Celebrating a Century of Flight
Thirty-three years ago, when astronauts Neil Armstrong and ‘Buzz’ Aldrin skillfully piloted the lunar module Eagle to a soft landing on the Moon, they paid tribute to America’s aviation heritage by bringing with them a piece of the original Wright Flyer’s fabric and propeller. That incredible summer day in 1969, our moonwalkers demonstrated for all time that the sky’s no longer the limit.

As flight’s second century begins, the United States is still boldly pioneering the air and space frontier. And the National Aeronautics and Space Administration, NASA, is a proud leader in this effort.

Fittingly, NASA’s roots extend back to aviation’s infancy. In 1915, our predecessor, the National Advisory Committee for Aeronautics, NACA, was formed to promote the advancement of aeronautical science and methods of flight safety. Today, NASA scientists, engineers, and test pilots continue to push the envelope of flight technology.

NASA’s vision for the next century of flight—to improve life here, extend life to there, and find life beyond—compels us to improve and create all types of aircraft, better understand Earth’s climate, probe the universe’s mysteries, and send explorers to the planets. This celebration of the centennial of flight reminds all of us how privileged we are to be engaged at just the start of an adventure without end.

—Sean O’Keefe, Administrator, NASA

Cover photo: Since 1915, the National Advisory Committee for Aeronautics (NACA), transformed into NASA in 1958, has performed cutting-edge research to solve the problems of flight. Using a Grumman F4F-3 Wildcat during World War II, NACA engineers at the Langley Aeronautical Laboratory (now Langley Research Center) in Hampton, Virginia, used this aircraft to investigate the cuffs on the propeller blades to determine their efficiency. While not built to the full production standard of other Grumman Wildcats, research on this aircraft, the second F4F-3, proved most successful in advancing knowledge of the aerodynamics of this engine and propeller system. This photo shows a close-up of the propeller blades with Curtiss Electric Propellers’ logo.


The most beautiful dream that has haunted the heart of man since Icarus is today reality. —Louis Blériot

From the sands of Kitty Hawk in 1903 to the outer edges of our solar system in 2003, no invention has made such an indelible imprint on our world as the airplane. Crafted by two ordinary men who were driven to achieve extraordinary results, the 1903 Wright Flyer represents an achievement of creativity, determination and courage. The national Centennial of Flight: Born of Dreams—Inspired by Freedom commemoration celebrates the human desire for freedom, the power of dreams and the astonishing realities they can create.

Let us use the story of flight to build a new level of enthusiasm for perseverance and resolve in the quest for ingenuity. The U.S. Centennial of Flight Commission is committed to providing educational material on the history and influence of flight. As you read this brochure, I hope that you find the information both informative and inspiring. Ask yourselves, and those around you, “If we can fly, what can we do?” It is through this spirit of adventure and determination that we will create the next century of aviation milestones.

—J. R. Dailey Chairman, U.S. Centennial of Flight Commission

One hundred years ago, the promise of flying machines and powered airships was found exclusively in the minds of dreamers. Most believed powered flight was a far-fetched idea, the stuff of myths and legends. On 17 December 1903, Orville and Wilbur Wright dispelled those myths and propelled us into a new era of exploration and innovation. Flying a biplane made of wood and cloth from a Kitty Hawk sand dune, they transformed our dream of flight into a breathtaking reality.

Since that first 20-second flight, the achievements of civilian and military aviation have far surpassed the dreams of those early visionaries. Airmen have revolutionized travel and commerce, pioneered the development of groundbreaking technologies, redefined the way we define our interests, and helped shape a world in which our nation’s safety and prosperity would flourish. Powered flight is and will continue to be one of mankind’s most significant accomplishments. If properly guided and nourished—with the same vision that characterized its creators—the second century of flight will further advance the peaceful and productive interaction of nations, continue to protect our cherished freedoms, and provide for the benefit of all mankind.

The United States Air Force joins the world in celebrating the spirit of the Wright brothers’ creativity and our nation’s aviation pioneers. As we reflect on a century of flight, we reaffirm our commitment to continue the dream started by those first airmen. We’ve come a long way in our first 100 years of flight . . . imagine where the next 100 years will take us.

—John P. Jumper, General, USAF Chief of Staff

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1000 B.C. The Chinese invented kites that carried scouts on recon-
naissance missions.

1162 A man in Constantinople fashioned sail-like wings from a fabric gathered into pleats and folds. He plummeted from the top of a tower and died.

1783 June 4. Montgolfier brothers launched the first public balloon flight. November 21. Pilâtre de Rozier and the Marquis d’Arlandes were the first humans to fly in an untethered balloon.

1784 June 4. Elisabeth Thible was the first woman to make a balloon flight. June 24. In a tethered flight from Baltimore, Maryland, thirteen-year-old Edward Warren was the first to fly in a balloon from American soil.


1797 First parachute jump

Hot-air balloons became popular once again after World War II, when the advent of new materials and propane-fired burners offered sportsmen a new way to venture aloft. In 1999, after a twenty-day, nonstop flight, Bertrand Piccard and Bertrand Piccard became the first balloonists to complete a nonstop circumnaviga-
tion of the globe. The last solo balloon hurdle was crossed in 2002 when Steve Fossett circumnavigated the world by balloon alone. Today, colorful hot-air bal-
loons of fanciful designs are seen float-
ing in the skies all over the world. Those who see them might agree with Joseph Montgolfier, who long ago instructed his brother to beware the dangers for their first balloon—and “you will see one of the most incredible things in the world.”

A Montgolfier-type balloon is depicted at a time of launch in Paris in 1783.

The Prehistory of Flight

■ Human beings have always wanted to fly. Evidence of our ancient desire to join the birds in the sky can be found in our earliest legends of winged gods and heroes, flying horses, and magic car-
pets. Then there were the log-boat tales of real human beings who were carried aloft by kites or who sought to fly with wings of their own design. All too often, these intrepid souls suffered broken bones or worse.

When the age of flight finally did arrive, it came from an unexpected direction that had nothing to do with wings. The invention of the balloon created a wave of excitement that swept across Europe and America. Although the balloon would be put to good use by science and the military, it could only travel where the wind blew it. The age-old dream of flying remained very much alive.

■ Human beings have dreamed of flight for centuries. But the first creatures to venture aloft in a balloon were a duck, a sheep, and a rooster. An enormous crowd joined the King of France, Louis XVI, his Queen, Marie Antoinette, and their children at the Versailles palace on 19 September 1783. The occasion was the flight of these three hapless animal passengers aboard a hot-air balloon constructed by brothers Joseph and Étienne Montgolfier. After an aerial voyage lasting only eight minutes and covering some two miles, the first three air travelers returned safely to Earth, none the worse for wear.

The Montgolfier brothers, natives of Annonay, in the south of France, belonged to one of the leading paper-
making families of France. Fascinated by new discoveries in science, Joseph Montgolfier began to experiment with paper and fabric bags filled with hot air in the early 1780s. With his younger brother Étienne, he launched a balloon measuring ten feet in diameter from the town square on 4 June 1783. When news of what the two brothers had achieved in distant Annonay reached Paris, a prize was offered to the individ-
ual who could repeat the Montgolfier experiment. Not sure how the brothers had accomplished the feat, J. A. C. Charles, a popular lecturer on scientific topics, constructed the first balloon filled with hydrogen, a gas very much lighter than air. He launched the first gas balloon in Paris on 27 August 1783, near the spot where the Eiffel Tower now stands. Not to be out-
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Winging It

■ For hundreds of years, human beings have attached all manner of wing-like struc-
tures to their bodies, from the tops of towers and other high places, and attempted to fly. Most of these would-be aviators sought to fly with ornithopters, machines that beat their wings like birds. Even the bril-
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neer Leonardo da Vinci, who understood some of the basic prin-
ciples of flight as early as the 1480s, could only dream of flying ornithopter and helicopter designs that could never have left the ground. He and others of his time realized that human beings lacked the necessary muscle power to imitate bird flight.

Hindu mythology talks of the bird deity Garuda, often depicted in art as having the body of a man and the head and wings of an eagle. This great and powerful flying god-bird lent his body as a vehicle to the Hindu god Vishnu, with whom he is worshiped. Garuda’s image can be seen in sculpture, paintings, and architecture, especially that of royalty and noblemen.

Daedalus carefully instructed his son to fly “a middle course,” safely between the water that might weigh down the feathers if it sprayed on them and the Sun, which could melt the wax that held the feathers in place. Icarus, thrilled by the freedom of his flight and curious to explore the heavens above him, soared higher and higher, until the heat of the Sun destroyed his wings and he plunged to his death in the sea. The story of Icarus and Daedalus is told and retold through the cen-
turies, inspiring human beings to fly and cautioning those who dared to dream of trespassing on the domain of the gods.

Daedalus and Icarus

The story of Daedalus and Icarus is the most famous of all flight myths. Minos, the King of Crete, hired the talented craftsman Daedalus to design a Labyrinth, or maze, in which to imprison the Minotaur, a half-man, half-bull creature. Each year, young people were sacrificed to appease the monster. When Daedalus helped Theseus, a young hero selected for the sacrifice, to kill the Minotaur and escape, Minos imprisoned the inventor and his son, Icarus. Realizing that flight was the only way in which he could free himself, Daedalus fashioned wings out of feathers and wax to carry them across the sea, away from King Minos.
The Prehistory of Flight

Human beings have always wanted to fly. Evidence of our ancient desire to join the birds in the sky can be found in our earliest legends of winged gods and heroes, flying horses, and magic carpets. Then there are the hundreds of real human beings who were carried aloft by kites or who sought to fly with wings of their own design. All too often, these intrepid souls suffered broken bones or worse.

