



museum of
science+industry
chicago

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HISTORY OF FLIGHT: A TIMELINE

The Museum of Science and Industry, Chicago's temporary exhibit *Above and Beyond* celebrates the history and future of flight, from the first hot air balloon ride to the creation of the spacecraft that will one day transport humans far beyond the Moon. At a multilayered digital touchscreen timeline in the exhibition, with over 100 historical events presented through rare archival footage, photos, and art, guests can retrace the innovators and innovations that have transformed the world through flight.

HIGHER

Hot Air Balloon (1783)

Humans take flight! Two French adventurers float over Paris in a hot air balloon made by brothers Joseph-Michel and Jacques-Étienne Montgolfier. The passenger basket is attached to a **paper-lined silk balloon**, which rises when the air in it is heated.

Gas Balloon (1783)

French scientist Jacques Charles and engineer Nicholas Robert make the first flight with a gas balloon. The balloon contains **hydrogen gas**, which is lighter than air. Gas balloons become the preferred method of flight until airplanes come along.

Observation Balloon (1794)

The French Revolutionary Wars inspire a new purpose for balloons—to **track enemies**. Colonel Jean-Marie-Joseph Coutelle builds a hydrogen observation balloon for the French Army. Coutelle uses the balloon to report Austrian troop movements.

Passenger Airship (1852)

French engineer Jules Henri Giffard invents and flies the first steerable passenger airship, or **dirigible**. A large hydrogen balloon keeps the craft aloft, while a steam engine turns a propeller to drive it forward. Giffard steers with a rudder.

Aerial Photography (1858)

French artist Gaspard-Félix Tournachon ("Nadar") combines his two passions—photography and ballooning—to take pictures from the sky. Nadar snaps the **world's first aerial photograph** as he drifts over the French village of Petit-Becetre.

Mid-Air Rescue (1908)

With balloons come parachute jumpers—and mishaps. In 1908, British jumper Dolly Shepherd **shares her parachute** with fellow performer Louie May when May's ripcord fails. The women descend safely from 3,352 meters (11,000 feet) on one 'chute.

Bombs Away (1915)

During World War I, there's a new reason to fly high—to drop bombs. Germany carries out the first major **aerial bombing**, using airships to attack London. Italian aviation pioneer Gianni Caproni develops the first significant heavy bomber airplane.

Liquid Fuel Rocket (1926)

American physicist Robert Goddard launches the **first rocket using liquid**, not solid, fuel. Goddard is ridiculed for believing such rockets might one day reach the Moon. But his work paves the way for the Apollo 11 Moon landing 43 years later.

To the Stratosphere (1931)

Swiss scientist Auguste Piccard and his assistant Paul Kipfer are the first humans in the **stratosphere**. Their pressurized gondola is lifted by a helium balloon. In 1934, Auguste's sister-in-law, Jeannette Piccard, is the first woman to reach the stratosphere.

Pressure Suit (1934)

American aviator Wiley Post and the B.F. Goodrich Company invent a **pressure suit** to protect pilots from low air pressure and oxygen levels at high altitudes. Using the suit, Wiley takes his Lockheed Vega to a record height of 15,240 meters (50,000 feet).

Pressurized Cabin (1940)

Boeing's 307 Stratoliner is the first commercial airplane to offer a **pressurized cabin**. Passengers can "fly above the weather"—without getting altitude sickness or passing out. This makes for a smoother, less turbulent ride.

Reaching Space (1949)

America's Bumper-WAC rocket is the **first human-made object to enter space**. The rocket consists of a captured German V-2 missile, topped by a U.S. Army WAC Corporal missile. This new two-stage approach provides the boost needed to reach space.

Artificial Satellite (1957)

The Soviet Union ignites the Space Race and the Satellite Age with **Sputnik 1**, the first human-made object to orbit Earth. Four months later, the United States orbits Explorer 1. Today, satellites help us navigate, study our planet, make phone calls and more.

Cold War Spy Planes (1957)

The Cold War between the United States and the Soviet Union leads to the invention of high-altitude **spy planes**. Lockheed's U-2 goes into service for the U.S., followed by the A-12 and the SR-71 Blackbird. The Soviets develop the Yak-25 Mandrake.

