up-and-down movement of the elevator. By moving the lever with his hand, he could climb or descend. By moving his hips, he pulled on the cables connected to the wings and rudder. This movement could direct the plane left or right.

Before the brothers invented the single, movable rudder, their gliders often slid sideways rather than turned. *A sidewise movement is called a* yaw. With the new, flexible rudder, the plane finally turned in the intended direction. For instance, if the pilot moved his hips so the cable pulled down on the left wing, the plane would veer left. The cables attached to the wings from the cradle twisted one wing down while forcing the other wing up. If the aircraft began to yaw, the rudder corrected this by reacting to pressure from airflow.

To design the propellers, the brothers drew on their bicycle-shop experience. They made the propellers rotate by attaching them to the engine with bicycle chains. To rotate the propellers in opposite directions, they simply twisted one of the two chains into a figure 8.

Before launch, wires tethered the airplane to earth. Only when the engine had fully revved up did the trolley start to move down the tracks. The plane lifted off the trolley as it rose into the air.

The Principles of Airplane Flight

To get the *Wright Flyer* off the ground the brothers had to solve the principles of flight you have read about: *lift, drag, thrust, angle of attack, center of pressure, airfoil,* and *relative wind*. The combination of solutions they found is still used for modern airplanes.

An engine and propellers gave Wilbur and Orville the ability to use not only lift but also thrust to propel their plane through the air. Both these forces are necessary for powered flight. As you learned in Chapter 1, lift is an upward force, and thrust is a forward, or horizontal, force.

Principles of Flight

Lift
Drag
Thrust
Angle of Attack
Center of Pressure
Airfoil
Relative wind

When working on their gliders, the Wrights focused most of their attention on the lift exerted on the wings. Now that they had an engine and propellers, they could start to think more about thrust. They considered the propellers as extra wings on their airplane. But unlike wings, which are stable and horizontal, the propeller "wings" rotated and sat vertically. The propellers on the *Flyer* were eight feet in diameter.

If a horizontal, curved wing reacts to lift, the Wright brothers reasoned, vertically mounted propellers could provide the airflow for thrust. They calculated they needed 90 pounds of thrust to propel the *Wright Flyer*. Their 12-horsepower engine and the large propellers proved equal to the task.

The History of the Wright Brothers' Involvement With the US Army

After their first success, the Wright brothers continued refining their airplane. Once they had achieved powered flight, they no longer needed the wind conditions of the North Carolina coastline for their tests. In October 1905 they circled a field in Dayton for 38 minutes and traveled 24 miles. They decided it was time to cash in on their remarkable invention.

They'd already started their marketing effort. Back in January of 1905 they contacted their representative in Congress, R. M. Nevin, and asked him to try to interest the US government in buying their airplane. Mr. Nevin passed along their letter to the Board of Ordnance and Fortifications, which made military weapons purchases. The board was leery of wasting government money. It turned down the brothers' offer.

The brothers, patient as always, contacted the secretary of war later that year. Again, their offer was rejected. After all, as Chapter 1 related, the government had already invested $50,000 in Samuel Langley's flight experiments. The secretary didn't want to spend more money when the outcome seemed so uncertain.

Why the US Army Purchased the *Wright Flyer*

Meanwhile, the British and French governments got into the act. They were interested in buying the *Flyer*. Representatives from both countries made offers to the Wrights. But the brothers wanted the US government to have first crack at owning a *Wright Flyer*.

A turning point came on 22 May 1906. On that date, after three years of trying, the brothers received a government patent for their invention. This spurred the Aero Club of America, a group of aviation enthusiasts and scientists, to take action. They sent a clipping about the Wrights to President Theodore Roosevelt. The president ordered the Board of Ordnance and Fortifications to look again into the airplane.

After that, things started to happen. On 23 December 1907, Brig Gen James Allen, chief of the Army Signal Corps, sent out a request for bids to build a plane for the government. A bid *is an offer or a proposal, with a price attached*. The brothers received their copy of Brig Gen Allen's request on 3 January 1908.

The bid set forth the technical requirements for the craft. These requirements stated that the craft must:

- achieve a speed of 40 miles per hour
- carry two passengers for a total of 350 pounds
- have a fuel tank large enough to fly 125 miles nonstop
- be able to land without damage.

The government also required that the successful bidder train two Army pilots to fly the craft.

The *Wright Flyer* met these requirements. Orville Wright signed a contract on 10 February 1908 selling the *Flyer* to the US government.

Ways the Wright Brothers Contributed to Army Aviation

With the purchase of the *Wright Flyer*, the Army bought not only the military's first plane but also access to the Wright brothers' inventive minds. In the years that followed, the Wrights continued to improve their aircraft. For instance, they created wheels for the *Flyer*. The wheels enabled it to take off and land in a wider variety of settings.

Orville spent much of 1908 and 1909 improving the *Flyer*. He made more test flights and took up military passengers. One such flight tragically ended in a crash that seriously injured Orville and killed 1st Lt Thomas Selfridge—the first US military aviation casualty. Wilbur was often overseas giving demonstrations during this time.

The brothers switched roles in mid-1909. Wilbur trained two pilots for the Army—1st Lt Frank P. Lahm and 2d Lt Fredric E. Humphreys. In October 1909 both men made their first solo flights with less than a month's training. These were adventurous men: each had barely three hours' instruction in the air before going it alone.

A third pilot, 1st Lt Benjamin Foulois, got instruction late that month. One of the men initially picked for pilot training, he was delayed because of business in France. He took the *Wright Flyer* to Fort Sam Houston, Texas, where he continued teaching himself to fly. He corresponded with Wilbur and Orville whenever he had a question. On 2 March 1910 he took his first solo flight. By the time of his retirement a quarter-century later, Foulois had achieved the rank of major general. He was also chief of the Army Air Corps.

It took a while for the Army to decide how to use airplanes during war. At first, the Army thought that airplanes would be useful only for aerial reconnaissance, much as hot air balloons were used during the US Civil War and the Spanish-American War. But World War I brought about a change in strategy: soon, the warring sides were employing planes for bombing missions and to support troops on the ground. Before that could happen, however, airplanes needed improvements to make them faster, sturdier, and more reliable.

World-record flight, 1909

Orville Wright and 1st Lt Frank P. Lahm making a world-record flight at Fort Myer, Virginia, in 1909

Courtesy of Corbis Images

CHECKPOINTS

Lesson 1 Review

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

1. What three choices did pilots have to experiment in flight?
2. How did the Wright brothers' approach to building an aircraft differ from Samuel Langley's?
3. What three important points did Wilbur and Orville Wright learn from their gliders?
4. What did the Wright brothers do in Ohio to test for the perfect wing shape?
5. What role did fabric play in the anatomy of the *Wright Flyer*?
6. What kind of force do propellers provide?
7. Which powerful man in government sent out a request for bids to build a plane for the government?

Applying Your Learning

8. What process allowed the brothers to turn their box kite from side to side? How would you apply that process if you were building a biplane kite?

LESSON 2

Developing Aircraft

Quick Write

Both the Wright brothers and Glenn Curtiss were heavily involved with bicycles before taking up flight. What similarities do you see between bicycles, early motorcycles, and early airplanes?

Learn About...

- **the key individuals involved in early aircraft development**
- **the names and anatomy of period aircraft**
- **the significance of other American pioneers in aviation following the Wright brothers**

Glenn Curtiss, born in Hammondsport, New York, in 1878, sped onto the aviation scene in the early 1900s. But he was riding a motorcycle, not an airplane. At Ormond Beach, Florida, in 1907, he set a world speed record for motorcycles: 136.3 miles per hour (mph). People called him the "fastest man on Earth." This was the same year the Wright brothers received their bid request for a military airplane from the Army Signal Corps chief, Brig Gen James Allen.

Much was happening all at once in the world of transportation. And any advance in one field sparked progress in another.

Curtiss's passion for speed began with bicycles. As a teenager, he raced at county fairs and often won. This experience led to his love of fast motorcycles. Curtiss liked to fiddle with the mechanical side of bicycles, motorcycles, and engines as well. Actually, he did more than tinker with them. He built gasoline engines for motorcycles. Barely out of his teens, he started his own motorcycle business, the G. H. Curtiss Manufacturing Company.

His work with motorcycle engines eventually caught the eye of people in the field of flight. Once they introduced Curtiss to aircraft, he was hooked for good.

Key Individuals Involved in Early Aircraft Development

In the first decade of the 1900s, when the Wright brothers were making aviation history, other people were also becoming aviation pioneers. Each person made developments in aircraft that earned him or her a place in aviation history.

Glenn Curtiss

Glenn Curtiss pushed aviation forward in several ways. Even before his record-setting motorcycle ride in 1907, Curtiss was dipping his toes into aviation. He'd begun racing with his bike motors in Florida in 1904. It was there that Thomas Baldwin discovered Curtiss.

Baldwin, an American balloonist, owned a dirigible. As you read in the lesson "The Early Days of Flight," a dirigible is a lighter-than-air craft filled with helium. By the early 1900s aviators in France and Germany were using engines to maneuver such aircraft in the sky. But balloonists in the United States hadn't yet taken that step. Baldwin was looking for a lightweight engine for his aircraft when he spotted Curtiss racing in Florida. He saw how well Curtiss's engine performed. He asked if he could buy one. The young mechanic agreed. He tweaked one of his engines for use in an aircraft.

Baldwin's aircraft, equipped with a Curtiss engine, was the first powered dirigible in America. Before long, other balloonists wanted Curtiss motors, too. And in 1908 the US government purchased one of Curtiss's engines for the US Army's first dirigible, SC-1. Later, the military would purchase Curtiss planes and engines for use in World War I. The Army used the Jenny airplane—or JN-4—for training pilots. Curtiss's Wasp engine broke records for speed and rate of climb.