When the age of flight finally did arrive, it came from an unexpected direction that had nothing to do with wings. The invention of the balloon created a wave of excitement that swept across Europe and America. Although the balloon would be put to good use by science and the military, it could only travel where the wind blew it. The age-old dream of wings remained very much alive.

With the advent of a hot-air balloon, people began to experiment with paper and fabric bags filled with hot air in the early 1780s. With his younger brother Étienne, he launched a balloon measuring ten feet in diameter from the town square on 4 June 1783. When news of what the two brothers had done spread, the King of France offered a prize to the individual who could repeat the Montgolfier experiment. Not sure how the brothers had accomplished the feat, J. A. C. Charles, a popular lecturer on scientific topics, constructed the first balloon filled with hydrogen, a gas very much lighter than air. He launched the first gas balloon in Paris on 27 August 1783, near the spot where the Eiffel Tower now stands. Not to be outdone, the Montgolfiers hurried to the capital and arranged the flight from Versailles in September.

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Winging It

For hundreds of years, human beings attached all manner of wing-like structures to their arms, flung themselves from the tops of towers and other high places, and attempted to fly. Most of these would-be aviators sought to fly with ornithopters, machines that beat their wings like birds. Even the brilliant Italian artist, scientist, and engineer Leonardo da Vinci, who understood some of the basic principles of flight as early as the 1480s, could envision no way of achieving powered flight, and his ornithopter designs that he described in his notebooks have never been put to the test by man.

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Drawings, left to right: da Vinci air screw sketch, Pénault sketch. National Air and Space Museum (89-6085, 93-7763)
Aviation Pioneers

Sir George Cayley, a nineteenth-century English baronet, richly deserves to be remembered as the “father of aeronautics.” His inseparable curiosity led him to conduct the first real experiments designed to uncover the basic principles of flight. He discovered that the arched shape of a bird’s wing was one of the secrets of bird flight and reasoned that a similar shape on a fixed-wing machine might allow it to fly. Cayley designed, built, and flew the world’s first model glider in 1804. He continued his experiments throughout his long life and is said to have sent his coachman on a short glide across a shallow valley near his home, Brampton Hall, in 1853. Legend has it that the frightened servant resigned on the spot, explaining that he had been hired to drive, not to fly.

Otto Lilienthal built on both the experiments and information provided by Sir George Cayley. He published the results of his ground-based research, “Bird-flight as the Basis of Aviation,” in 1890; he then began to apply what he had learned to the design of the gliders with which he would continue his work. Between 1890 and the time of his death in a glider crash in August 1896, Lilienthal made as many as 2,000 flights in eighteen different designs, including both monoplanes (single-wing) and biplanes. All his craft were hang gliders, controlled in the air by movements of the pilot’s body, which hung beneath the machine. The work of Otto Lilienthal provided the starting point for the experimenters who would take the final critical steps toward the invention of the airplane.

Interesting Reading


Inventing Wings

Early in the nineteenth century, the age of dreams had given way to serious attempts to understand the principles of flight and to apply the lessons learned to the design of real flying machines. Cautious experimenters tested their ideas with powered models, while the more daring sampled the delights and the dangers of gliding flight. Their successes and failures helped move human beings toward what some considered impossible and others considered inevitable—piloted, powered flight.

Above, left to right:
Sir George Cayley (1773–1857);
Octave Chanute (1832–1910);
Otto Lilienthal (1848–1896).

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Cayley designed, built, and flew the world's first model glider in 1804. He continued his experiments throughout his long life and is said to have sent his coachman on a short glide across a shallow valley near his home, Brompton Hall, in 1853. Legend has it that the frightened servant resigned on the spot, explaining that he had been hired to drive, not to fly.

Octave Chanute, a self-taught American engineer, became interested in aeronautics in the 1870s. Corresponding with flying machine experimenters around the globe, he quickly emerged as the focal point of an international community of engineers who were attempting to fly. An admirer of Lilienthal, Chanute sponsored a series of glider trials on the sand dunes at the southern tip of Lake Michigan in the summer of 1896. The trials produced a triplane/biplane hang glider that represented a distinct improvement over the Lilienthal designs. A passionate promoter of aviation who believed in the importance of collecting information about the progress being made in the field and then sharing it with others who could carry on its development, he helped move and stimulated other aviation experimenters, including a pair of brothers from Dayton, Ohio.

Octave Chanute attracted the American scientist Samuel P. Langley to aeronautics. Appointed Secretary of the Smithsonian Institution in 1887, Langley conducted extensive research into the principles of flight, then began his design experiments with small rubber-band-powered models that he called "aerodromes." In 1896, Langley completed two flights of up to 4,200 feet with model steam-powered aerodromes. While the aerodromes were too small to carry a pilot and could not be controlled, they were the first powered, significantly large models to fly. The War Department then provided Secretary Langley with $50,000 to design and build a full-scale aerodrome capable of carrying a pilot. He tested his machine in October and December of 1903. On both occasions, the structure collapsed when catapulted into the air from a houseboat anchored in the Potomac River. It flew, one reporter observed, "like a handful of mortar." Pilot Charles Manly survived both trials, but the aeronautical career of Samuel Langley was at an end.


to invent an airplane is nothing. to build one is something. to fly is everything. —Otto Lilienthal

Aviation Pioneers

Sir George Cayley, England's "father of aeronautics," built and flew the world's first successful model glider.

Matthew Boulton obtained a British patent on a design for aeronauts as control surfaces.

Astrid Bergrüner got a job as a coachman, refusing to fly.

Samuel P. Langley flew the first powered aerodrome models.


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Interesting Reading


1901 Using existing aerodynamics tables, the Wright brothers constructed new wings for a larger glider. However, its flight was marginal, so they tested the tables by analyzing model wings in a wind tunnel. The tables proved to be wrong, and the Wrights painstakingly computed new ones.

1902 Using tables created in 1901, the Wrights built a glider that had almost twice the efficiency of their previous ones and made more than 1,000 flights that year at Kill Devil Hills near Kitty Hawk, North Carolina.

1903 December 17 The Wright brothers completed the first powered, piloted, heavier-than-air controlled flight. December 18 Wilbur Wright made a second flight, but the Wright Flyer I crashed in a sand dune.

1904 Returning to Ohio, the Wright brothers experimented with new planes and motors and flew an improved Flyer II.

1905 The Wright’s Flyer III became the world’s first practical airplane but attracted little attention.

1906 The Wrights were granted a patent for the airplane control system.

1907 November 13 Paul Cornu, a French inventor, flew the first helicopter. The flight lasted only 20 seconds and hovered just 1 foot (30 cm) above the ground.

1908 The Wrights finally began to receive credit and attention for their invention. Submitting a bid to the Army for a military flying machine, Orville bought a Flyer to Fort Myer, Virginia; passed the trials, and won a contract for the world’s first military airplane. Later that year, the plane crashed after a propeller failure, seriously injuring Orville and killing his passenger, Lieutenant Thomas Selfridge.

1909 Albert Einstein published theory of special relativity

1918 First transatlantic radio signal

1920 Ford Motor Company founded

1945 NASA Langley Research Center

1967 San Francisco earthquake occurred

1967 C. F. Cross invented cellophane

Two Ordinary Men, One Extraordinary Dream

■ Orville Wright once explained that he and his brother, Wilbur, were lucky to have grown up “in an environment where there was always much encouragement to children to pursue intellectual interests, to investigate whatever aroused curiosity.” The sons of a church bishop and his mechanically inclined wife, the Wright boys first became interested in flight as children when their father presented them with a rubber-band-powered helicopter toy of the sort designed by Alphonse Pénaud. Although neither of them attended college, Wilbur and Orville Wright were intellectual, intuitive, confident, and mechanically gifted. As young men, they operated both a print shop and a bicycle shop in their hometown of Dayton, Ohio. Still, their curiosity and technical skills drove them to pursue other challenges. The death of Otto Lilienthal rekindled their boyhood passion for wings.

Success!

■ The great moment arrived on a windy winter morning on a North Carolina beach, the result of the work of two brothers with a passion for bicycling and an insatiable curiosity. The Wright brothers introduced the era of powered flight, and men and women everywhere were anxious to follow them into the air. Steady improvements in the design of engines and aircraft structures produced a new generation of aircraft capable of flying higher, faster, and farther.

Disappointed with the performance of their early gliders, the brothers conducted a series of wind tunnel tests in the bicycle shop during the fall of 1901. On the basis of these trials and their experience with the gliders, they designed and built their third full-scale glider in 1902 and completed 1,000 flights with it, remaining airborne for as long as 26 seconds and covering distances of up to 622.5 feet.

Now they were ready to attempt a powered, powered flight. With assistance from their machinist, Charles Taylor, they designed and built the aircraft and a four-cylinder internal combustion engine that would deliver precisely the amount of power required. They also built the propellers, based on their wind tunnel data, that proved to be the most efficient of the time. Success came on the morning of 17 December 1903. Orville Wright made the first flight at about 10:35 A.M., a bumpy and erratic 12 seconds in the air. A few minutes later, Wilbur flew the plane 175 feet — just a few feet shorter than the wingspan of a Boeing 747. Orville then flew again, a distance of 200 feet. During the final flight of the day, piloted by Wilbur, the Wright Flyer remained airborne for 59 seconds and flew 852 feet.

These four flights marked the first time that a powered, heavier-than-air machine had made a sustained flight, under the complete control of the pilot. The Wright brothers were not surprised by their success, for they had meticulously calculated how their machine would perform and were confident that it would fly once they had ironed out all the problems from their previous tests.