Humans in Space (1961)

Soviet cosmonaut **Yuri Gagarin** is the first human to reach space and the first to orbit Earth. American astronaut Alan Shepard launches into space three weeks later. In 1963, Soviet cosmonaut Valentina Tereshkova becomes the first woman in space.

Spaceplane (1963)

U.S. test pilot Joseph Walker soars past the edge of space in a North American Aviation X-15. The rocket-powered aircraft is the first reusable **spaceplane**. It launches from under the wing of a Boeing B-52. The X-15 blazes a trail for future spaceflights.

Space Shuttle (1981)

Liftoff of NASA's **Space Shuttle Columbia!** The Space Shuttle is the first reusable spacecraft capable of entering Earth orbit. For 30 years, shuttles launch crews to deploy satellites, do research, build the International Space Station (ISS) and more.

Space “Jetpack” (1984)

NASA astronaut Bruce McCandless makes the **first untethered spacewalk**. McCandless exits the Space Shuttle Challenger wearing a nitrogen-propelled Manned Maneuvering Unit (MMU). Today, crews are always tethered when working outside the ISS.

Space Telescope (1990)

Another reason to fly high? To get a clear view of space! NASA and the European Space Agency (ESA) launch the **Hubble Space Telescope** into Earth orbit. One of the largest space telescopes, it has revolutionized astronomy with its stunning cosmic images.

International Space Station (1998)

Assembly of the **International Space Station** begins in Earth orbit. Fifteen nations partner to build what becomes the largest human-made object in space. On board the ISS, crews carry out experiments to help improve life on Earth and prepare humans for flights to Mars and beyond.

Space Tourist (2001)

American businessman Dennis Tito pays a hefty sum to fly to the ISS aboard a Russian Soyuz spacecraft. Tito is the **first tourist** to pay his own way to space. New reusable spacecraft in the works today may help make space a popular vacation destination.

Solar High Flyer (2001)

AeroVironment’s Helios **flying wing** makes the highest flight of a non-rocket-powered aircraft. The remotely piloted, solar-powered aircraft is almost all wing. Solar cells cover its 75 meters (247 feet) long wing, powering 14 propellers.

Private Spaceplane (2004)

Test pilot Mike Melvill flies **SpaceShipOne** beyond the edge of space. The spacecraft is funded by Microsoft co-founder Paul Allen and designed by visionary aerospace engineer Burt Rutan. It is the first private (non-government) spacecraft in space.

Near-Space Balloon (2014)

World View launches a test version of its future passenger balloon to the stratosphere. The company plans to lift tourists to near-space in a pressurized capsule, using a giant gas balloon. A parachute-like **parafoil** will float the capsule back to Earth.

Space-Balloon Event (2015)

More than 100 teams of amateur balloonists around the world launch high-altitude balloons in the **Global Space Balloon Challenge**. It is the world’s largest space-balloon event. All of the balloons carry cameras. Many also carry science experiments.

FASTER

Fixed Wings (1799)

British engineer George Cayley proposes an idea that forms the basis for today’s airplanes. Wings can remain fixed to create lift, while an engine provides **thrust**. Prior to this, aviation pioneers thought an aircraft’s wings would need to flap like a bird’s.

Unpiloted Airplane (1896)

American aviation pioneer Samuel Langley launches the first successful flight of a steam-

powered model airplane. His unpowered Aerodrome Number 5 is equipped with a **steam engine** that turns two propellers. Steam engines prove impractical for piloted airplanes.

Piloted Airplane (1903)

Orville and Wilbur Wright achieve the dream! The American brothers are first to fly a piloted, powered airplane that can be controlled and steered. Their 1903 Flyer is a **biplane**, with two sets of wings. It is powered by an internal combustion engine.

Air Races (1909)

Game on! The French city of Reims hosts the first major international air meet. Pilots compete for the Gordon Bennett Trophy and cash prizes in contests of flight duration, distance and speed. American **Glenn Curtiss** wins big in his Curtiss No. 2 biplane.

Single Shell Plane (1912)

The French Deperdussin **Monocoque** (“single shell”) introduces the idea of streamlining. It has a wood shell with a hollow body, instead of fabric skin over a wood framework. Its sleek shell reduces weight and air resistance, or **drag**. This increases speed.

Fighter Planes (1914)

World War I breaks out in Europe, sparking an interest in planes as weapons. Allied and Central powers build fighter planes to shoot down enemy observation craft. **Dogfighting** begins when these fighters battle. Speed and maneuverability become essential.