Vocabulary

- aileron
- fuselage
- multiengine plane
- cockpit
- tandem
- porthole
- radial
- crankshaft
- rotors
- torque
- boom
- solo
- pylons
- jumpsuit

Glenn Curtiss

Courtesy of Underwood & Underwood/Corbis

The Aerial Experiment Association

Glenn Curtiss was a busy man in 1907. In addition to working on some of the devices already mentioned, he joined the Aerial Experiment Association. Alexander Graham Bell, best known as the inventor of the telephone, formed this group. The inventors who belonged made some important design breakthroughs.

First, they built the first American plane equipped with ailerons. An aileron *is a small flap on the wing for controlling turns*. Ailerons replaced the Wright brothers' wing-warping technique, which used cables to pull on the ends of the wings. The aileron was a more effective means to move an aircraft left or right. It also provided lateral balance. This was critical whenever airplanes had rigid metal rings.

Although association members get credit for introducing this idea to America, none of them dreamed it up. The aileron was patented in Great Britain in 1868. In 1904 a Frenchman who was flying a glider used ailerons for the first time.

Second, members of the group built and flew the country's first seaplane. Curtiss would later win the first government contract with the US Navy for seaplanes.

Curtiss's Fame Grows

Curtiss continued to enter contests. In 1908, piloting an association plane called the *June Bug*, he won the Scientific American trophy. The award was for making the first public flight of more than one kilometer (0.6 miles). At the Rheims Air Meet in France in 1909, Curtiss picked up a prize for speed. He flew the fastest two laps over a triangular, 6.21-mile course. For this feat he took home the Gordon Bennett trophy. Curtiss won the trophy in his *Golden Flyer*. His average speed? An amazing 47 mph.

THE AERIAL EXPERIMENT ASSOCIATION

Members include Glenn Curtiss (left) and Alexander Graham Bell (center)

Courtesy of the Library of Congress

THE JUNE BUG

Courtesy of Bettmann/Corbis

THE GOLDEN FLYER

Two of Glenn Curtiss's award-winning planes: the June Bug and the Golden Flyer

Courtesy of Corbis Images

Never one to rest, Curtiss opened a flight school in 1910, the same year the Wright brothers opened their school. Also in 1910, a pilot named Eugene Ely flew a Curtiss biplane from the deck of a ship off Hampton Roads, Virginia. Later, Ely landed the plane on a wooden platform built on the armored cruiser USS *Pennsylvania*.

Curtiss's effect on aviation can still be felt today. To begin with, motorcycle engines were light and powerful. Aircraft also need light, powerful engines that won't weigh them down. Less weight puts less strain on the aircraft during takeoff, landing, and flight.

Louis Blériot

Across the Atlantic Ocean, the French pilot Louis Blériot was also pushing the limits of flight. He was the first man to cross the English Channel in a heavier-than-air craft. And what an adventure it turned out to be.

He took off from near Calais, in northern France, without a compass. Within 10 minutes, he was lost. He could see nothing but water and sky. He had no coastline in sight to guide him. Blériot piloted his aircraft as best he could toward England. He knew the journey was about 25 miles.

Finally he caught sight of the English cliffs of Dover. But then he encountered another hitch. His engine was overheating, and he was still above water and could not land. Then he spotted a small rainstorm. He veered toward it. The rain cooled his engine, and he landed safely. The flight took 37 minutes.

This flight took place in a powered monoplane that Blériot built. A *monoplane*, as you read in Chapter 1, is an airplane with one set of wings. The Wright brothers' aircraft were biplanes, or aircraft with two sets of wings. Louis Blériot was the first man to build a powered monoplane. He named the aircraft that brought him across the English Channel the *Blériot XI* because he'd built 10 others before it. He'd crashed nearly 50 times during test flights of those aircraft. The 11th plane brought him safely to England's shores.

Blériot achieved other accomplishments. Like Curtiss, he entered the first international air meet in Rheims in August 1909. While Curtiss won the two-lap contest for speed, Blériot snapped up a trophy for a one-lap contest by flying at 47.8 mph. Also like Curtiss, Blériot built planes for the war effort during World War I. But Blériot built aircraft for his own country, France.

Louis Blériot and his monoplane
Courtesy of the Library of Congress

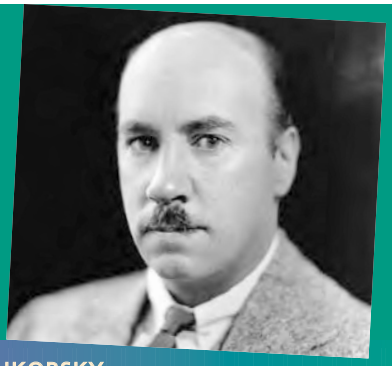
The Names and Anatomy of Period Aircraft

During the years between the Wright brothers' famous flight of 1903 and the start of World War I in 1914, aircraft continued to grow more sophisticated. The first man to use ailerons, Frenchman Robert Esnault-Pelterie, was also the first to fully enclose the fuselage. A fuselage *is the body of an airplane containing the crew and passengers (or cargo)*. Enclosed cabins protected pilots and passengers from the wind and rain.

Multiengine Planes

While Louis Blériot was experimenting with monoplanes, brothers Eustace, Howard, and Oswald Short of England were adding engines to their aircraft. A multiengine plane—*a plane with more than one engine*—had greater power, reliability, and safety than a single-engine plane. Just as two heads are supposedly better than one, two (or more) engines upped an aircraft's power. Safety increased, too. If one engine died during flight, the second could provide enough power to get the plane back to earth.

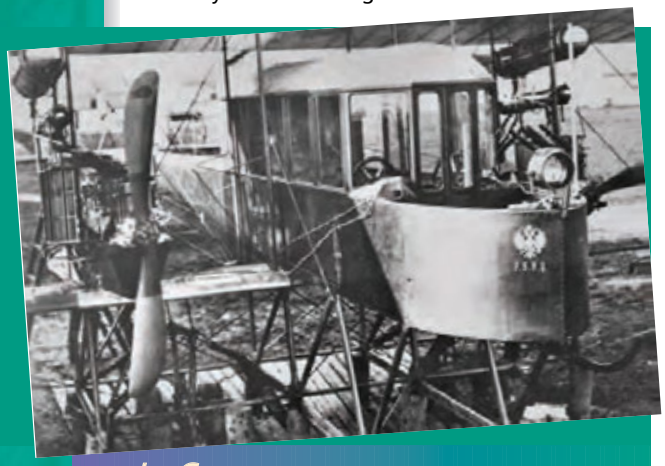
The Short brothers built the *Triple Twin*, a two-engine, three-propeller aircraft in 1911. They placed one engine in front of the cockpit—*a space inside the fuselage where the crew sits*. They mounted the second engine behind the cockpit. The forward engine ran the two propellers on the wings; the rear engine drove the third propeller.



IGOR SIKORSKY

Courtesy of Corbis Images

Meanwhile a Russian pilot named Igor Sikorsky was designing a four-engine aircraft called *Le Grand*. He flew it on 13 May 1913. He used four 100-horsepower engines to lift the 92-foot-wingspan airplane. He mounted the four engines in two pairs in tandem—*two objects with one placed directly behind the other*—on the lower wings. The front engines powered the forward propellers, and the back engines drove the pusher propellers. Because the plane was so big, the landing gear had 16 wheels. The aircraft also had an enclosed cockpit. Each passenger could peer through a porthole—*a small, circular window*.



LE GRAND

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. 85-18305)

Passenger-friendly inventions such as portholes and enclosed cabins contributed greatly to the development of today's commercial airliners. Flying in a protected body and having viewing windows made air travel more attractive to paying passengers.

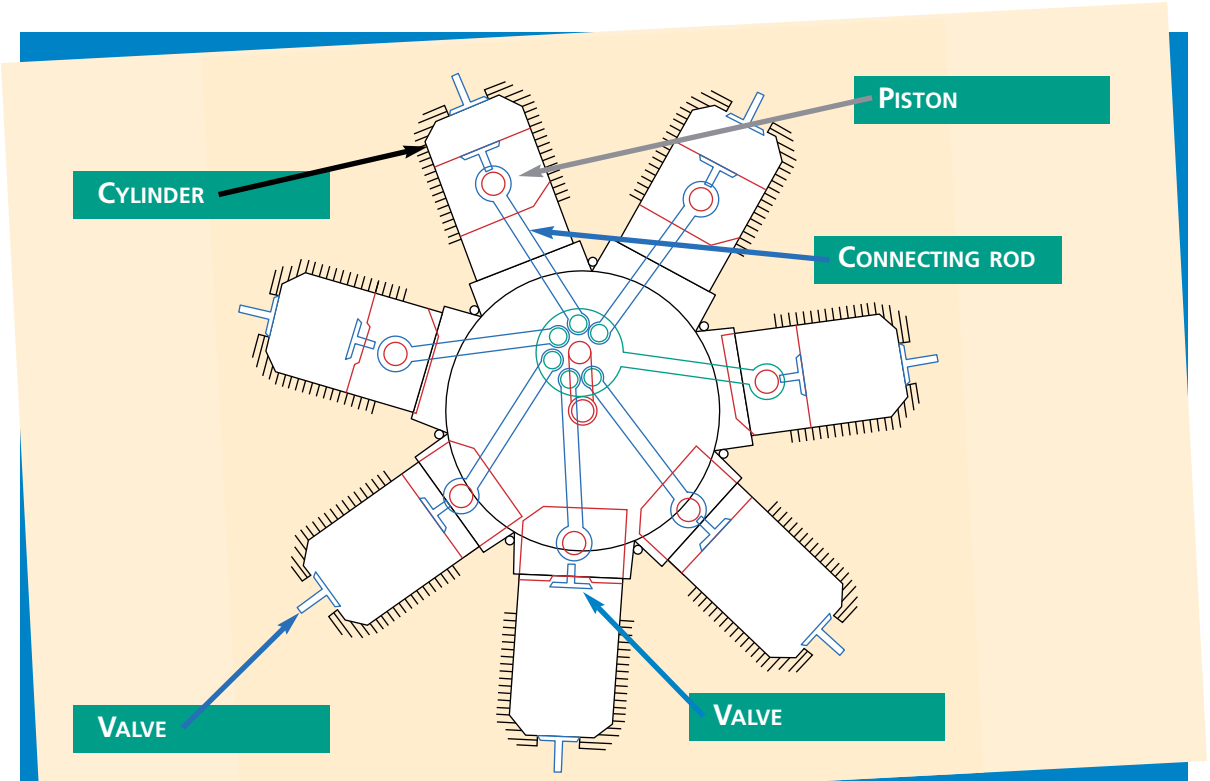


Figure 2.1 The Gnome rotary engine

Rotary Engines

Strong engines were essential for sustained flight. But the earliest engines were relatively heavy. The engine and propellers on the 1903 *Wright Flyer* weighed about 200 pounds. One reason for this heft was that these early engines used water as a coolant. They also weren't efficient: in 1907 every 10 pounds of engine generated just one horsepower.