Within a few days of these flights, the Wright brothers were the subject of what had signed contracts for the sale of their machine. They ceased flying completely in the fall of 1905 and concentrated on finding buyers for their technology.

In 1908, the Wright brothers finally received due acclaim when Wilbur made public flights in Europe, amazing spectators with his flying skill and the maneuverability of the Wright Model A biplane. That same year, Orville took a plane to Fort Myer, Virginia, where he demonstrated the Flyer. In 1909, they returned to Fort Myer and sold the world’s first military plane.

By 1909, the Wright Company was turning out four planes a month, making it the largest airplane manufacturer in the world. They also found media interest in the Aviation World, appearing on the front pages of major newspapers from coast to coast. When they did not follow up with public flights in 1904, the press assumed that the Kitty Hawk story had been an exaggeration, if not a hoax.

Wilbur and Orville Wright pressed ahead, moving their experiments closer to their Dayton, Ohio, home. There, in 1904, in a meadow called Huffman Prairie, they built the Wright Flyer II, the first airplane to fly a circle in the air. The Flyer III followed in 1905, a plane that could stay in the air for over half an hour, turn, bank, and fly figure eights. The Wrights were determined not to fly in public until they had received the protection of a patent and for some years I have been afflicted with the belief that flight is possible to man. —Wilbur Wright
Two Ordinary Men, One Extraordinary Dream

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1902 1913

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The brothers launched their own aeronautical effort in 1899 after corresponding with both the Smithsonian Institution and Octave Chanute. They realized their first challenge was finding a way to control a machine in the air. They tested their notion of a wing-warping control system on a small kite flown from a hill in Dayton. Between 1900 and 1902, they built three gliders, testing them over the sands of Kill Devil Hills near Kitty Hawk, North Carolina, a location that was ideal because of its high winds and tall dunes, with plenty of sand for soft landings.

Within a few days of these flights, the Wright brothers were the subject of what were, for the most part, wild and inaccurate reports on the front pages of major newspapers from coast to coast. When they did not follow up with public flights in 1904, the press assumed that the Kitty Hawk story had been an exaggeration, if not a hoax.

Wilbur and Orville Wright pressed ahead, moving their experiments closer to their Dayton, Ohio, home. There, in 1904, in a meadow called Huffman Prairie, they built the Wright Flyer II, the first airplane to fly a circle in the air. The Flyer III followed in 1905, a plane that could stay in the air for over half an hour, turn, bank, and fly figure eights. The Wrights were determined not to fly in public until they had received the protection of a patent and had signed contracts for the sale of their machine. They ceased flying completely in the fall of 1905 and concentrated on finding buyers for their technology.

In 1906, the Wright brothers finally received due acclaim when Wilbur made public flights in Europe, astounding spectators with his flying skill and the maneuverability of the Wright Model A biplane. That same year, Orville took a plane to Fort Myer, Virginia, where he demonstrated the Flyer. In 1909, they returned to Fort Myer and sold the world’s first military plane. By 1909, the Wright Company was turning out four planes a month, making it the largest airplane manufacturer in the world. They also formed one of the earliest exhibition teams, flying in various venues where they could publicize and market their planes. Orville continued to fly through 1918, six years after Wilbur’s death from typhoid fever. He sold his interest in their business in 1915 but remained actively engaged in other related pursuits, among them an ongoing disagreement with the Smithsonian Institution over who had been the first to fly a powered aircraft, the Wrights or Samuel Langley. The Smithsonian had originally given the nod to Langley but later accused him in favor of the Wright brothers.

When Orville Wright died in 1948, he had seen many of the advances in aviation that were a direct result of the work he and his brother had accomplished.

Success!

The great moment arrived on a windy winter morning on a North Carolina beach, the result of the work of two brothers with a passion for bicycling and an insatiable curiosity. The Wright brothers introduced the era of powered flight, and men and women everywhere were anxious to follow them into the air. Steady improvements in the design of engines and aircraft structures produced a new generation of aircraft capable of flying higher, faster, and farther.
World War I: The First Air War

Since only eleven years old in August 1914, the fragile airplane in its role as an observer contributed significantly to the murderous carnage that characterized combat in World War I. The great killer of the war was artillery and aerial reconnaissance vastly increased artillery's effectiveness. Observation aircraftphotographed and mapped trenches and military positions, reported transient artillery, and provided direct control for artillery batteries. Further, aircraft photographs and reports enabled commanders to identify the enemy's position, determine his strength, surmise his intentions, and organize their response to best effect.

The need to protect one's own observation aircraft or deny the air to the enemy quickly led to a quest for control of the air. In 1915, an asynchronization or "interrupter" mechanism allowed machinegunners to fire through a spinning propeller, enabling the pilot to aim the entire airplane. This ability gave birth to the "pursuit" or fighter. To gain superiority in the air, the airplane now hunted other airplanes. Over time, this new role demanded more sophisticated machines and combat techniques, and the men who flew the machines, as well as the machines themselves, became famous, dramatic symbols of knightly combat.

Soon, the airplane was also used as a bomber. Initially, pilots simply tossed small, handheld bombs or even darts from the cockpit. But the potential of destruction from the air quickly led to larger, more powerful, often multi-engine aircraft designed specifically for bombing. The size of the bombs themselves grew rapidly, and mechanical sights enabled aircraft to hit targets more accurately and from higher altitudes. Most aerial bombardment targeted enemy troops and facilities along the front, but the airplane also allowed the war to be carried to manufacturing and population centers far behind the lines. In 1915, Germany began Zeppelin raids against England. The Zeppelins—large, slow, rigid airships filled with explosive hydrogen gas—ultimately proved vulnerable to aerial defenses and were gradually replaced by giant multi-engine strategic bombers, the vanguard of future war.

By 11 November 1918, the end of the war, commanders had explored almost every role that the airplane would play in the future except global air transport. Although the airplane was not the decisive weapon of World War I, it had demonstrated its potential to change the way wars were fought.

The Flying Aces

French newsmen crowned Adolphe d'Hautpoul the first "flying ace" in 1915. In France and England, the title came to identify a pilot who had shot down five enemy airplanes. The Germans adopted a similar system that required ten victories. In any case, the airmen, especially the fighter pilots, quickly emerged as the great heroes of aninhuman war. The German airmen Manfred von Richthofen, the "Red Baron," led the pack with a total of 80 victories. The French ace René Fonck survived the war with 73 victories. With 58 victories, Edward "Mick" Mannock was England's most victorious ace, despite an infection that had caused him to experience temporary blindness and subsequent trouble seeing out of his left eye. Captain Edward Rickenbacker, a Medal of Honor winner and America's "Ace of Aces," scored 26 victories during a relatively short career as a combat pilot in 1918.

Flying the Mail

The Origins of Airmail in the United States

One of the federal agencies to recognize the valuable role airplanes could play was the U.S. Post Office. Faster mail delivery and increased reliability were becoming increasingly important to business people across the country, and they pressed the post office for the service.

On 15 May 1918, the first official airmail flight in the U.S. left Washington, D.C. heading for New York with 140 pounds of mail on board. Although the flight was not flawless, it proved the concept.

Over the next two years, a growing structure of communities along the Atlantic seaboard with Pittsburgh, Cleveland, and Chicago, thereby developing a relatively efficient air mail system in the eastern United States. In 1924, the transcontinental airmail route between San Francisco and New York was also established.

Although these flights between cities occurred routinely, the pilots, flying in open-cockpit aircraft, faced not only difficult weather conditions, but also narrow mountain passes and rugged terrain. They needed to climb thousands of feet above sea level, heights at which sudden snowstorms, emerald winds, subzero temperatures, and mountain peaks meant that only the most diligent of pilots would prevail.

While it may sound romantic, even exciting, this was a very inefficient way to deliver the mail, and by the mid-1920s, with the advent of effective navigational aids, better and more reliable communications and weather reporting systems, and enclosed aircraft with greater ceilings and all-weather capability, things began to change. The emphasis was on safety and reliability as well as speed, so the postal service worked to increase efficiency. Their next step was to undertake night operations, which required special searchlights to guide pilots, aircraft wingtip flares for forced landings, landing fields large enough to ensure adequate room for landings, searchlights actually mounted on air mail airplanes, and radio communications and other flight instruments. By 1924, the first coast-to-coast, day-and-night airmail service had been established.

In 1930, Congress passed legislation that allowed President Herbert Hoover's Postmaster General, Walter Folger, to realign the air routes. Exercising near-dictatorial powers, Brown engineered the merger of several carriers to create a national air system. From these mergers, grew the major U.S. airline companies—TWA, American Airlines, United Airlines, and Northwest Airlines—established and integrated a transcontinental route system.

Income from airmail contracts breathed life into the country's fledging commercial aviation industry in the 1920s and 1930s. Despite the Great Depression, the expansion continued through the World War II era, partly as a result of technological improvements in aircraft that allowed more economical operations.

Today, air mail is still an important market for the air transport industry, and airliners continue to carry mail as part of their cargo.

Airmail was an impractical sort of fad and had no place in the serious job of postal transportation. —Col. Paul Henderson, U.S. 2nd Asst. Postmaster General, 1919.
1911
September 29 Walter Brookins set American record by flying 92 miles from Chicago to Springfield, Illinois, making two stops.