Metal Monoplane (1915)

During World War I, aircraft makers start shifting from wood to metal construction. This leads to **monoplanes** with one set of thick, internally braced wings. One set of wings creates less drag than two. Germany’s Junkers J-1 is the first practical all-metal plane.

Woman Races (1929)

Women join the quest for speed with the first **Women’s Air Derby**, or “Powder Puff Derby.” Twenty pilots begin the race from California to Ohio, USA. Eight days later, after stops for refueling and rest, Louise Thaden crosses the finish line to win.

Jet Engines (1930s)

Two engineers—Frank Whittle in England and Hans von Ohain in Germany—separately invent the **jet engine**. Their engines burn fuel with air to produce gas that shoots out the back to create **thrust**. Jet engines will transform flight and change the world.

WWII Prop Planes (1939-1945)

During World War II, better internal combustion engines lead to faster propeller planes. North American’s P-51D Mustang is one of the fastest “**prop**” **planes** of the day, at 703 km/h (437 mph). However, at this speed propellers begin to reach their limits.

Swept Wing (1935)

German aerospace engineer Adolf Busemann unveils the concept of the **swept wing**. He proposes that angled airplane wings will generate less drag than traditional straight wings at high speeds. Swept wings later become standard on high-speed jets.

Fighter Jet (1944)

Late in WWII, Germany’s Willy Messerschmitt introduces the first operational **fighter jet**. His

Messerschmitt Me 262 Schwalbe (Swallow) blows past the Allied propeller planes. The British respond with their first fighter jet, the Gloster Meteor I.

Speed of Sound (1946)

Humans go **supersonic**! American test pilot Chuck Yeager creates the first sonic boom when he flies 1,127 km/h (700 mph) in a rocket-powered Bell X-1. Seven years later, American Jacqueline Cochran is the first female pilot to exceed the speed of sound.

Swept-Wing Fighter (1947)

The Soviet Union introduces one of the first successful **swept-wing fighter jets**. The wings of their Mikoyan-Gurevich MiG-15 are angled 35 degrees. That's the magic number to delay shock waves, yet maintain control, near the speed of sound.

Swept-Wing Bomber (1947)

Boeing introduces the B-47 Stratojet **long-range bomber**. It is the world's first large jet with swept wings and engine pods mounted under the wings—the standard form for modern jetliners. In 1949, the B-47 sets a record crossing the U.S. in under four hours.

Jetliner (1952)

The British de Havilland Comet roars into the sky. The first jet-propelled airliner, or **jetliner**, it beats the fastest prop airliners of the day by 161 km/h (100 mph). Tragically, in 1953-54, three Comets break apart in midair due to a fatal design flaw.

Mach 2 (1953)

U.S. test pilot A. Scott Crossfield pushes the Douglas D-558-2 Skyrocket into a shallow dive and goes **Mach 2**, twice the speed of sound. Not bad for 50 years after the start of powered flight! The U.S. uses the D-558-2 to study swept wings at high speeds.

Jet Age (1958)

The **Boeing 707** enters service for Pan American World Airways. The 707 is the first commercially successful passenger jetliner. It features swept-back wings with four engines mounted under them. The age of intercontinental jet travel has arrived.

Mach 2 Woman (1964)

The first woman to exceed the speed of sound becomes the first to double it. **Jacqueline Cochran** pilots a Lockheed F-104G Starfighter to Mach 2. Nicknamed the "Zip," the Starfighter was the first combat aircraft capable of sustaining Mach 2 in level flight.

Fastest Humans (1969)

NASA's Apollo 10 astronauts become the **fastest humans in flight**—a record that holds today. Their Command Module accelerates under the pull of Earth's gravity on their way home from the Moon. They reenter the atmosphere at 39,937 km/h (24,816 mph).

Supersonic Jet Age (1976)

Supersonic commercial flights begin. The Aérospatiale-BAC Concorde whisks passengers who can afford it across the Atlantic in half the time of other airliners. The plane's triangular **delta wings** and pointy nose soften shockwaves and reduce drag.

Fastest Probe (1976)

NASA's Helios 2 probe flies faster than any other human-made object, reaching 252,793 km/h

(157,078 mph) on its way to study the Sun. The probe gets a boost from the Sun's immense gravity. Spacecraft can use **gravity assists** like this to increase their speeds.