Another set of brothers, Laurent and Gustav Seguin of France, set out to reduce the motor weight. Their solution? Rotary engines. Rotary engines used circulating air, rather than water, as a coolant. The Seguins placed the engine's cylinders in a radial, *or round*, pattern. They fitted each cylinder with a fin to draw out the heat as the plane flew.

With these changes, engines became more efficient. The number of pounds of engine weight needed to generate one horsepower dropped from 10 to three. The Seguins named their engine the Gnome.

But the Gnome was still a work in progress. The brothers needed to find a way to prevent the engine from overheating when the aircraft was revving up before takeoff. The brothers decided that the crankshaft—*a shaft that turns or is turned by a crank*—should no longer rotate the propeller and engine. Instead, the propeller and engine ought to rotate around the crankshaft. The Seguins bolted the crankshaft to the plane's frame. So even when the plane was at a standstill, air would circulate around the engine and keep it cool.

Helicopters

One of the last aircraft invented during the pre-World War I period is one you can still see almost every day. You've seen these aircraft in action movies or caught a glimpse of them on your local television news station's traffic report. They are helicopters.

Helicopters are different from the aircraft you've been studying in two important ways. First, they don't have fixed wings. They have rotating wings. Second, they take off and land vertically.

All aircraft need lift to remain in the air. Biplanes and monoplanes rely on their wings and forward motion to maintain lift. But what's to keep an aircraft in the air when it rises straight up like a helicopter does? The wings of helicopters, like those of other aircraft, must be in constant motion. Helicopters have rotors—*another name for propellers*. Rotors are made up of blades, each of which acts as a wing. As the blades rotate, they lift the helicopter. Helicopters are also known as rotary-wing aircraft.

Inventors as far back as Leonardo da Vinci tried to design a helicopter. Some models made it into the air. But it wasn't until 1842 that a man named W. H. Phillips got a model helicopter with a steam engine into the air.

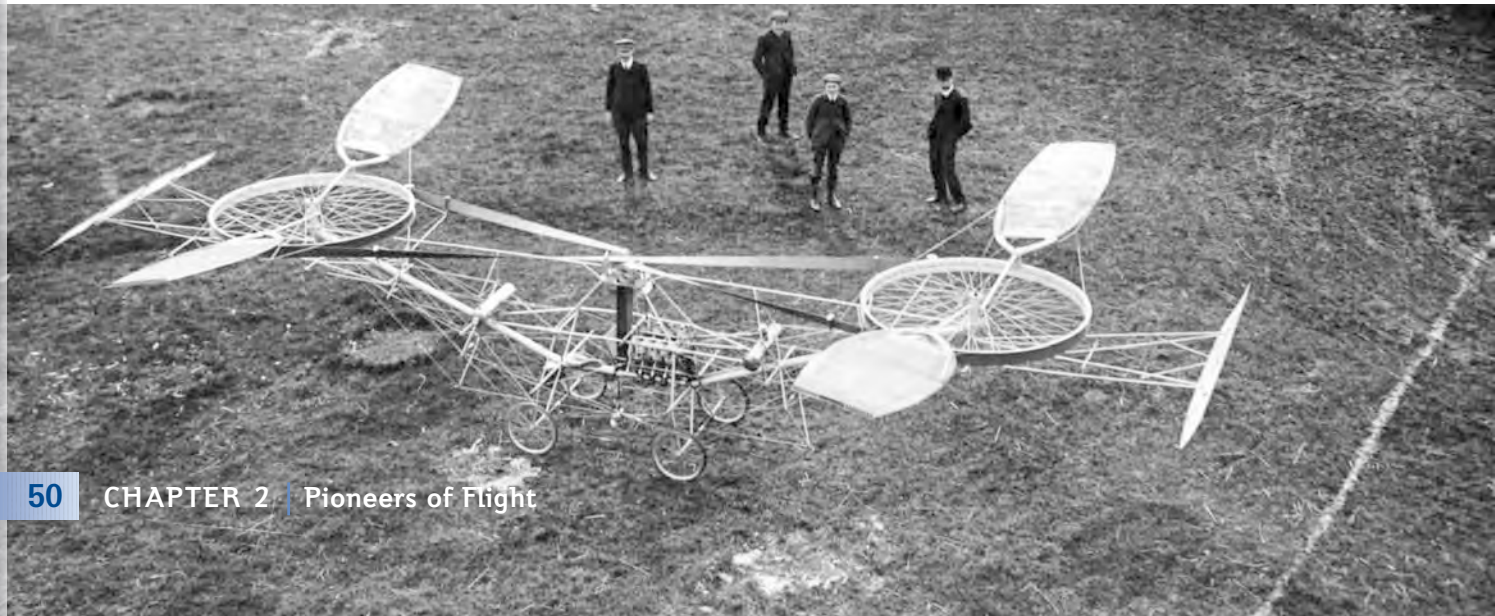
The first two manned attempts at helicopter flight were in 1907. Frenchman Louis Bréguet flew one with the help of four assistants who had to hold it steady. His countryman Paul Cornu also got a helicopter to lift. In 1909 an American father-son pair, Emile and Henry Berliner, also built and piloted a helicopter.

All these men faced one common problem: helicopters are difficult to balance. Bréguet needed four assistants to steady the aircraft. They needed to do this because rotating blades create torque, *which is a twisting force*. Because of torque, while the blades are turning in one direction, the body of the aircraft spins in the other.

No one would find a solution for 30 years. But when they did, they came up with two possibilities. The first was to use two rotors and to make them spin in opposite directions. The second solution was to place a small rotor at the end of a long tail boom. A boom *is the section of the helicopter that connects the tail with the main body*. The tail rotor spins in a direction opposite that of the main rotor.

Paul Cornu's helicopter

Courtesy of Branger/Getty Images



Other American Pioneers in Aviation Following the Wright Brothers

While some aircraft pioneers were achieving fame as inventors, others were breaking barriers as pilots. Those barriers ranged from distance to altitude to gender and race. Calbraith Perry Rodgers made the first cross-country flight in the United States. American Bessie Coleman was the first black woman in the world to get a pilot's license. Blanche Stuart Scott was the first woman to fly solo. The early 20th century was a time when all kinds of records could be broken.

Other American Aviation Pioneers

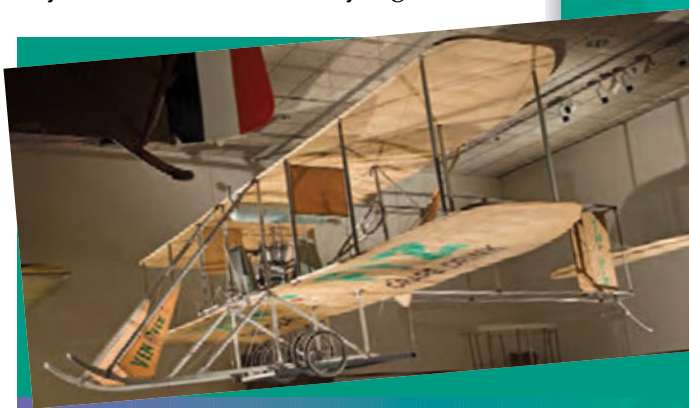
All these aviation pioneers needed great courage. They were flying in an age when planes were, frankly, quite flimsy. They also had to be very curious. They were exploring a new frontier. And like Glenn Curtiss, they shared a passion for flight and speed—for soaring into the sky. Each one faced challenges—crashes were many, and all pilots knew the possible consequences. But they dared to continue flying.

The *Vin Fiz Flyer*

Could Calbraith Perry Rodgers fly across the United States in 30 days? That was his goal in 1911. Newspaper publisher William Randolph Hearst was offering a $50,000 prize to the first pilot who made the journey in that timeframe. Rodgers wanted to give it a try. But he had no money. Like today's NASCAR drivers, he needed a sponsor.

Rodgers asked soft drink manufacturer Vin Fiz if it would provide financial support for his flight in exchange for nationwide publicity. The company agreed. It bought him a Wright airplane (the *Vin Fiz Flyer*) and made sure he had all the spare parts he'd need. Rodgers hired mechanic Charles Taylor away from the Wright brothers to help him out on his adventure.

Rodgers took off on 17 September 1911 from Sheepshead Bay, on New York's Long Island. Vin Fiz, with publicity in mind, mapped his route. The flight plan called for stops in major cities such as New York City, Chicago, Kansas City, San Antonio, El Paso, and Yuma. The destination was Pasadena, California.