1912
April 16 American Harriet Quimby became the first female pilot to fly a plane across the English Channel.

1914
January 13 The 51st Pennsylvania Artillery Line became the world’s first regularly scheduled airline service.

1917
Two-way radio contact was established between pilot and ground control.

1920s
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The origins of airmail in the United States

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NACA: A Tradition of Excellence

Spurred by the beginning of World War I and a heightened interest in aviation research, the United States Congress created the National Advisory Committee for Aeronautics (NACA) in 1915. In its early days, the NACA concentrated on problems related to military aviation. When the war ended, however, the engineers of the newly combined California Memorial Laboratory in Hampton, Virginia, turned their attention to the solution of a broad range of problems in flight technology. During the 1920s and 1930s, NACA engineers built a reputation for excellence in research and achieved a host of critical breakthroughs resulting in improved airplane design and performance. The NACA contributed to victory in WWII and pioneered the postwar research that transformed the airplane into a high-speed, high-altitude aerospace vehicle.

NACA would expand to encompass three research centers: Langley, Ames Research Center in California, and Lewis Research Center in Ohio. By 1958, these would employ over 8,000 people with a budget of over $117 million. They would contribute to the development of or improvements to every American aircraft produced during this time. NACA engineers and scientists were responsible for the basic and applied research that led to the development of aircraft structures, safety, fluid dynamics, aerodynamics, ground test facilities (including the slotted-throat wind tunnel), flight test high-speed flight from theory to practice (including the area rule to the X-1 and lifting body aircraft). The NACA was to make advancements and contributions in every field associated with aeronautics and the fledgling field of spaceflight.
Lindbergh—An American Eagle

Charles Lindbergh was only 22 months old in 1903 when the Wright brothers lifted their Wright Flyer off the ground at Kill Devil Hills, North Carolina. That event shaped Lindbergh’s life. Twenty-four years later, Lindbergh forever changed aviation and the world’s passion for flying—when he became the first person to fly solo nonstop across the Atlantic Ocean.

When he made the 3,600-mile flight from New York to Paris, the young man from Minnesota became an instant hero. He landed his high-wing monoplane, the Spirit of St. Louis, in Paris on 21 May 1927 to the cheers of 100,000 people. Blessed with movie-star good looks, resolute courage, and a passion for aviation, Lindbergh captured the world’s imagination. His love for flying was infectious, and its impact on popular culture was legendary.

Lindbergh and his exploits inspired everything from clocks and lamps to movies, books, plays, musical compositions, cartoons, and all manner of other memorabilia. A popular dance called the “Lindy Hop” was also named after him.

There is no doubt about Lindbergh’s instant fame. Following his flight, Lindbergh chose to use his newfound fame to promote what he was most passionate about—aviation. After returning from Paris, he flew the Spirit of St. Louis across the United States for three months to promote aviation and inspire support for its development.

Later that year, he toured Central and South America for Pan American Airways with the same mission; while in Mexico, he met his future wife, Anne Morrow.

Air Racing: Flying’s Golden Age

Lindbergh and his exploits inspired movies, books, plays, musical compositions, and all manner of other memorabilia. Poems were written, and hundreds of songs such as “Lucky Lindy” became popular.

Charles Lindbergh—The “Lone Eagle,” set records and attracted popular culture as no other flyer did.

For the Greatest Achievement:

The Collier Trophy was established in 1911 by Robert J. Collier, publisher and early president of the Aero Club of America. The trophy is awarded annually for the greatest achievement in aerodynamics or aeronautics in America, with respect to improving the performance, efficiency, and safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year.

It represents the most prestigious award offered in the United States for excellence in aerospace research and development and is administered by the National Aeronautic Association. It is named after Robert J. Collier, who stated: “The flying machine should be unselﬁshly and rapidly developed to its potential for America’s economic advancement.” As a demonstration of his belief, he was the ﬁrst person to purchase an airplane for private use from the Wright brothers. The ﬁrst winner of the trophy was Glen Curtiss, followed by the top individuals and organizations in the aerospace industry. NAAS received its ﬁrst trophy in 1929 for its research and development of a new cooling...
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First Ladies of Flight

The role women have played in the progress of aviation is punctuated by the achievements, many of them “firsts,” of hundreds of brave and determined aeronautical pioneers.

These pioneers included women like Juanita Pritchard Bailey, the first woman to fly a plane solo from the United States to Panama, and Evelyn “Bobbi” Trout, who, in 1929, became the first woman to complete an all-night flight.

The following year, Amy Johnson, considered by many to be Britain’s most famous female pilot, became the first woman to fly alone from England to Australia. In 1931, Anne Morrow Lindbergh, wife of Charles Lindbergh, became the first woman to receive a glider pilot’s license.

In 1937, Earhart embarked upon a journey that, had it been successful, would have given her the distinction of being the first woman to fly around the world. The mystery of her disappearance during that flight, along with that of her navigator and plane, remains to this day a matter of debate. It was Geraldine Mock who, in 1964, flew a single-engine Cessna 180, completed this circumnavigation, becoming the first woman to do so.

Earhart also has the distinction of being the first president of The Ninety-Nines, an organization that was formed in 1929 and still exists today. The name comes from the total number of the group’s charter members, licensed female pilots who came together to create an entity that would help advance aviation and provide a vehicle for female pilots to support each other. Today, The Ninety-Nines, Inc., boasts over 6,500 members worldwide.

Jackie Cochran, a former beautician from Florida, served as president of The Ninety-Nines between 1941 and 1943. She was also the first female pilot to ferry a bomber across the Atlantic, and in 1943, she was appointed director of the Women’s Airforce Service Pilots (WASP). The WASPs were approximately 1,000 civilian women who, as the United States entered World War II, delivered aircraft to combat areas all over the world. Though the program was deactivated only sixteen months after its inception, it was and still is considered a success. Cochran was awarded the Distinguished Service Medal and the USAF Legion of Merit for her service.

Rightfully called America’s leading female pilot, Cochran is also remembered as the first woman to break the sound barrier; she did that in 1953.

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U.S. government accepted the Wright aircraft in 1909.

1928
June 28–29 Albert Hegenberger and Lester Maitland accomplished the first nonstop crossing of the Pacific.

1929
Fritz von Opel of Germany flew the first rocket-powered plane for 1 minute, 15 seconds.

1931
June 23–July 1 Wiley Post and Harold Gatty completed the first circumnavigation of the world by a lone aircraft.

1932
May 20–21 Amelia Earhart became the first woman to fly solo across the Atlantic.

1935
November 22 Pan American Airways made the first Pacific mail service route, leaving San Francisco with 111,000 letters.

1939
December The first Douglas DC-3 flew. By 1938, it carried the bulk of American air traffic.

1939
June 28 Pan American Airways flew the first transatlantic passenger service.

1959
U.S. Air Force

1964, flying a single-engine Cessna 180, completed this circumnavigation, becoming the first woman to do so.

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Left: Bessie Coleman became the first African American female pilot when she received her pilot’s license from the Fédération Aéronautique Internationale. Today’s global U.S. Air Force grew from the Aeronautical Division and this first airplane, but the road to independence was tortuous. The U.S. Army established the Air Service in May 1918, and in 1926, the Air Service became the U.S. Army Air Corps.

Creation of the U.S. Army Air Forces in 1941 provided the autonomy necessary for victory during World War II. The U.S. Air Force achieved full independence on 18 September 1947.
First Ladies of Flight

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As for heavier-than-air craft, Army leaders gave Samuel P. Langley $50,000 for construction of a full-sized “aerodrome” in 1898. Langley failed to fly, but fly Army interested in aviation continued. Its leaders began correspondence with the Wright brothers in May 1907, established an Aeronautical Division in August, and prepared requirements for a military airplane in December. The Army accepted the Wrights’ bid in February 1908. Trials began later in the year, but a crash delayed the results. The U.S. Army ultimately accepted Signal Corps No. 1 on 2 August 1909.

Today’s global U.S. Air Force grew from the Aeronautical Division and this first airplane, but the road to independence was tortuous. The U.S. Army established the Air Service in May 1913, and in 1926, the Air Service became the U.S. Army Air Corps. Creation of the U.S. Army Air Forces in 1941 provided the autonomy necessary for victory during World War II. The U.S. Air Force achieved full independence on 18 September 1947.
Air Power in World War II

Air power played a crucial role in almost every aspect of World War II. Germany’s air force, the Luftwaffe, supported the Nazi ground forces early in the war as they devasted western Europe. The scream of Stuka dive-bombers heralded Blitzkrieg, which dominated the early conflict. The Luftwaffe was ill-equipped to fight England, however, and the tide began to turn when Britain’s Royal Air Force (RAF) defeated it during the now-famous Battle of Britain. “Achtung, Spitfire!” became terrible words for German pilots.

The United States entered World War II on 7 December 1941, when the Japanese conducted a surprise air attack on the American naval base at Pearl Harbor, Hawaii. However, although the Japanese drew the U.S. into the war, early planning made Germany the primary foe. The RAF began with a bombing campaign conducted mostly at night against German cities. It was soon joined by the mighty Eighth Air Force of the U.S. Army Air Forces (USAAF), which specialized in high-altitude, daylight attacks on German industrial targets. Over the skies of northwest Europe, great bomber fleets of the Combined Bomber Offensive attacked the Third Reich, with B-17s, B-24s, and RAF Lancasters and Wellingtons pounding Germany’s industry, transportation, and communications around the clock. The strategic bombing campaign devastated the Nazi transportation system and cut the enemy’s oil production. In February 1944, during “Big Week,” the Luftwaffe contested the European skies, and as a result, the American escort fighters took a heavy toll on the German Air Force—a turning point in the war over Europe.

Moreover, allied strategic and tactical air forces, as Supreme Commander Dwight D. Eisenhower emphasized, made safe the invasion of the Continent on 6 June 1944 by defeating the Luftwaffe prior to D-Day and by reducing the enemy’s ability to reinforce the battlefield. In his words, “Unless we had faith in air power as a fighting arm to intervene and make safe that landing, it would have been more than fantastic, it would have been criminal.”