Fastest Crewed Jet (1976)

As the Cold War simmers on, the U.S. and the Soviet Union develop super-fast spy planes. Lockheed's SR-71 Blackbird sets a record as the fastest crewed jet craft. Its **titanium** structure enables it to endure searing heat generated by friction at Mach 3+.

Fastest Launch (2006)

NASA'S New Horizons probe sets a record for the **fastest launch speed** of a spacecraft. An Atlas 5 rocket fires the probe onto a blazing fast, Earth-escape trajectory on its way to orbit the distant dwarf planet Pluto. Launch speed: 58,537 km/h (36,373 mph).

Hypersonic Milestone (2010)

Boeing's X-51 WaveRider makes the longest **hypersonic** (Mach 5+) flight of an aircraft with a non-rocket, air-breathing engine. The uncrewed research vehicle sets the stage for the development of future hypersonic aircraft and spaceplanes.

FARTHER

Channel by Balloon (1785)

Frenchman Jean-Pierre Blanchard and American John Jeffries achieve the **first balloon crossing** of the English Channel. Their hydrogen-filled balloon nearly crashes into the water, after losing gas. The men toss out most of their supplies to stay aloft.

Distance Record (1906)

Brazilian-born aviator Alberto Santos-Dumont makes a sustained flight in his 14-bis airplane in Paris. It is the first officially observed flight of a piloted, powered airplane. The flight earns Santos-Dumont the first official **airplane distance record**.

Channel by Plane (1909)

French aviator Louis Blériot becomes the first person to fly across the English Channel in an airplane. His Blériot XI is a **monoplane**, meaning it has one set of wings. American Harriet Quimby is later the first woman to pilot a plane over the Channel.

Seaplanes (1910)

French aircraft designer Henri Fabre makes the first flight of a powered **seaplane**. His Hydravion rests on hollow wooden floats for water takeoffs and landings. The invention of seaplanes enables flights to and from any place with a large body of water.

International Airmail (1919)

Boeing Company founder William Boeing and pilot Edward Hubbard perform the first international airmail flight. They carry mail from **Seattle, Washington, USA, to Victoria, Canada**. Their plane is a Boeing Model C, a modified World War I trainer.

Across the Atlantic (1919)

U.S. Lt. Cmdr. Albert Read pilots the first flight across the Atlantic Ocean. His Curtiss NC-4 seaplane finishes the trip in 19 days, with many stops. Weeks later, British Royal Air Force pilots John Alcock and Arthur W. Brown fly the Atlantic nonstop.

Aerial Refueling (1923)

Planes can only fly as long as their fuel lasts. The invention of **aerial refueling**—getting fuel from another plane in mid-air—lets planes go farther. In 1923, U.S. Army Lts. L.H. Smith and J.P. Richter use aerial refueling to set a flight duration record of 37 hours.

Around the World (1924)

The Douglas World Cruiser (DWC) becomes the first aircraft to fly around the world. Five U.S. Army Air Service DWCs set out westward from Seattle. Two of the planes—Chicago and New Orleans—touch down back in Seattle six months and many stops later.

Pan American (1927)

Former World War I pilot Juan Trippe founds **Pan American (“Pan Am”) World Airways**. The airline eventually launches the first passenger services across the Pacific and Atlantic Oceans and around the globe. Flight begins to shrink our world.

Solo Atlantic Crossing (1927)

American aviator **Charles Lindbergh** completes the first nonstop solo flight across the Atlantic. Five years later, American pilot Amelia Earhart is the first woman to do so. Their flights thrill the public and spark an increased demand for air travel.

Sleeper Transport (1935)

U.S. aircraft maker Douglas introduces the **DC-3**. Its range and speed beat other airliners of the time. The first model, the Douglas Skysleeper Transport, has sleeping berths for overnight flights. More people begin to cross the U.S. in planes than in trains.

Large Bomber (1938-1945)

During World War II, aircraft makers build bombers that fly farther and carry heavier loads. In 1945, one of the largest, the **Boeing B-29 Superfortress**, drops the atomic bombs that devastate Hiroshima and Nagasaki, Japan. The war ends three days later.