THE VIN FIZ FLYER

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. 2006-25765-640)

A VIN FIZ ADVERTISEMENT

Showing the route of Calbraith Perry Rodgers' cross-country flight

Taken from Aerofiles.com

Rodgers's biggest worry was getting over the Rocky Mountains with a 40-horsepower engine. Head winds and weather would slow him down. As the flight progressed, his shortest laps were around 40 miles, and his longest was 133 miles. He averaged around 52 mph. He made 68 landings. The plane needed countless repairs along the way. In fact, by the time it got to Pasadena, the *Vin Fiz Flyer* had only two original parts—the rudder and one strut.

The trip turned out to be 4,251 miles long, rather than the anticipated 3,390. It took 49 days. Rodgers didn't win the award because the flight took too long. But he'd earned a place in aviation history—he made the first airplane crossing of the United States from coast to coast.

The First Enlisted Pilot Gets His Wings

Private First Class (PFC) Vernon Burge was the first enlisted man to become a pilot. The US Army Signal Corps' Aeronautical Division, created in 1907 to take charge of ballooning and air machines, had a general rule that only officers could be pilots. Enlisted men trained as mechanics. And as late as 1908, the bulk of the "flying" done in the Aeronautical Division was done in balloons. The mechanics had to know how to work with balloon fabric, to control the aircraft, and to prepare the gases for the balloons.

Burge was one of eight enlisted men who joined the division in 1907. In 1909 he and nine other enlisted men joined 1st Lt Benjamin Foulois and a civilian mechanic at Fort Sam Houston in San Antonio, Texas. This was when Foulois was teaching himself how to fly. Burge and another private, Glenn Madole, assisted by the civilian mechanic, built a landing system for Foulois' airplane. During this time, Burge learned as much as he could about repairing and flying airplanes.

COL VERNON BURGE

Col Vernon Burge on the eve of his retirement, right before his final flight

Courtesy of the Airmen Memorial Museum

ENLISTED MEN LEARNING THE BALLOON TRADE

Courtesy of the Airmen Memorial Museum

By the time Burge became a pilot in 1912, the Army had 11 aircraft, 14 officer pilots, and 39 enlisted men. But it wasn't until 18 July 1914 that the US House of Representatives passed a bill that authorized enlisted men to fly. The bill limited the number of enlisted pilots to 12. That bill was also important because it gave official status to the Army's aviation arm—it created the Aviation Section of the Army Signal Corps, which replaced the corps' Aeronautical Division.

Flight Paths

A Private's Persistence

PFC Vernon Burge knew he wanted to be a pilot from the moment he laid eyes on an airplane. When he volunteered for balloon duty in August 1907, he began a five-year journey as ground crewman, balloon handler, and airplane mechanic. He and his fellow mechanics spent a good deal of those five years at air shows around the country, helping prepare aircraft and keep them fit for flight. Burge absorbed all he could about balloons and airplanes.

SGT VERNON BURGE IN UNIFORM

Courtesy of the Airmen Memorial Museum

In early 1912 Burge, by now a corporal, shipped with a *Wright B* airplane to the Philippines. Brig Gen James Allen had ordered that an air station be established at Fort McKinley. Burge reported to 1st Lt Frank P. Lahm, who was setting up a flight school at the station. Aware of the shortage of officers, Burge took the plunge. He asked Lt Lahm whether he could train to be a pilot.

Lahm agreed, and Burge began his instruction 8 April 1912. He already knew a good deal about flying. As a mechanic, he'd taxied a good many airplanes along runways to make sure the engines were running right and repairs were correctly done. He passed his flight test 14 June 1912.

Burge's hard work, love of flying, and persistence eventually earned him a place in the Army as an officer. He retired 31 January 1942 at the rank of colonel. He'd spent 35 years in military aviation and had served as a pilot for 30 of those years. He'd logged 4,667 hours and 55 minutes in the air—quite a career.

CAPSULES

Europe Versus America

Although the Wright brothers invented the airplane in America, Europe had more pilots than the United States did in those early days. France was the leader; by 1911 it boasted 353 pilots. Great Britain had 57, Germany 46, Italy 32, and Belgium 27. The United States had 26, giving it a sixth-place ranking in the world.

Tearing Down the Barriers

Bessie Coleman faced two obstacles to becoming a pilot—her race and her gender. She overcame both. In 1921 Coleman became the first black woman to get a pilot's license. She had to go to France for training because no flight school in the United States would accept her. She died in an airplane crash only four years after getting her license. You'll read more about Coleman in Chapter 3.

Opportunities for Women in Aviation

Before Bessie Coleman got her license in 1921, other women found it difficult to realize their dream of joining men in the skies. Even the most successful female pilots felt the strain.

Blanche Stuart Scott, the first American woman to solo in a plane, said, "There seemed to be no place for a woman engineer, mechanic, or flier. Too often people paid money to see me risk my neck, more as a freak, a woman freak pilot, than as a skilled flier." Because of this public pressure and a few severe accidents in the air, Scott retired from flight in 1916 when she was only 27 years old.

Despite the obstacles, many women thrived on the thrill of lifting and looping and diving through the air. They broke records and paved the way for women in the future to enter careers in commercial and military aviation.

BESSIE COLEMAN AND HER PILOT'S LICENSE

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-99-15416)

Blanche Stuart Scott

Blanche Stuart Scott was used to setting records. She became the first woman to drive a car across America in 1910. And she didn't do it on a highway, or even on a state route. At that time, there were fewer than 300 miles of paved roads in the entire United States.

When men started setting records in aviation, Scott wanted to be part of the action. She was Glenn Curtiss's only female student in 1910. In fact, she was Curtiss's first student ever, and he never took on another. In addition, Scott was the only female student pilot in the United States at that time. Curtiss worried about this. If Scott crashed, he feared he'd be blamed for putting a woman in harm's way. What's more, she'd be using a single-engine plane that Curtiss designed, and some people might think the plane was faulty. For these reasons, he did what he could to keep Scott from being able to take off.

Scott would taxi back and forth across the runway in Curtiss's plane. But she could never get into the air. Frustrated, on 2 September 1910, she got out of the plane and took a close look at the engine. She was, after all, a curious person. She noticed a small piece of wood lodged under the throttle lever. She deduced this hindered the lever's motion. And she also concluded that Curtiss had placed the wood there to make sure the aircraft wouldn't be able to get off the ground when she sat at the controls.

Scott removed the wood, climbed back into the cockpit, and asked a mechanic to crank the propeller. The plane lifted off the runway. Scott was airborne.

Scott had become the first American woman to solo in a fixed-wing airplane. To solo *is to fly with no one else on board*. She flew with exhibition groups for six years, although she never got her pilot's license. She was known for two stunts. In one, she flew under bridges upside-down. Her other stunt was the "death dive." She would climb to 4,000 feet, and then plunge the plane toward earth, leveling off only when she reached 200 feet.

Scott was adventurous, but even daring people get their fill. After a number of accidents, she retired in 1916 at the age of 27. She died in 1970 at the age of 81. She'd lived to see the first man land on the moon.

Blanche Stuart Scott

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-72-4803-A)

Bessica Medlar Raiche

Bessica Medlar Raiche

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2007-5475)

Some aviation historians think Bessica Medlar Raiche was really the first woman to go solo. She made that flight on 13 October 1910. They contend Scott got into the air purely by accident. But Raiche herself gave Scott credit for the event.

"Blanche deserved the recognition," Raiche said, "but I got more attention because of my lifestyle. I drove an automobile, was active in sports like shooting and swimming, and I even wore riding pants and knickers. People who didn't know me or understand me looked down on this behavior. I was an accomplished musician, painter, and linguist. I enjoyed life, and just wanted to be myself."

Raiche never got a license. But flying excited her. She and her husband, François, formed a lightweight airplane company called the French-American Aeroplane Company. They did two important things to make their planes better than other lightweight aircraft. They took off some pounds by exchanging heavier fabrics, such as muslin, for silk. They also used piano wires instead of iron wires.

Raiche eventually left flying. She entered medical school and became a doctor.

Harriet Quimby

Harriet Quimby

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2002-23705)

Quimby was the first American woman to earn her pilot's license. A journalist, she wrote for a popular magazine called *Leslie's Weekly.* But she wanted to make more money to support herself, her parents, and her ambition to become a creative writer.

In 1910 she watched aviator John Moisant fly around the Statue of Liberty in New York harbor. The sight thrilled her. She signed up for flying lessons. She got her license on 1 August 1911, after completing a two-part test. The first part of the test required her to make five left and right turns around pylons—*tall, thin towers.* She also had to fly five figure eights. Quimby passed this part with ease. For part two, she had to land within 100 feet of her takeoff point. Quimby failed this part first time around. She took the test again the next day. This time she succeeded. She landed within 7 feet, 9 inches, of her takeoff point. What was so remarkable was that in those days, planes did not have brakes. Quimby set a record with her mark.

Quimby set other records: She was the first woman to fly at night (1911) and the first woman to cross the English Channel in the pilot's seat (1912).

She broke a fashion barrier, too. The long dresses that women wore at that time weren't practical for a pilot. Most of the planes were open to the elements, and long pieces of fabric might get caught in a propeller or other mechanism. Quimby designed an outfit for female pilots. Her tailor sewed a one-piece uniform made of purple satin. Quimby had invented the jumpsuit, *a one-piece outfit.*

Despite the progress, flight was still a dangerous business. Quimby entered the Boston Air Meet on 1 July 1912 in a Blériot monoplane. She and her passenger, William P. Willard, took off over Boston Harbor in hopes of making a record 58 mph flight over a body of water. At 5,000 feet, the plane flipped and nosed downward. As horrified spectators watched, Quimby and Willard fell from the plane and plunged into the waters. Both perished. Amazingly, the monoplane—now with no pilot or passenger—righted itself and landed in the harbor with a light crash.

In 1991, the US Post Office created a stamp in Quimby's honor.