In addition to the strategic bombing campaign, the Allied tactical air forces made a major contribution to the European victory through their enormous support of the ground forces as they fought their way eastward into Germany. Victory in Europe on 8 May 1945 was in so many ways a victory for air power.

Not all bombs that fell from airplanes during the war were destructive. One in particular, the “Monsore Bomb,” named after its inventor, U.S. Army Air Force Captain James Monsore, employed the explosives of psychological warfare—propaganda愚蠢的宣传—dropping hundreds of thousands of them over broad areas from planes like the B-17 and B-24.

*By day and by night, with United Strength,* from the World War II propaganda leaflet collection of Ian V. Hocial, see http://www.doolittleraid.com/pamphlet.html

The Hawker Hurricane is a British fighter plane.

The Tuskegee Airmen

In July 1941, the Army Air Corps began a program to train Black Americans as military pilots. The military selected Tuskegee Army Air Field to complete flight training and transition to combat-type aircraft. “Tuskegee Airmen” included pilots, navigators, bombardiers, maintenance and support staff instructors, and all the personnel who kept the planes in the air.

The Tuskegee Airmen exemplified courage, skill, and dedication in combat. They flew more than 15,000 sorties, completing over 1,500 missions during the war. Equipped with their red-tailed P-51 Mustangs, the pilots of the 332nd Fighter Group never lost an escorted bomber to enemy fighters—a record only the Tuskegee Airmen can claim.

American bomber crews, reverently referred to them as “The Black Redtail Angels” because of the identifying red dot on their tail assemblies. Feared and respected by the Germans, the Airmen were known as the “Schwarze Vogelwesen” (“Black Bird Beast”). At the end of the war, the Tuskegee Airmen returned home with numerous awards for gallantry in the air and dignity on the ground. They were honored by President Franklin D. Roosevelt, who became the first chief executive to make a wartime flight with the men.

Because spectators never knew from which direction airplanes would come, they were trained to quickly look for the shape of the wing, the number of engines, the forward profile, and any other markings on the plane that would enable them to quickly identify it. Each spotting card showed several perspectives of the plane it represented, along with the plane’s markings.

On 7 December 1941, the Japanese attack on Pearl Harbor started the United States into World War II, and the U.S. military began to plan for air power to be a major factor in any conflict. General George Kenney, commander of the Allied Air Forces in the Pacific, knew that air power could be the key to victory. He emphasized the importance of air power to the Allied victory in Europe and helped shape the role of air power in the Pacific. Kenney believed that air power was crucial to the success of any military operation, and he worked to ensure that the Allied air forces were equipped with the latest technology and trained to use it effectively.

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Air Power in World War II

■ Air power played a crucial role in almost every aspect of World War II. Germany's air force, the Luftwaffe, supported the Nazi ground forces early in the war as they devastated western Europe. The scream of Stuka dive-bombers heralded Blitzkrieg, which dominated the early conflict. The Luftwaffe was ill-equipped to fight England, however, and the tide began to turn when Britain's Royal Air Force (RAF) defeated it during the now-famous Battle of Britain. "Achtung, Spitfire!" became terrible words for German pilots.

The United States entered World War II on 7 December 1941, when the Japanese conducted a surprise air attack on the American naval base at Pearl Harbor, Hawaii. However, although the Japanese drew the U.S. into the war, early planning made Germany the primary foe. The RAF began with a bombing campaign conducted mostly at night against German cities. It was soon joined by the mighty Eighth Air Force of the U.S. Army Air Forces (USAAF), which specialized in high-altitude, daylight attacks on German industrial targets. Over the skies of northwest Europe, great bomber fleets of the Combined Bomber Offensive attacked the Third Reich, with B-17s, B-24s, and RAF Lancasters and Wellingtons pounding Germany's industry, transportation, and communications around the clock. The strategic bombing campaign devastated the Nazi transportation system and cut the enemy's oil production. In February 1944, during "Big Week," the Luftwaffe contested the European skies, and as a result, the American escort fighters took a heavy toll on the German Air Force—a turning point in the war over Europe.

Moreover, allied strategic and tactical air forces, as Supreme Commander Dwight D. Eisenhower emphasized, made safe the invasion of the Continent on 6 June 1944 by defeating the Luftwaffe prior to D-Day and by reducing the enemy's ability to reinforce the battlefield. In his words, "Unless we had faith in air power as a fighting arm to intervene and make safe that landing, it would have been more than fantastic, it would have been criminal."

In addition to the strategic bombing campaign, the Allied tactical air forces made a major contribution to the European victory through their enormous support of the ground forces as they fought their way eastward into Germany. Victory in Europe on 8 May 1945 was in so many ways a victory for air power.

Not all bombs that fell from airplanes during the war were destructive. One in particular, the "Morneau Bomb," named after its inventor, U.S. Army Air Force Captain James Monroe, employed the weapons of psychological warfare—propaganda leaflets dropped on enemy territory. In addition to their destructive potential, these leaflets were designed to demoralize the enemy and undermine his will to continue the war.

By day and by night, with United Strength, "By Day and by Night, with United Strength," from the World War II propaganda leaflet collection of Hans Moonen; see http://www.coldwarPROPAGANDA.com

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During World War II, the aircraft spotter provided an invaluable service on the ground. These volunteer civilians kept a close watch for enemy aircraft that might appear in the skies overhead, skies that were sometimes filled with planes flying from one point to another on training missions or to and from bases. It was an important aspect of defense to be able to distinguish quickly and accurately between friendly and enemy aircraft. Spotters used "spotter cards" to help them do the job.

Because spotters never knew from which direction airplanes would come, they were trained to quickly look for the shape of the wing, the number of engines, the forward profile, and any other markings on the plane that would enable them to quickly identify it. Each spotter card showed several perspectives of the plane it represented, along with the plane's markings.

The Hawk is a British fighter plane.
No matter what nickname they go by, modern helicopters are amazingly versatile aircraft with the ability to lift directly off the ground and fly without the need for a runway.

The concept of vertical flight can be traced to the Chinese top, a toy first used around 400 B.C. By the mid-1500s, Leonardo da Vinci was sketching helicopter-like machines.

In 1907, French engineer Paul Cornu managed to lift a helicopter he designed into the air for 20 seconds. Though not a long flight, it was enough to stimulate other designers, who made great advances in helicopter design.

It was not until 1939 that the first successful helicopter flight took place in the United States. Igor Sikorsky, a Russian-born U.S. citizen who is known as the "Father of the Helicopter," flew his VS-300 and launched a lucrative business that provided helicopters for World War II, Korea, and Vietnam.

Today, aircraft manufacturers continue to adapt their machines to the market's desire to get there faster, more efficiently, and more comfortably.

Breaking the Sound Barrier

The Concorde supersonic transport was the result of a partnership between the French and British governments. Only 16 Concordes were built, but given its ability to travel at Mach 2.2 (over twice the speed of sound) at an altitude of 50,000 feet, flying the Concorde became an incredible experience for its passengers.

One of the greatest beneficiaries of jet development was commercial aviation, and by the 1960s, passenger jets were eclipsing ships and trains as the dominant mode of passenger transport.

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■ With the advent of jet technology, the world of aviation was again on the edge of change. This time, the changes would revolutionize military as well as civilian aircraft and turn the business of passenger transport into a race to see which airline could carry the most people the greatest distance in the least amount of time.

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The U.S. Air Force Academy was created.

The Berlin Blockade and airlift proved the power of airplanes to help resolve diplomatic crises.

Scott Crossfield became the first pilot to fly the X-10, a supersonic research aircraft.

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Break the sound barrier

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### Choppers. Copters. Whirlybirds.

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Today, helicopters are used for transporting accident victims, crop seeding, traffic reports, aerial photography, fighting forest fires, rescues at sea, lifting construction materials for skyscraper construction, and hundreds of other practical applications. This fascinating machine that can take off and land vertically; hover in midair; and fly forward, backward, sideways, or straight up and down is as indispensable as it is versatile.

In 1939, the first successful flight of a helicopter was accomplished in the United States by Igor Sikorsky.

### Passenger Jets

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The flying machines will eventually be fast; they will be used in sport, but they should not be thought of as commercial carriers. —Octave Chanute, 1910

Breaking the Sound Barrier

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Air Force Test Pilot Captain Charles E. "Chuck" Yeager broke the "sound barrier" for the first time by flying Mach 1.06 on 14 October 1947. This first supersonic, or above Mach 1, flight occurred at 43,000 feet above California's Mojave Desert in the bright orange air-launched, rocket-powered Bell X-1 aircraft named Glamorous Glennis in honor of his wife. Mach is the ratio of the speed of an object to the speed of sound. The speed of sound varies with pressure and temperature, so at sea level, Mach 1 is about 760 miles per hour and at 35,000 feet, it is about 660 miles per hour.

The Bell X-1 named Glamorous Glennis.
Dawn of the Space Age

The National Aeronautics and Space Administration (NASA) was formed with President Dwight D. Eisenhower's signing of the National Aeronautics and Space Act of 1958. The NASA and parts of other agencies formed its core; its purpose was research and development for the exploration of space. NASA's decision was in large part due to some measure because of the pressures of national defense during the Cold War with the Soviet Union, a broad context over the ideologies and allegiances of the nonaligned nations of the world in which space exploration emerged as a major area of interest.

Space race took hold, as the Soviet Union, in a broad context over the ideologies and allegiances of the nonaligned nations of the world, had launched the world's first satellite on 4 October 1957. This event precipitated a wave of international interest in space exploration and technology development. A United Nations scientific conference in July 1958 called for a peaceful use of space. The United States and other nations responded by investing in research and development programs aimed at achieving spaceflight capability.

Testing the Boundaries

A desire to expand the capabilities of aircraft led airplane designer Burt Rutan to the ambitious idea of building an airplane that could fly around the world without refueling. His Voyager achieved the task.

A Typical Day in Space

It's human nature to stretch, to go, to see, to understand. Exploration is not a choice, really; it's an imperative.

—Michael Collins

Exercising, doing nothing (yes, "breaks" are also scheduled), and eating. Some astronauts even like the food, though it does have to be reconstituted from its dehydrated state. Menu items like shrimp cocktail, scrambled eggs with bacon, and beefsteak burritos are pretty normal fare while in orbit.

The X-15: Bridging the Gap

In the X-15 program, the Air Force, NASA, Navy, and North American Aviation embarked upon a new frontier—exploring the possibility of a piloted, rocket-powered, air-launched aircraft capable of speeds about five times that of sound. Between 1959 and 1969, in 199 flights, the X-15 demonstrated the human desire to fly higher, faster, and beyond Earth's atmosphere. On 22 August 1963, the X-15 set an altitude record of 354,200 feet (67 miles). Four years later, the aircraft set a speed record of Mach 6.7 (4,520 miles per hour).

The X-15 rocket-powered aircraft under the wing of a B-52, waiting to be air-launched. This photo was taken from an observation window in the B-52 shortly before dropping the X-15.

Unconventional Methods of Flight

A bird's ability to fly, powered by its own musculature system, has, for thousands of years, inspired humanity's desire to fly and especially to achieve flight without the use of anything other than muscle power.

Paul H. MacCready envisioned, designed, and built the human-powered Gossamer Condor, a 70-pound craft with a wing span of 50 feet. On 3 April 1988, the 69-pound Daedalus 88 made the flight between the island of Crete and the island of Santorini, a distance of 115.11 kilometers, or 71.53 miles. Over the next 15 years, the lightweight human-powered aircraft evolved into lightweight, high-altitude, solar-powered aircraft. This series of research aircraft set numerous records, culminating in the recordbreaking flight of the Helios aircraft to 96,863 feet over Hawaii during 2001. This lightweight, unpiloted, propeller-driven, solar-powered, 247-foot-long aircraft is a prototype for future long-duration, high-altitude flights spending days aloft, using only the Sun for power, either directly or through new advanced fuel cells that store the Sun's energy. This high-flying wing could significantly enhance scientific missions studying Earth, assist farmers, act as a telecommunications platform, enhance weather observation, and provide disaster monitoring and emergency response.
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The space age actually began before the creation of NASA. From the latter 1940s, the Department of Defense pursued research, rockets and aerodynamics, as a means of ensuring American leadership in technology. A major step forward came when President Eisenhower approved a plan to orbit a scientific satellite as part of the International Geophysical Year (IGY), a cooperative effort to gather scientific data about Earth. The eighteen-month period from 1957 to 1958. The Soviet Union quickly followed suit, announcing plans to orbit its own satellite. The Naval Research Laboratory’s Project Vanguard was chosen on 9 September 1955 to support the IGY effort, largely because it did not interfere with high-priority ballistic missile development programs, while an Army proposal to use the Redstone ballistic missile as the launch vehicle failed in the wings. The technological demands upon the Vanguard program were too great and the funding levels too small to ensure success.

A full-scale competition when the Soviets launched Sputnik 1, the world’s first artificial satellite, on 4 October 1957. This had a dramatic effect on American public opinion, creating an illusion of a technological gap, and provided the impetus for increased spending for aerospace endeavors, technical and scientific educational programs, and the chartering of new federal agencies to manage research and development.

The United States launched its first Earth satellite on 31 January 1958, when Explorer 1, launched atop a modified Redstone, documented the existence of radiation zones encircling Earth. These zones, shaped by Earth’s magnetic field, came to be called the Van Allen Radiation Belt. This mission began a series of flights to the Moon and planets.

Methods of Flight

The X-15:

Bridging the Gap

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The vehicle provided the platform for many scientific and technological studies. With an exterior skin of a nickel-chrome alloy that could withstand extreme heat, (over 1,000°F) and a structure specially designed for the harsh unknown environment encountered at hypersonic speeds, the vehicle was able to carry out scientific research and survive. This research helped prove that a pilot could master the skills required for flight into space, even the ability to function in a weightless environment.

The program also resulted in the first full-pressure suit to protect pilots in space, metal alloys that could survive high temperatures, new electronic and control methods, including a reaction control system to effect maneuvering in the thin atmospheres of near space, and knowledge of high-speed flight.

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Paul B. MacCready envisioned, designed, and built the human-powered Gossamer Condor, a 70-pound craft with a wingspan of 31 feet. For sale of aluminimum, mylar, corrugated cardboard, and styrene foam. In 1977, the Condor flew 1.35 miles in just eight minutes, its average speed between 10 and 11 miles per hour.

In 1979, the Gossamer Albatross was “pedaled” from England to France, making the first complete human-powered aircraft to cross the English Channel. Inspired by the Greek myth of Daedalus and Icarus, the Daedalus Project was conceived to fly a human-powered aircraft nearly 100 miles. On 3 April 1988, the 69-pound Daedalus 88 made the flight between the island of Crete and the island of Santorini, a distance of 115.11 kilometers, or 71.53 miles. Over the next 15 years, the lightweight human-powered aircraft evolved into lightweight, high-altitude, solar-powered aircraft. This series of research aircraft set numerous records, culminating in the record-breaking flight of the Helios aircraft to 96,863 feet over Hawaii during 2001. This lightweight, propeller-driven, solar-powered, 247-foot-long aircraft is a prototype for future long-duration, high-altitude flight missions and aloft using only the Sun for power, either directly or through new advanced fuel cells that store the Sun’s energy. This high-flying wing could significantly enhance scientific missions studying Earth, assist farmers, act as a telecommunications platform, enhance weather observation, and provide disaster monitoring and emergency response.

Testing the Boundaries

A desire to expand the capabilities of aircraft led airplane designer Burt Rutan to the ambitious idea of building an airplane that could fly around the world without refueling. His Voyager achieved the task. Rutan used a ultralight graphite composite for the plane, designing it with long, ribbed wings that would, along with other frame areas, be filled with fuel. In fact, three-fourths of the Voyager’s total weight was composed of fuel.

On 29 December 1986, Voyager completed a nine-day flight that ended in California. The Voyager had circumnavigated the world, a nonstop trip of 25,000 miles, without refueling.

A Typical Day in Space

It’s human nature to stretch, to go, to see, to understand. Exploration is not a choice, really. It’s an imperative. —Michael Collins

Exercising, doing nothing (yes, “breaks” are also scheduled), and eating.

Some astronauts even like the food, though it does have to be reconstituted from its dehydrated state. Menu items like shrimp cocktail, scrambled eggs with bacon, and beefsteak burritos are pretty normal fare while in orbit.

Being an astronaut means being well trained and ready to perform whatever task the mission commander assigns. Just like jobs on Earth, there’s a boss. This boss, however, probably doesn’t mind too much when employees are seen staring off into space.

Guy Bluford served on four Shuttle missions—STS-6, STS-61-A, STS-39, and STS-53.
To the Moon: Apollo

As an effort to offset world perception of Soviet leadership in space and technology, President John F. Kennedy made a public commitment on 25 May 1961 to land an American on the Moon by the end of the decade. Following the devastating Apollo 1 capsule fire in January 1967, the first Apollo mission of public significance was the circumlunar flight of Apollo 8.

As that mission orbited the Moon on Christmas Eve 1968, the nation united as one, if only for a few moments, to witness this epochal event.

The flight of Apollo 11, lifting off on 16 July 1969, made the epic voyage to land on the Moon. On 20 July 1969, the Lunar Module, with astronauts Neil A. Armstrong and Buzz Aldrin aboard, landed on the lunar surface while Michael Collins orbited overhead in the Apollo command module. These astronauts were the first humans ever to reach another world. Armstrong was first to set foot on the surface, telling millions on Earth who saw and heard him that it was “one small step for [a] man—one giant leap for mankind.” Aldrin soon followed him out, and the two plodded around the landing site in the lunar gravity (1/6 of Earth’s) and planted an American flag.

Five more landing missions followed at approximately six-month intervals through December 1972 (in addition to the aborted Apollo 13 flight), each of them spending an increasing amount of time on the Moon. The scientific experiments placed on the Moon and the lunar soil samples returned have provided grist for scientific investigations ever since.

Apollo left several important legacies: it accomplished its political goals, it was a triumph of management in the enormously difficult systems engineering and technological integration requirements; and it enabled the people of the world, for the first time, to see their home from afar—a tiny, lovely and fragile “blue marble” hanging in the blackness of space.

Higher and Faster

Flight has fired the world’s imagination with two words: speed and altitude, the pantheon of flying. The attainment of these feats depends on multiple complex factors. Generally, the reasons to strive for faster planes capable of greater altitude are practical, rather than heroic or poetic.

After the first successful supersonic flight in 1947 by the X-1, a series of milestones were accomplished by research pilots flying aircraft designed to test the boundaries of speed and altitude. Later, the Navy and NASA developed the D-558, which first flew Mach 2 on 30 November 1953.