HARRIET QUIMBY IN A PURPLE JUMPSUIT OF HER CREATION
Courtesy of the Library of Congress

CAPSULES

Dressed for Success

Harriet Quimby was a good friend of Matilde Moisant, John's sister. The two women decided to sign up for flight training together. When they did, both dressed as men. Why? Women were discouraged from learning how to fly, so they figured they'd need a disguise. Somehow, newspapers found out. They'd uncovered a fascinating story about two determined women.

Matilde Moisant

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-73-3564)

Matilde Moisant

Matilde Moisant didn't buy into the superstition that the number 13 is unlucky. Her achievements proved how wise she was to ignore such beliefs. To begin with, she was born Friday, 13 September 1887. That was a good day for her and her parents.

Nearly 24 years later, on 13 April 1911, Moisant became the second woman in America to get a pilot's license. She won the Rodman Wanamaker Trophy for flying at an attitude of 2,500 feet. This was amazing in a day when planes weren't as stable as they are now. She also got a court to acknowledge it was legal to fly on Sundays. This happened after a sheriff in Long Island, New York, tried to arrest her for flying on a Sunday. Moisant's response was to hop in her plane and fly to another field.

One tragedy did strike: her brother, John Moisant, also a pilot, died in a crash in 1910. Matilde crashed a number of times herself, but she continued flying. Her brother's death deeply affected her, and on 13 April 1912, she said she'd make her last flight the next day. It turned out to be a very dangerous flight. The fuel tank sprang a leak, and by the time Moisant landed, her clothes were on fire. Fortunately, the thickness of her clothing and her leather helmet protected her. Matilde Moisant died in 1964 at the age of 77.

European Women in Aviation

Women in Europe also turned their eyes to the sky during the early days of flight. Thérèse Peltier was the first European woman to fly as a passenger in a powered airplane in July 1908. The first European woman to pilot a plane was French baroness Raymonde de la Roche. The date was 22 October 1909. Soon after, she attained another first. On 8 March 1910 she became the first woman to earn a pilot's license.

Raymonde de la Roche

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-81-3423)

Julia Clark

On 19 May 1912, Julia Clark was the third American woman to gain her pilot's license. Sadly, she achieved an unfortunate other first: she was the first woman pilot to die in a crash.

Clark had a fascinating life. She emigrated to the United States from London and became an American citizen. She learned to fly at the Curtiss Flying School at North Island in San Diego. After soloing in a Curtiss plane, she joined an exhibition group. On the evening of 17 June 1912, she decided to take a test flight. It was dark, and she couldn't see that one of her plane's wings was about to hit a tree limb. The aircraft crashed. She died only about two weeks before Harriet Quimby.

Katherine and Marjorie Stinson

Flying was a family affair for the Stinsons. Katherine, her two brothers, and her sister all became pilots.

Katherine earned her pilot's license on 24 July 1912. She was the fourth American woman to do so. And at age 16, she was also the youngest. She would eventually become one of the most successful women in aviation.

For example, Katherine was the first pilot of either gender to take part in a parade. She covered her plane with roses for the 1913 New Year's Day Tournament of Roses Parade in California and flew over the parade route. Later, she set a distance record for both genders in a nonstop cross-country flight.

Her younger brothers, Eddie and Jack, became pilots. Jack was a test pilot. Her younger sister, Marjorie, graduated from the Wright Flying School in August 1914 (Wilbur Wright had her mother sign a waiver because of Marjorie's age). At 17, Marjorie became the first woman authorized to fly the experimental airmail service.

Katherine Stinson

Courtesy of the National Air and Space Museum, Smithsonian Institution (SI Neg. No. SI-2007-5474)

All four siblings had the support of their mother, Emma. She even went so far as to move the family to San Antonio, Texas, so her daughters could open a flying school. When World War I began, the sisters tried to enlist as pilots in the Army, but they were rejected. So the sisters opened a school to train Americans and Canadians as pilots for the war. A supporter, New York Congressman Murray Hulbert, tried unsuccessfully to get Congress to pass a bill allowing women to join the Flying Corps. But women were allowed to do little more than serve as nurses during the war. Katherine went to France to work as an ambulance driver because, in her own words, "I didn't feel I was doing enough for the war effort."

That war would lead to revolutionary developments in aviation.

Marjorie Stinson
Courtesy of Corbis Images

CHECKPOINTS

Lesson 2 Review

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

1. Who was the famous founding member of the Aerial Experiment Association?
2. Which of Glenn Curtiss's effects on aviation are felt today?
3. What did Louis Blériot do when his engine overheated as he was crossing the English Channel?
4. What type of "wing" does a helicopter have that gives it lift?
5. When did the first enlisted man become a pilot? What was his name?
6. Who was the first black woman to get a pilot's license? What two obstacles did she have to overcome?
7. What did Blanche Stuart Scott remove from her plane's engine to get it to fly?
8. Why was it remarkable that Harriet Quimby landed her plane 7 feet, 9 inches from her takeoff point?

Applying Your Learning

9. What are the advantages of multiengine planes?

LESSON 3

Air Power in World War I

Quick Write

Faced with seven German planes against his one, Eddie Rickenbacker knew he must remain calm. Why do you think that was important? What lesson do you think you can learn for use in emergencies you might face?

Learn About...

- **the contributions of US pilots during World War I**
- **the role of air power during World War I**
- **how air power expanded during World War I**

Edward Rickenbacker was an American combat pilot during World War I. He shot down 26 German airplanes in just five months. He was the only surviving pilot of that war to receive the Congressional Medal of Honor during his lifetime.

Rickenbacker earned his medal for an act of bravery on 25 September 1918. He was flying alone when he came across seven German planes—five Fokker D-VIIs and two Halberstadt CL-IIs. When facing such situations, he knew a pilot must remain calm. And he certainly must have done so. Defying the huge odds, he shot down two of the seven enemy planes.

Rickenbacker was one of the American "aces" in the war. The French came up with the title of ace for any pilot who had knocked five or more enemy planes out of the sky over the course of the war. The Germans, however, insisted their ace pilots bring down at least 10 aircraft to earn the title. An "ace of aces" was the pilot from each country who had taken down the most enemy aircraft. France's ace of aces was René Fonck. He had 75 kills, or planes shot down. Edward Mannock, with 73 kills, took the prize in Britain. And Baron Manfred von Richthofen of Germany (known as the "Red Baron") shot down 80 airplanes. Rickenbacker, with 26 kills, was America's ace of aces.

Edward Rickenbacker was America's ace of aces. He shot down 26 planes during World War I.
Courtesy of Bettmann/Corbis

The Contributions of US Pilots During World War I

Despite the contributions of brave pilots on both sides, most World War I battles were fought on land or at sea. Airplanes were still fragile when the war started in 1914. After all, the Wrights didn't make their historic flight until 1903.

But during the war, aviation engineers made tremendous advances. Some American commanders in the field had great faith in the capabilities of the Aviation Section of the Army's Signal Corps. In a few key instances, aircraft contributed to the Allied victory. Aircraft had important functions—from doing aerial reconnaissance to shooting down enemy aircraft.

Vocabulary

- **Allies**
- **Central Powers**
- **U-boat**
- **escadrille**
- **machine gun**
- **stalemate**
- **appropriate**
- **strategic**
- **zeppelin**
- **dogfight**
- **strafe**

The Outbreak of World War I

World War I began in Europe, when a Serb assassinated Archduke Franz Ferdinand on 28 June 1914. Ferdinand was next in line to the Austro-Hungarian throne. Because of alliances among different nations in Europe, one country after another soon declared war.

First Austria-Hungary declared war on Serbia. Then Russia entered the fray on Serbia's side. Germany, which had ties to Austria-Hungary, was the next to step into the conflict by declaring war on Russia. Soon *Russia, France, Serbia, and Britain*—the Allies—were at war against *Germany, Austria-Hungary, and Turkey*—the Central Powers. (Many other countries later joined the fight, including the United States and Italy on the side of the Allies. Russia withdrew from the war after the Russian Revolution at the end of 1917.)