With the Bell X-2 of the mid-1950s, pilots had a vehicle whose powerful rocket engine could reach speeds in excess of Mach 3. At such high speeds, air friction heated the aircraft’s skin sufficiently to cause it to reach certain temperature limits; therefore, it was made of an advanced, lightweight, heat-resistant alloy. The X-2 flights of Apollo 11, lifting off on 16 July 1969, made the epic voyage to land on the Moon. On 20 July 1969, the Lunar Module, with astronauts Neil A. Armstrong and Buzz Aldrin aboard, landed on the lunar surface while Michael Collins orbited overhead in the Apollo command module. These astronauts were the first humans ever to reach another world. Armstrong was first to set foot on the surface, telling millions on Earth who saw and heard him that it was “one small step for [a] man—one giant leap for mankind.” Aldrin soon followed him out, and the two plodded around the landing site in the lunar gravity (1/6 of Earth’s) and planted an American flag.

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Air Power and the Cold War

The Cold War began in the aftermath of World War II as a struggle between the Soviet Union and the United States over the future of Europe, and ultimately spread to most parts of the globe. The opponents sought to influence events through non-military means, but at times, in Korea in the early 1950s and Vietnam in the 1960s, it flared into armed conflict. Throughout, air power played a defining role.

U.S. air power and its ability to deliver nuclear weapons counterbalanced the massive Soviet ground forces. Following World War II, the U.S. continued to develop the strategic air power that dominated the skies over Europe and Japan. The massive B-36 provided early deterrence, giving way during the 1950s to the B-47, B-52, B-58, and, much later, the stealthy B-1 and B-2. Intercontinental Ballistic Missiles (ICBMs) began entering service in the late 1950s, and rockets like Atlas, Titan, Minuteman, and Peacekeeper played roles in deterrence.

As power served the U.S. as a platform for electronic and photographic intelligence. Aircraft flew at the periphery of the Soviet Union, photographing installations, collecting signals, and locating radar systems. Aircraft like the U-2 and SR-71 achieved fame until reconnaissance satellites during the 1960s took responsibility for many of these dangerous missions.

The U.S. also developed global air transport, enabling it to project power around the world and provide humanitarian airlift to peoples in distress using C-130, C-141, and giant C-5 aircraft. Global air transport demonstrated its importance early during the Berlin Airlift in 1948–49, when it gave the West its first great victory of the Cold War.

The U.S. nuclear advantage and development of air power over the economies of the western nations to grow without the excessive burden of military spending faced by the Soviet Union and its satellites, which maintained huge ground armies throughout the Cold War and, at the same time, attempted— with considerable success—to match U.S. strategic power. The Soviets achieved military parity by the 1970s, but at terrible cost to the Soviet economy. Militarization of the Soviet Union and its satellites strained economic development and undermined political stability. The decision of the U.S. and its allies to entrust their security to nuclear weapons and air power paid off with the collapse of the Soviet bloc and the end of the Cold War in 1991.

We can lick gravity, but sometimes the paperwork is overwhelming. —Attributed to Wernher von Braun

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1966</td>
<td>March 16–17: Neil Armstrong and David Scott performed the first orbital walking.</td>
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<td>1967</td>
<td>December: Apollo 8 circumnavigated the Moon.</td>
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<tr>
<td>1968</td>
<td>March 2: The first Concorde flight occurred.</td>
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<td>1961</td>
<td>The Concorde prototype and Boeing 747 first flew.</td>
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<tr>
<td>1963</td>
<td>President Kennedy assassinated.</td>
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<td>1966</td>
<td>The first human being to travel in space.</td>
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<tr>
<td>1969</td>
<td>Woodstock Pop Festival held in upstate New York.</td>
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The X-15 aircraft set an altitude record of 47 miles. Astronauts Gus Grissom, Roger Chaffee, and Ed White died in the Apollo 1 capsule fire during a ground test in preparation for their launch.

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Test Pilot School

The U.S. Air Force Test Pilot School at Edwards Air Force Base in the Mojave Desert was established to improve weapon systems testing. The fundamental key to success in weapon systems testing is the capability, knowledge, and skill of the flight test pilot. Without him and, increasingly, her—the work of the Air Force Flight Test Center would be impossible. It is through flight testing that test pilots determine whether an aircraft will be suitable for its intended mission. The school teaches flight test techniques for evaluating aircraft performance, flying qualities, and systems characteristics. Today's test pilots are responsible for determining the viability of a new generation of extremely sophisticated aircraft weapon systems that include lasers capable of destroying missiles, unimplanted craft that drop bombs and eavesdrop inside enemy lines, and aircraft that fly like cargo planes but take off like helicopters.

As part of their training, pilots and engineers fly about twenty different aircraft. Graduates will fly the newest prototype Air Force aircraft and weapon systems, including fighters, attack, bomber, reconnaissance, cargo, and helicopter aircraft. Some alumni become NASA astronauts. The U.S. Navy operates a similar school in Maryland.

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Right: Titan II ICBM rocket.
Before the 1970s, powered flight was a thing of the past. But in 1970, April 13, the X-15 became a "success failure" when, despite a ruptured oxygen tank that crippled the spacecraft, the crew safely returned to Edwards Air Force Base. October 24, the X-24A lifting body exceeded Mach 1.

1971
- April 19: Soviet Union placed the world's first space station, Salyut 1, in orbit.
- NASA launched Skylab 1, the first remote sensing satellite.
- Apollo 13 became a "successful failure" when, despite a ruptured oxygen tank that crippled the spacecraft, the crew returned safely.

1972
- October 24: The X24A lifting body exceeded Mach 1.
- NASA launched Landsat 1, the first remote sensing satellite.
- 2.5-million-year-old human skull discovered.

1973
- November 7: "Star Wars" was released.

1974
- October 30: The Airline Deregulation Act was signed into law.

1975
- TCP/IP (Internet protocol) designed.

1976
- The Future of Flight
- Small, Personal Aircraft
- Imagine being able to plan an entire trip, home to destination, on the Internet: you drive to your local airport—not the major hub of today; board a small jet aircraft; and, in a matter of hours, arrive at your destination. NASA and industry are currently involved in a research project to determine the possibility of using small, personal aircraft to create a safe alternative for both business and personal travel. At the 99 percent of all airports that are currently undersized, small aircraft could be used to carry people and products safely and affordably from one local community airport to another. Delays and travel time would be reduced as a result of creating greater air access into more communities in less time. This provides the flying public with jet-like performance at an affordable cost.

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1979
- June 13: The Gossamer Albatross human-powered aircraft crossed the English Channel. The F-16 became the first production military aircraft to incorporate a fly-by-wire flight control system.
- June 11: The F-15, the most advanced fighter aircraft in the world, was flown for the first time.

1980
- May 27: The F-22 Raptor, (USAF) was unveiled. The F-22 Raptor is the most advanced fighter aircraft in the world, F-22 is now being tested at Edwards Air Force Base. The Raptor is a revolutionary leap in aircraft technology that unites advanced capability with reduced maintenance costs and support requirements. The F-22’s combination of stealth, advanced avionics, and maneuverability will give pilots a first look, first shot, first kill capability against the aircraft of any potential enemy.

Proposed box wing aircraft concept.

The aeroplane has unveiled for us the true face of the earth. —Antoine de Saint-Exupéry

The Future of Flight

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Looking Up

As the nation’s air traffic increases, the ability of the airspace system to handle the traffic is being stressed. Realizing that we will soon be operating at capacity, NASA and the aviation industry are investigating solutions to the problems of airspace and runway congestion. The Civil Tiltrotor aircraft may provide an answer. Regardless of size, all airplanes require valuable runway space for takeoff and landing. These unique aircraft fly like an airplane but tilt their wing-mounted engines and propellers, enabling them to take off and land much like a helicopter, thereby reducing the need for runway space to become airborne. The versatility of tiltrotors would meet the needs of short-haul and commuter flights and would free up valuable time on the runway for large aircraft. NASA and industry have developed advanced technologies to make tiltrotor aircraft easier to operate, quieter, more efficient, and safer to use than previous tiltrotors.

Bell/Agusta BA 609 Tiltrotor. Tiltrotors can land in a parking lot and cruise at over 300 miles per hour.
1970 April Apollo 13 became a "successful failure" when, despite a ruptured oxygen tank that crippled the spacecraft, the crew returned safely.


1971 Soviet and American spacecraft docked in orbit during the Apollo-Soyuz Test Project.

1971 April 19 Soviet Union placed the world's first space station, Salyut 1, in orbit.

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1979 M. Tushar first female elected Prime Minister (UK).

1972 2.5-million-year-old human skull discovered.

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1972 At the other end of the spectrum are unpiloted aerial vehicles such as the Helios Prototype (p. 19) and unpiloted combat air vehicles whose use could prevent losses of personnel in extremely hazardous situations. Additionally, the "Morphing Project" is exploring highly adaptable airplanes with flexible, bird-like wings that will allow for even greater safety, efficiency, and versatility.

The future of flight is as full of promise and excitement as it must have been decades ago, to those who first took to the skies in powered flight. The possibilities are boundless.

Small, Personal Aircraft

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The future, now small, efficient jet airplanes that are easy to fly like the Eclipse 500.

■ The future of flight may include aircraft capable of responding to changes in speed or environmental conditions by altering or "morphing" their shape. The wings of these aircraft would sweep back and reconfigure to minimize drag and sonic boom. The engine inlets and nozzles would adapt to new conditions. Small jets of air and feather-like surfaces would provide additional control. Morphing would include small changes, using structures and fluids for control. NASA and industry researchers are looking closely at the characteristics of flight in birds to develop a new generation of flying machine that changes itself to fly more efficiently. This new type of aircraft would be capable of various modes of flight from supersonic to hover.

Some of the current areas of research include developing smart materials, adaptive structures, and biologically inspired flight systems. Instead of the traditional jet engine location on an aircraft's body or wings, scientists are investigating the effects of using multiple small engines to power these aircraft. The results from this research may provide technologies for aerospace vehicles that efficiently adapt to the diverse and varying conditions of flight.