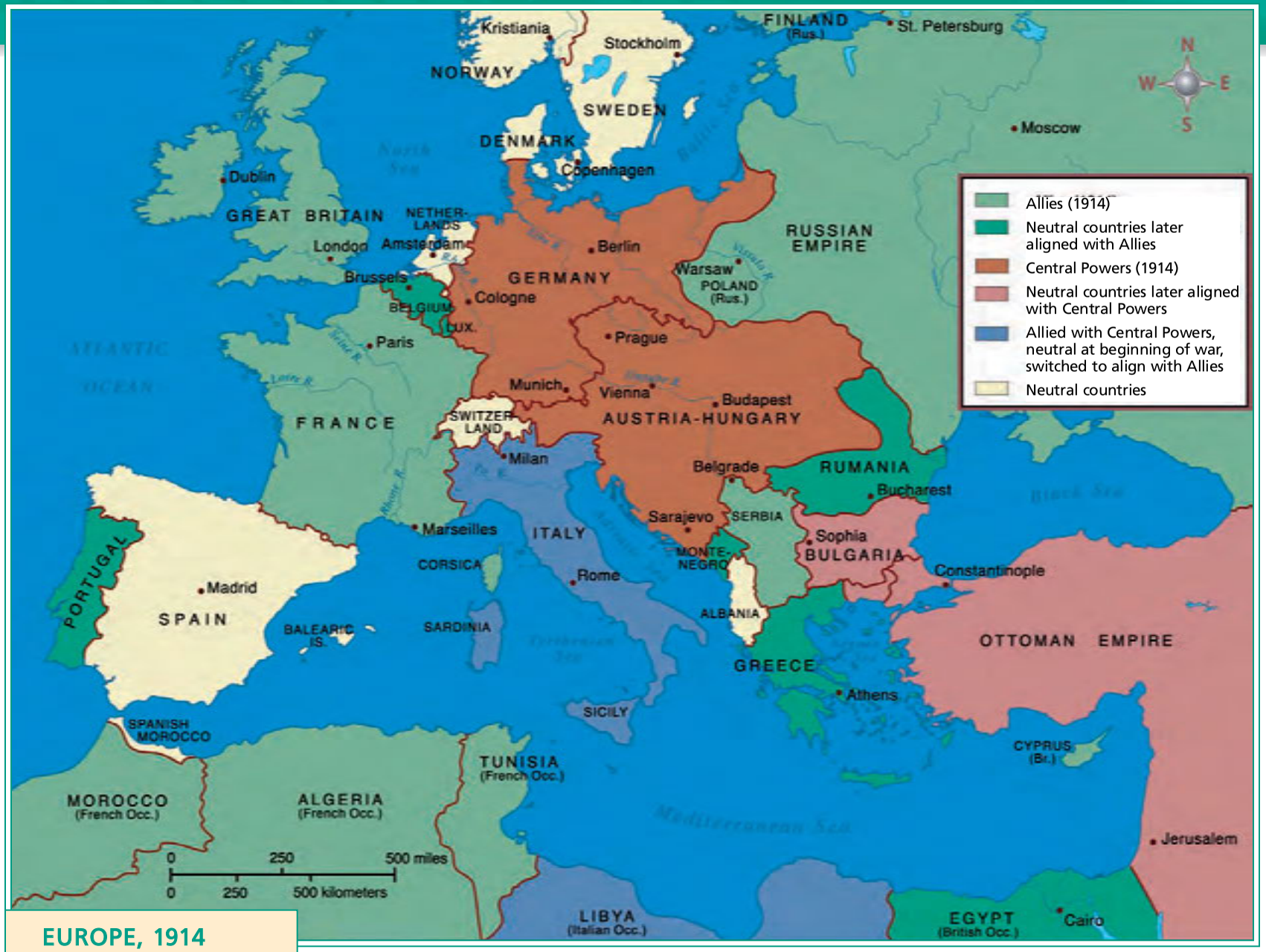
When Germany invaded France on 4 August 1914, the war started in earnest.

American President Woodrow Wilson vowed that the United States would remain neutral. But over time, that proved impossible. German U-boats—*German submarines*—attacked American ships in the Atlantic because the United States was sending goods to Britain. Wilson asked Germany to stop sinking American ships. And for a while, Germany did.

But in early 1917 two things happened. Germany once again targeted all American ships headed toward Britain. And in a telegram discovered by British intelligence, Germany asked Mexico to make war with the United States if the United States did not remain neutral. If Mexico joined the war and the Central Powers won, Germany promised Mexico it could have Texas, Arizona, and New Mexico.

President Wilson asked the US Congress to declare war on Germany. Congress agreed. The United States entered World War I in April 1917.

The use of airplanes as weapons took major leaps forward during that war. The heroic central figure in air power was the pilot.



EUROPE, 1914

This map shows the alignment of the Allies versus the Central Powers in 1914. Turkey would join the side of the Central Powers in October of that year.

Courtesy of Maps.com

The Contributions of World War I Pilots

Four American pilots in particular made their marks during World War I, also known as the Great War. But it all began with a group of US pilots who together formed the Lafayette Escadrille in France.

The Lafayette Escadrille

Some American pilots didn't wait for the United States to join the war. They tried to enter the military services of the Allies. For legal reasons, most countries couldn't accept the men's offers. But France, with its French Foreign Legion made up entirely of fighters from outside France, could sign up these volunteers.

In April 1916 seven American pilots formed a fighting group that they called *Escadrille Américaine*. An escadrille *is a small squadron of planes*. The pilots were wealthy young men who had been living in Paris. In the next few days seven more Americans, then serving in French units, joined the squadron.

When the men of *Escadrille Américaine* began racking up German kills, Germany protested. It said that the United States was breaking its promise of neutrality. The men had to change their group's name. They decided to call it the Lafayette Escadrille. Its name honored the Marquis de Lafayette, who fought for the 13 American colonies during the Revolutionary War. Now individual Americans were fighting on behalf of France and the Allies in the war against the Central Powers.

In the escadrille's first five months, its pilots fought in 156 air battles and shot down 17 enemy planes. By the time the United States Air Service brought the unit under its supervision in 1918, its pilots had made 199 kills. Six members were aces. Forty died by the war's end. The escadrille included Eugene Bullard, the only African-American to serve as a pilot in the war.

The Lafayette Escadrille, 1916

Members of the Lafayette Escadrille with their mascots, which included a lioness and a lion cub.

Courtesy of Bettmann/Corbis

Raoul Lufbery

Raoul Lufbery was the most famous pilot of the Lafayette Escadrille. He had 17 combat victories during the war. A native of France, he came to the United States as a child and became an American citizen. As a young man, he tried the US Army but didn't care for the discipline. During travels abroad, he met Marc Pourpe, a French pilot. Pourpe took him on as his mechanic. Together they traveled to India, China, and Japan.

Raoul Lufbery

Raoul Lufbery flew with the Lafayette Escadrille.

Courtesy of the Library of Congress

The pair was in France when war broke out. Lufbery followed Pourpe into the military by way of the French Foreign Legion. He continued working as Pourpe's mechanic. No doubt he was also listening to the pilots talk about effective combat maneuvers and flying techniques. When Pourpe died in action in 1914, Lufbery trained to be a pilot. He signed up with the Lafayette Escadrille shortly after it was established.

Lufbery used to give two pieces of advice to new combat pilots. First, he said, don't lunge headfirst into combat. Take stock of the scene before committing yourself. Second, he cautioned that a pilot in a burning plane would have a better chance of survival if he tried to bring it in for a landing. Parachutes were not standard equipment in those days, so pilots couldn't safely jump from a damaged aircraft.

Sadly, Lufbery was not able to follow his own advice. When a German aircraft shot Lufbery's plane on 19 May 1918, his aircraft became engulfed in flames. Lufbery jumped to his death.

Edward Rickenbacker

America's ace of aces started out as a professional racecar driver. He competed in the Indianapolis 500 three times. Rickenbacker learned a lot about automobiles through an engineering correspondence course. He also worked at a car-manufacturing company. Like Glenn Curtiss, who'd broken speed records on motorcycles, Rickenbacker set a record in a racecar. His top speed was 134 mph.

Although he was making excellent money as a racer, Rickenbacker wanted to be a part of the war effort. In 1917, he asked the US Army to consider forming a squadron of pilots made up of racecar drivers. The military didn't take him up on his offer, but they did ask whether he would like to enlist and serve as a staff car driver.

Rickenbacker said yes, and fate stepped in. One day while Rickenbacker was driving a member of Gen John J. Pershing's staff, they passed the broken-down car of Col William "Billy" Mitchell, chief of the US Air Service. Rickenbacker pulled over to the side of the road. Drawing on his expertise in engine repair, he fixed the car. Col Mitchell was impressed. Later he asked Rickenbacker to be his driver. Before long, Rickenbacker had Mitchell's permission to train as a pilot.

Rickenbacker rose from an enlisted Soldier to the rank of captain and took command of the 94th Squadron. He did two important things for his men. He got them equipped with parachutes. And he figured out how to keep an airplane's machine gun—*an automatic rifle that uses belt-fed ammunition*—from jamming.

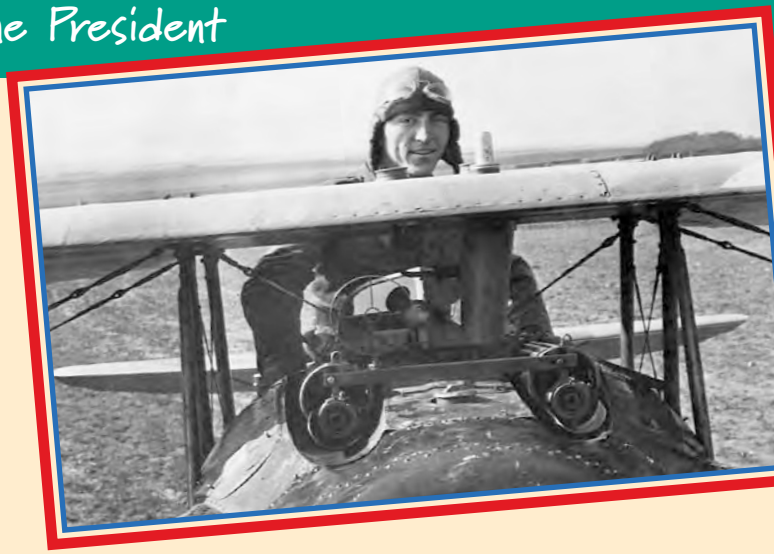
The Ace Who Became an Airline President

American ace of aces Edward Rickenbacker (1890–1973) didn't slow down when World War I ended. He remained in the reserves and worked his way up to colonel. He also returned to one of his first loves—cars. Rickenbacker founded an automobile manufacturing company.

The personal side of his life flourished, too. He got married and had two children. In 1927, the pace picked up. Rickenbacker, who'd once raced in the Indianapolis 500, bought the Indianapolis 500 Speedway. He sold it after World War II.

Rickenbacker remained engaged in engines, cars, and planes in other ways as well. He was an aviation advocate. He managed General Motors Fokker Aircraft Company. Next he took on the job of vice president of American Airlines. He eventually left that job to go back to Fokker, where he became manager of its Eastern Airlines division.

Then in 1938, Rickenbacker bought Eastern Airlines. Friends gave him financial support for the purchase. He worked at Eastern for more than 20 years and retired in 1959 as president. He remained as chairman of the board until 1963. Rickenbacker spent the last 10 years of his life promoting aviation, both military and civilian.



1st Lt Edward Rickenbacker

A former racecar driver, 1st Lt Rickenbacker of the 94th Squadron is shown here in his Spad airplane on a French field.

Courtesy of Corbis Images

Frank Luke

Frank Luke was a wild card. He didn't have the discipline of a Rickenbacker or a Lufbery. But he did have their guts. He was tough—he came from the Arizona mountains and had worked in copper mines.

As soon as the United States entered the war, Luke volunteered. He chose the Army Signal Corps and completed his nine-week flight training in seven weeks. In March 1918 he went to France as a second lieutenant. After more training, he began to go out on patrols. But he never saw any German aircraft. Running out of patience, he flew solo over a German airfield in August 1918. He met up with six Albatros fighters (a German biplane) and shot one down.

One month later Luke asked permission to go after a German balloon that another squadron had tried unsuccessfully to shoot down. Balloons were always heavily guarded because they were so vulnerable. Another plane went along with Luke to watch his back. Luke got his balloon.

Luke still sometimes went off by himself. Once he disappeared overnight. When Luke returned, his commander grounded him. Luke took off again anyway, even though he risked court-martial. This time he downed three balloons. He also shot some German soldiers on the ground. He landed his plane later to get a drink of water from a stream. A German foot patrol surrounded him. When he drew his revolver, they killed him.

Luke's career as a combat pilot was short: he died just 17 days after his first kill. In that time, he shot down 15 balloons and three airplanes. It was one of the records of the war.

2d Lt Frank Luke

Frank Luke once shot down three German balloons within 35 minutes. Balloons were among the most heavily guarded aircraft during World War I and were, therefore, extremely dangerous to attack.

Courtesy of Corbis Images

Eugene Bullard

Only one African-American served as a pilot during World War I. His name was Eugene Bullard. Bullard was also one of the few enlisted men to fly an airplane.

Bullard carved his own path throughout his life. When he was only eight years old, he ran away from his home in Georgia. His goal was to get to France. He'd heard France was a wonderful place for people of all races. It took him 11 years, but he finally got there.

Like other Americans wishing to join the fight in World War I, Bullard signed up with the French Foreign Legion in October 1914. He was wounded four times while with an infantry unit whose members called themselves the "swallows of death." After his fourth wound, he transferred to the French Air Service and became a pilot. He was the first black man to get a pilot's license and the first black American fighter pilot. He tried to join the US Air Service, but the Army turned him down. He shot down two German aircraft while in the French Air Service. Finally, he got into a tussle with a French officer—rather than court-martial him, the French military transferred him back to the infantry, where he served the rest of the war.

Bullard eventually returned to the United States, where he lived in Harlem, New York. The French government awarded him a *Croix de Guerre* (War Cross) medal, which it gave to individuals who displayed heroism during fighting with enemy forces. Bullard also received several other medals for his contributions to the war effort, both in the air and in the infantry. In 1954, France asked him to visit to help light the Eternal Flame of the Tomb of the Unknown French Soldier in Paris at the Arc de Triomphe. This was a great honor.

Eugene Bullard

Eugene Bullard was the only African-American combat pilot during World War I.

Courtesy of the US Air Force

From War Hero to Elevator Operator

When Eugene Bullard (1894–1961) hung up his infantry boots at the end of World War I, he returned to Paris. This was the city that felt like home to him. Before the war he'd been a boxer. But now he was a war veteran who'd suffered many wounds. He needed work that exercised his mind more than his body. He went into the nightclub business and met many famous people such as authors Ernest Hemingway and F. Scott Fitzgerald. He also got married. His wife was the daughter of a countess. They had two children. Years passed and another war was brewing—World War II.

During all his time in Europe, the former war pilot had picked up language skills. In addition to English and French, Bullard spoke German quite well. Because Bullard had great affection for his adopted country of France, he agreed to help when the French government asked him to spy on Germans living in France. War broke out in 1939 and with the German army about to take the city of Paris in 1940, Bullard knew he had to leave. He did this because if he were captured he'd be charged as a spy and because he wanted to protect his two children. Bullard and his wife had separated years before but when she died, Bullard gained custody of their children.

After fleeing Paris, Bullard went with his children to the city of Orleans, south of the French capital. He joined a group of uniformed troops defending that city, and was once again wounded. A woman spy smuggled him and his children into Spain. The family was later sent back to the United States, where Bullard recovered.

Bullard spent the rest of his life in Harlem, New York, working as an elevator operator at the Rockefeller Center. The US military didn't recognize his wartime achievements until after his death, when the US Air Force commissioned him as a lieutenant.

But the grateful French never forgot him. French President Charles de Gaulle even praised Bullard on a visit to New York City in 1960.

Manfred von Richthofen, the Red Baron

Courtesy of the National Archives and Records Administration

The Red Baron

Baron Manfred von Richthofen was Germany's ace of aces. He made 80 kills. He came from a wealthy military family. By age 20, he was a lieutenant in a Prussian Army cavalry regiment. But once the fighting moved to the trenches, the horse cavalry no longer had an important role in combat.

So Von Richthofen joined the German Imperial Air Service. He soon commanded a group with scarlet-colored planes. Because of his record of conquests in the air and the color of his planes, he became known as the Red Baron. Allied fire killed Von Richthofen in 1918, three years after he became a pilot.

US Contributions to the Air War

By 1917, after years of bloody fighting which cost both sides terrible casualties, the war in Europe was at a stalemate. A stalemate *is a situation in which further action is blocked*. The French Army was demoralized. The British tried to reinforce France, but inexperienced replacements composed the bulk of British troops by this point. Germany was also weakening. A force was needed to tip the balance one way or the other. The Allies hoped that force would be the United States, which joined the effort in April.

In August 1917 the US Congress vowed to "darken the skies over Europe with US aircraft." It voted to appropriate—*to set aside for a specific use*—$64 million to build airplanes.

Congress had good intentions, but it had made an empty promise. The United States lacked both the engineers to design planes and the manufacturers to assemble them. Even by the end of the war, all American pilots were still flying British or French planes.

Britain and France had entered the war in 1914 with 450 aircraft. Germany at that time had 200. All three countries had working aviation industries in those years. By 1917 France and Germany each boasted more than 2,000 aircraft. Britain was continually flying patrols along the North Sea, but the Allies were running out of steam. At that time, the United States had just one manufacturer: Curtiss Aircraft.

While the United States never built more than a handful of airplanes during the war years, it did provide considerable manpower in the air. It entered the European conflict with 100 pilots and trained 10,000 more before the war's end in November 1918. In all, 781 enemy planes fell to US aircraft. US pilots took part in 150 bombing raids.

It may have taken America the better part of a year to ramp up its effectiveness in the war, but its support of the Allies was crucial. In one of the most significant air battles of World War I—the Battle of Saint Mihiel—America's Billy Mitchell led the Allied air attack. That battle determined the war's outcome.

CAPSULES

Weakness in the Air: Congress Responds

August 1917 wasn't the first time Congress tried to pump up the country's air power. On 18 July 1914 the US House of Representatives authorized the Army's Signal Corps to create an aviation branch with 60 officers and 260 enlisted men. When in March 1916 the 1st Aero Squadron took to the field to help Gen John J. Pershing secure the US–Mexico border, the squadron had eight biplanes. But these planes were not nearly powerful enough to get over Arizona's Casa Grande mountains. Recognizing the need, the Congress appropriated $13.2 million to build up the Aviation Service.

CAPSULES

Enlisted Pilots

The United States entered the war in 1917 with 100 pilots. Billy Mitchell and another officer, Hap Arnold, had done their best to build up the number of pilots by training enlisted men. Both officers thought highly of the enlisted men in the Army's Signal Corps. The enlistees knew aircraft engines inside and out. Mitchell, an outspoken advocate of air power, helped ensure that the National Defense Act of 3 June 1916 included language that authorized the training of enlisted men as pilots.

The Role of Air Power During World War I

Until World War I, most people thought the role of aircraft in combat was limited to aerial reconnaissance. Countries won wars based on the strength of their infantries and the power of their navies. That's how it had been for centuries.

When the US Army bought its first *Wright Flyer*, even Brig Gen James Allen didn't think of an airplane as a potential offensive weapon. Dropping bombs from the sky seemed an unlikely idea. Conducting battles between squadrons of planes also seemed far-fetched. After all, planes of those days were built of plywood, and their wings were wrapped in fabric. But World War I would alter the military's views.

While many improvements were still needed to make the airplane the fierce weapon it is today, battlefield strategy evolved dramatically over the course of the Great War. The airplane reshaped the way countries fight wars more quickly than any other weapon in military history. A motto emerged by war's end: "If you control the air, you cannot be beaten; if you lose the air, you cannot win."

The Significance of Air Power in World War I

You've read that air power was essential to winning World War I. But where was its impact the greatest?

The Long-Range Raid and the Machine Gun

London, 1915: German airships floated over the city and dropped bombs with great accuracy. They destroyed buildings and killed many people. Through 1917 the Germans worked on perfecting these long-range strategic raids. Strategic means *designed to strike at the sources of an enemy's military, economic, or political power.* The British were really the first to attempt a long-range raid. In 1914 they targeted hangars housing German aircraft.

A German zeppelin

World War I German airmen dropped bombs on French and English cities from German zeppelins.

Courtesy of the Library of Congress

The Germans flew hydrogen-filled zeppelins. A zeppelin *is a German dirigible with a rigid frame used for observation and bombing raids*. Zeppelins, invented by the German Count Ferdinand von Zeppelin, had one major weakness: they easily burst into flames when hit by antiaircraft fire. So the Germans built a twin-engine bomber called the Gotha IV. The Gotha IV went on bombing raids over many British cities in 1917.

As a result of these raids, Britain had to take new measures to protect its own shores. English fighter squadrons were ordered to return from France so that they could guard British soil.