The F-22 Raptor

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The F-22 combines advanced supersonic flight with the ability to fly at slow speeds during combat, pointing its nose in any direction without loss of control. Integrating systems like radar and friend-or-foe identification into one cohesive platform, the Raptor is designed to provide superior air superiority and dominate to allow quick, decisive victory with few U.S. and allied casualties. This impressive aircraft will replace the F-15 as America's front-line air fighter.

F-22 Raptor (USAF)

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The F-22 Raptor
Flying to and from Earth Orbit: The Space Shuttle

As the Apollo lunar landing missions came to a close, NASA's major effort in human spaceflight involved the development of a reusable Space Shuttle that could travel back and forth between Earth and space more routinely and economically than had ever been done before. After nearly a decade of development, on 12 April 1981, the first operational orbiter, Columbia, was launched from the Kennedy Space Center, Florida. Five short years later, in 1986, NASA had chalked up twenty-four successful Shuttle flights. With each flight, NASA increased the number of people who could fly in space and contribute to a revolution in scientific understanding of the effects of long-duration, near-weightless conditions on all types of organisms.

Unfortunately, during the twenty-fifth Shuttle launch on 28 January 1986, a leak in the joints of a Solid Rocket Booster attached to the Challenger orbiter detonated the main liquid fuel tank. Seven astronauts died in this tragic accident. Out of this tragedy, an extensive evaluation and redesign effort placed the Space Shuttle on the road to becoming the safest and most reliable space system.

The redesigned Space Shuttle system returned to flight on 29 September 1988. Since returning to flight, the four orbiters, Atlantis, Columbia, Discovery, and Endeavour, have made more than eighty-five flights into space. Throughout the Shuttle era, the four orbiters have been workhorses of space exploration for both international and domestic projects.

The Space Shuttle has launched numerous scientific satellites and undertaken scientific and technological experiments ranging from Spacelab to a dramatic 72,000-mile nonstop flight around the world. The Shuttle is also instrumental in the servicing of the Hubble Space Telescope. Between April 1981 and the end of 2002, the Space Shuttle carried approximately 2.9 million pounds of cargo and more than 8000 major payloads into orbit.

In the beginning of the twenty-first century, the Space Shuttle is still the only vehicle in the world with the capability to deliver and return large payloads to and from orbit. It is the most reliable launch system now in service, with a success rate of better than 99 percent. The Space Shuttle remains one of the most successful and impressive technologies in American history. It is a reliable, mature, and flexible system on which stunning scientific experiments are launched and conducted.

The International Space Station

From virtually the beginning of the twentieth century, those interested in the exploration of space viewed as central the building of a massive Earth-orbital space station to serve as the jumping-off point for travel to other planets and to the Moon. Always, space exploration enthusiasts believed that a permanently occupied space station was a necessary outpost in the new frontier of space.

Skylab, the first flight of the YF22 fighter prototype was made by Lockheed test pilot Dave Ferguson. October 11 The first flight of the X-31, YF22, and YF23 took place.
Flying to and from Earth Orbit: The Space Shuttle

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Early next decade, a new generation of launch vehicles could be flying. These new vehicles will significantly reduce cost and dramatically increase safety for the human exploration and development of space.

The International Space Station

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The International Space Station promises to become the anchor tenant of a research park in space, contributing critical knowledge necessary to make life on Earth more rewarding and to aid humanity’s move beyond this planet. It is an idea whose time has come.
The air, as well as the earth and the ocean, has been subdued by science, and will become a common and convenient highway for mankind. —Edgar Allen Poe

Understanding the Changing Earth

Disturbances, and track movements and patterns. It provided new levels of precision to the evaluation of pressure fronts and air masses that are so critical for weather forecasting. Likewise, meteorological research beyond weather forecasting took on new life as climatological research contributed significant insights to our understanding of Earth. NASA launched the first Earth science satellites, Landsat 1, on 23 July 1972 to provide data on vegetation, insect infestations, crop growth, and associated land-use information. Since that time, six more Landsat spacecraft have been placed in orbit, each with greater capabilities to produce more detailed land-use data than the last. By the 1990s, Earth system science had come of age as the research of Earth-observing spacecraft enabled scientists to obtain sophisticated data about this planet’s physical characteristics. Among others, these spacecraft include the Upper Atmosphere Research Satellite (UARS) missions, the QuickScat and Topex/Poseidon ocean studies missions, the Sea-viewing Wide Field-of-view Sensor (SeaWIFS) mission, Tropical Rainfall Measuring Mission (TRMM), and the ACRIMSAT Instruments from these spacecraft are measuring atmospheric chemistry, biomass burning, and land surface changes in regions as diverse as Greenland and the Pacific Ocean. With the launch of Terra in 1999, NASA was on its way to deploying Earth’s first simultaneous view of all the major components of the Earth system—to understand and protect our home planet.

Space Research

What must we do to enable humans to live and work safely in Earth orbit and to venture beyond Earth orbit? In the search for answers to these questions, NASA has sponsored a multitude of experiments to increase our understanding of both the human experience and space science itself. We also devote part of our budget to education and outreach to help inspire and educate the next generation of scientists. Our total effort is transforming the technological foundations not only of the space program, but also of our society. Knowledge from space will make a difference in the health industry. Advances in biology, medicine, physics, and chemistry, associated analytical tools, and information systems are opening an era of unprecedented opportunities to benefit human life on Earth and to extend our reach into space.

Representation of DNA's role in biological and physical processes?

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Space Research

Revolution in Space Science

Since the dawn of the space age, NASA has sent numerous scientific probes to all of the planets of the solar system (except Pluto) and peered into the depths of space to discover satellites, asteroids, and planets outside our solar system. These explorations will change how science textbooks are written.

The first probes went to the Moon, Mars, and Venus in the 1960s; since that time, succeeding generations of scientific spacecraft have made revolutionary contributions. For example, Voyagers 1 and 2, launched in 1977, conducted a “grand tour” of our solar system, returning stunning knowledge about those giant worlds and their moons. NASA, H. Ford [JHU/APL], G. Illingworth

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### Aviation Fun!

#### Do You Wonder Why?

1. **Why do they push the plane from the gate?**
2. **Why do we need oxygen masks in case of emergency?**
3. **Why do my ears pop as we go up to and come down from cruising altitude?**
4. **Why do we need to have tray tables up and seats in their upright position for takeoff and landing?**

(Find answers at bottom of page.)

#### Celebrating Flight: Ring Wing Glider

- **1.** Fold 8.5 x 11-inch paper diagonally as shown.
- **2.** Make a half-inch fold along the previously folded edge.
- **3.** Make a second half-inch fold.
- **4.** Curl the ends of the paper to make a ring and tuck one end into the fold of the other.
- **5.** Gently grasp the "V" between the two "crown points" with your thumbs and index fingers and toss the glider lightly forward.

This wing demonstrates the great room there is for aeronautics innovation. Can you design a better wing?

The folds in the paper make an airplane wing where the front end is heavy and the back end is light. Curling the ends to make a ring changes the shape of the wing and improves the wing's flight performance.

#### Scavenger Hunt!!

- **1.** Why was Kitty Hawk, North Carolina, chosen for the test flights of the Wright brothers?
- **2.** What type of flying vehicle is credited to the "father of aeronautics?"
- **3.** Who was the first African American woman to receive a Fédération Aéronautique Internationale (FAI) license?
- **4.** Who pioneered rubber-band-powered motors called aerodromes in the 1800s?
- **5.** What total distance did the first four powered flights of the Wrights' 1903 flyer travel on December 17?
- **6.** What is the name of the remotely piloted aircraft that is being developed to fly at a high altitude for a long duration?
- **7.** How long was Lindbergh's flight across the Atlantic?
- **8.** Name two early flight pioneers who used birds as the inspiration for flights using solar power.
- **9.** Who were the first passengers aboard a hot air balloon?
- **10.** Who was the first person to step on another world and when?
- **11.** What was the first commercial jet aircraft?

Answers:

1. Most airplanes do not move in reverse and so they need a push.
2. There is less oxygen in the atmosphere at higher altitudes. Airplanes are airtight and pressurized so passengers have the correct mix of air in the cabin. If there is a sudden change in the aircraft’s pressurization, a mask would drop to give passengers needed oxygen.
3. Even though the cabin is pressurized, there are still slight changes in pressure as the airplane's altitude changes.
4. So you and others in your row could exit the row and airplane quickly and safely in an emergency.

#### Wanted: Online Adventure Seekers

WANTED: Online Adventure Seekers

http://spacelink.nasa.gov/celebratingflight

Do You Wonder Why?

1. Why do they push the plane from the gate?
2. Why do we need oxygen masks in case of emergency?
3. Why do my ears pop as we go up to and come down from cruising altitude?
4. Why do we need to have tray tables up and seats in their upright position for takeoff and landing?

(Find answers at bottom of page.)

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Aviation Fun!

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Scavenger Hunt!!

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In its more than 50 years of existence, the Air Force has become the world’s premier aerospace force. Its mission is simple in words, yet awesome in meaning—defend the nation through the control and exploitation of air and space. To learn more about opportunities within the Air Force, call 1-800-423-USAF or visit http://www.airforce.com

The U.S. Centennial of Flight Commission was created by Congress to expand interest in the commemoration of the centennial of powered flight and the Wright brothers’ achievement. The Commission is coordinating a national outreach campaign and advising the President, Congress, and federal agencies on the most effective ways to encourage participation in 2003. http://www.centennialofflight.gov