CAPSULES

Bombs on Britain

It wasn't a zeppelin that dropped the first bombs on Britain. It was a German FF-29 seaplane. The date was 21 December 1914, and the target was Dover, a city in southeast England. The FF-29 missed its target that day. But three days later it raided Britain a second time. Its bombs hit Dover this time, but no one was killed. The next day the aircraft invaded British airspace a third time. It dropped two bombs on nearby Kent. Over the course of the war, Germany hit London alone with 56 tons of bombs. German aircraft dropped 214 tons of bombs on the rest of the country.

Skynotes

The First Independent Flying Force

In response to German air raids on English cities and factories, the British formed their own bombing unit. Although the British were the first to conduct a long-range raid, they hadn't established a new arm of their military to do so. But in 1917 the British Royal Flying Corps (RFC) founded its first bombing wing. Unlike American and other Allied aviation units, the RFC did not answer to an infantry officer. It was independent. In 1918 the RFC merged with the Royal Naval Air Service and became today's Royal Air Force.

THE GERMAN *ALBATROS* D-II

The German *Albatros* D-II had two machine guns mounted toward the front.

Courtesy of the EAA/Jim Koepnick

Another innovation dreamed up by the Allies and picked up by the Germans was the airplane-mounted machine gun. Machine guns had been around since the late 19th century, and they were in full use by infantryman from the start of World War I. They weren't used right away in the air, however. Until 1915 pilots shot at one another with pistols and rifles. French pilot Roland Garros first bolted an automatic rifle to his plane so he could shoot straight through the propeller. To keep from shooting his propeller off, he attached steel plates to the backs of the blades.

The Germans got to see Garros's deadly invention up close when they downed his plane in April 1915. They asked a Dutchman, Anthony Fokker, to take the design a step further. Fokker built an interrupting gear. He hooked the machine gun to the plane's engine. In this way, the gun would not fire while the propeller was in the way. For the next year, the Germans ruled the skies.

But if the Germans could capture and copy Garros's design, it was only a matter of time before the Allies captured a German aircraft and copied Fokker's interrupting gear. In April 1916 the Allies did just that. Soon the Allies and the Central Powers were again on equal footing. The famous dogfights commenced. A dogfight *is a battle between fighter planes*. The fighter aces came out of these aerial battles. Sometimes squadrons with as many as 50 planes faced off.

The Battle of Saint Mihiel

In September 1918 the Battle of Saint Mihiel in France finally turned the tide in favor of the Allies. Air power played a tremendous role in this offensive. Brig Gen Billy Mitchell commanded nearly 1,500 Allied airplanes—American, French, British, Italian, and Portuguese—to drive the Germans out of France. This was the largest assembly of aircraft ever gathered for a single mission.

The Allied pilots had two goals. The first was to destroy German planes in the air. The second was to destroy German aircraft in hangars on the ground. Mitchell committed 1,000 planes to this portion of the mission. The rest of the planes protected the Allied ground troops. They scouted out enemy positions. Mitchell wrote that the Allied planes were "to be put into a central mass and hurled at the enemy's aviation, no matter where he might be found, until complete ascendancy had been obtained over him in the air."

The four-day Battle of Saint Mihiel established the role of mass movements of air power during wartime. It weakened the Central Powers and destroyed enemy supply lines. This offensive helped lead to Allied victory two months later.

How the Airplane Revolutionized War

When World War I began in 1914, pilots flew everything from balloons and dirigibles to airplanes. They soared over enemy positions to spot troop movements and artillery positions. They also took photos of what they'd seen.

Each side wanted to do something to counteract this use of aircraft. Both sent up airplanes to shoot down observation aircraft, first with pistols and rifles and later with machine guns, as you read in the previous section.

Whether the enemy was using pistols or machine guns, another countermeasure was now necessary. Each side had to protect its observation aircraft. Aerial combat was born.

Furthermore, once machine guns were mounted on planes, pilots could use them to strafe soldiers on the ground. To strafe *is to attack with a machine gun from a low-flying aircraft*. Planes also delivered bombs behind enemy lines. At first pilots carried small bombs in their laps and dropped them by hand. Once aircraft could carry heavier loads, some ferried thousands of pounds of bombs. Accuracy of bombing, however, remained an issue.

A PILOT USES A GRAFLEX CAMERA

A pilot takes pictures of enemy troop positions circa 1917–1918.
Courtesy of Corbis Images

A GERMAN PILOT

A German pilot drops a bomb on an Allied position.
Courtesy of Corbis Images

Airplanes now offered possibilities that challenged age-old warfare strategies. In traditional battles, troops dug trenches. They tried to hold their own lines and break through the enemy's trench lines. Assaults were from the front. But airplanes changed that. Planes could fly over an enemy's trenches, bomb from overhead, and strafe troops. What's more, they could hit important targets behind enemy lines, such as factories. This provided the element of surprise as well.

Planes didn't come into their own until World War II. Nevertheless, their use during World War I set the stage for the next worldwide conflict.

How Air Power Expanded During World War I

Airplanes flew a whopping 64 mph when the first shots of the Great War rang out. Most European nations had a few hundred planes. America had only about 20. But no one had aircraft that were combat worthy.

Over the next four years, the technology of the Allied and Central Powers' air power would continually leapfrog one over the other. Speeds picked up. Aircraft became stronger and sturdier. Maximum altitudes climbed from 10,000 feet to 24,000 feet.

As the saying goes, "Necessity is the mother of invention." And if survival in war isn't a necessity, what is?

New Developments in Aviation During World War I

When Louis Blériot crossed the English Channel in 1909, some thought his quick, 37-minute passage from one country to another suggested the face of future wars. If a friendly aircraft could travel that fast from Calais to Dover, couldn't an enemy do the same? Many countries built small armies of planes. Once war broke out, the pace of invention picked up.

By 1918 three specialized types of aircraft had emerged: the fighter, the observation aircraft, and the bomber. Observation aircraft were in use from the start. Most of them were dirigibles and balloons. Some planes even had extra seats for photographers.

The fighter came into its own with the birth of the dogfight. This era had the biggest impact on small-craft development. Once both the Allies and the Central Powers had mounted machine guns with interrupting gear on their airplanes, quick, easy maneuvers became essential. A pilot wanted to get out of the way of the bullet spray.

A British *Sopwith Triplane*

A British *Sopwith Triplane* was one of the aircraft designed during the war to engage in dogfights.

Courtesy of the EAA/Jim Koepnick

These fighter aircraft needed three qualities: they had to be lightweight, fast, and maneuverable. Both sides designed their own memorable fighters. The British built the Sopwith Camel and the SE-5A. The French had the Spad VII and Nieuport 28. The Germans crafted the Fokker Dr-I and D-VII.

Seven months before the war ended, a German designer named Hugo Junkers made a breakthrough. He built an all-metal, low-wing monoplane fighter, the Junkers D1. No longer would a pilot have to fly a plywood-and-fabric contraption that easily caught fire. Fortunately for the Allies, the Germans assembled only 45 of these planes.

During the war, airplanes became faster. By early 1918 fighters zipped along at a cool 130 mph. When Igor Sikorsky flew his four-engine, 92-foot-wingspan *Le Grand* in 1913, he probably couldn't have imagined that in just five years 100-foot-wingspan bombers would be carrying loads that weighed thousands of pounds. As the Germans learned with their zeppelins, bombs were best delivered by planes sturdy and large enough to carry heavy loads. The British, for example, designed the Super-Handley Page bomber. The first model had two engines; later models had four. The four-engine model could carry six men and 30 260-pound bombs.

Any breakthrough in design gave the side that had it an edge. Ground soldiers, pilots, commanders, and engineers—all contributed to the war effort.

Why War Sped Up Aviation Development in the United States

When Congress appropriated $64 million for airplanes in 1917, the United States was far behind other nations in air power. Curtiss Aircraft was the only aviation manufacturer in the country. Army staff officers still had their eyes focused on the infantry. They had no plans for their aviation section. The United States could never again be so unprepared.

Brig Gen Billy Mitchell believed strongly in the future of aviation as an instrument in warfare. He saw its possibilities, including as a weapon against navies. Mitchell didn't learn to fly until he was 36—that's old for a beginning pilot. But he was one of the freshest thinkers in air warfare.

After consulting with other officers, Mitchell devised a three-pronged theory to fight wars from the sky:

1. Air superiority over the battlefield must be completely assured.
2. Air power may then be employed offensively against the enemy's ground troops.
3. Finally, aerial bombardment may be directed against the enemy's supplies, railroads, communications, and airdromes.

As chief of the Air Service, Mitchell held great sway with Airmen. But the aviation arm still fell under the command of the Army. And the Army saw airplanes as nothing more than extensions of ground forces. Mitchell, on the other hand, always pushed for an independent air service. He considered new strategies, such as the mass use of airplanes in the Battle of Saint Mihiel. For these reasons, today's US Air Force still considers Mitchell one of its founding fathers. You'll read more about him in a later lesson.

BRIG GEN BILLY MITCHELL

Chief of the Air Service Brig Gen Billy Mitchell drew up the plan for the 1,500-plane movement in the Battle of Saint Mihiel.

Courtesy of the Wisconsin Aviation Hall of Fame

CHECKPOINTS

Lesson 3 Review

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

1. How many planes did an Allied pilot have to shoot down to earn the "ace" title? How many did a German pilot have to down?
2. What type of soldiers made up the French Foreign Legion?
3. What two important things did American ace of aces Edward Rickenbacker do for his men?
4. Who was the only African-American pilot during World War I? Which air service accepted him?
5. Did Americans ever fly their own planes during the Great War? Whose planes did they fly?
6. What motto regarding air power emerged by war's end?
7. What two good ideas concerning combat aircraft did the Germans borrow from the Allies?
8. What was the average airplane speed in 1914, and what was the average speed by 1918?
9. What three specialized types of aircraft had emerged by the end of World War I?

Applying Your Learning

10. Explain how the airplane revolutionized war.