Flying Boat (1939)

Boeing’s luxurious 314 Clipper carries the first scheduled passengers across the Atlantic. The long-range **flying boat** was built for Pan Am, to meet demand for transoceanic flights. During World War II, the U.S. drafts the 314 into service as a military transport.

Nonstop Global (1949)

A U.S. Air Force Boeing B-50 Superfortress makes the first **nonstop flight around the world**. Captain James Gallagher pilots the Lucky Lady II. It is refueled four times in mid-air during its 94-hour flight.

Cold War Bombers (1950s)

After World War II, tensions between the U.S. and the Soviet Union lead to a Cold War standoff. Aircraft makers respond with new **long-range bombers**. In 1962, Boeing’s B-52 Stratofortress sets a distance record, flying unrefueled from Japan to Spain.

ICBMs (1958-1959)

The Soviet Union and the U.S. test long-range **intercontinental ballistic missiles (ICBMs)**. The missiles can follow a **ballistic (arcing)** path more than 5,600 km (3,500 mi). Soviet and American ICBMs are adapted into launch systems to put satellites in Earth orbit.

Around the Moon (1968)

NASA's Apollo/Saturn V rocket blasts the **Apollo 8** astronauts on the first human flight around the Moon. The crew returns with the first photo of Earth seen from deep space. The image inspires generations to better care for our beautiful, fragile planet.

Moon Landing (1969)

Flight takes a giant leap! Neil Armstrong pilots the Apollo 11 Lunar Module through a harrowing descent to **land humans on the Moon**. Armstrong and crewmate Edwin "Buzz" Aldrin explore the lunar surface. Five crewed Apollo Moon landings follow.

Jumbo Jet (1970)

The Boeing 747 is the first wide-body, long-range jetliner, or **jumbo jet**. With nearly 500 seats, it carries 3-4 times more passengers than other airliners of the day. That means lower fares. International air travel becomes possible for millions more people.

Mars Landing (1976)

NASA's **Viking 1** is the first spacecraft to fly to Mars and touch down safely on the surface. The robotic lander studies the Martian soil and atmosphere and transmits high-resolution photos of the surface to NASA's Jet Propulsion Laboratory.

Human-Powered Flight (1977)

In the 1970s, an energy crisis inspires a variety of efforts to fly farther burning less fuel. In 1977, cyclist Bryan Allen **pedals the Gossamer Condor** on a 1.6-km (1-mi) flight. It is the first sustained flight of a human-powered aircraft.

Wingtip Device (1977)

Ever noticed those swooping tips on airplane wings? In 1974-76, NASA researcher Richard Whitcomb demonstrates how **wingtip devices (or winglets)** could reduce drag, to fly farther with less fuel. In 1977, the Learjet 28 is the first jet to fly with winglets.

Solar Crossing (1981)

Pilot Stephen Ptacek crosses over the English Channel in an aircraft powered entirely by energy from the Sun. It is the first long-distance flight of a **solar-powered aircraft**. The Solar Challenger is the invention of AeroVironment founder Paul MacCready.

Global Unrefueled (1986)

The Rutan Model 76 Voyager is the first plane to circle the world nonstop, without refueling. Jeana Yeager and Richard Rutan fly the lightweight, carbon-composite craft at a slow 177 km/h (110 mph) for fuel efficiency. They finish the trip in nine days.

Nonstop Global Balloon (1999)

The **Brierling Orbiter 3** carries Swiss Bertrand Piccard and British Brian Jones on the first nonstop balloon ride around the world. Their balloon is a Rozier—a hybrid craft that uses helium and hot air. They navigate with the latest satellite-based systems.

Longest Range Jetliner (2005)

Boeing's 777-200LR sets a world record for the farthest nonstop flight of a commercial jetliner. The plane can fly more than halfway around the globe without refueling. It is powered by two large, powerful General Electric GE-90-115BL jet engines.

Composite Jetliner (2009)

Boeing's 787 Dreamliner goes "wheels up" for the first time. This is the first flight of a commercial jetliner with an airframe made mostly of **carbon composite**. This lightweight material helps the 787 use 20-30 percent less fuel than similarly sized planes.

Asteroid Return (2010)

The Japan Aerospace Exploration Agency's (JAXA's) Hayabusa mission returns the **first asteroid samples to Earth**. The robotic spacecraft arrives home five years after landing on the small asteroid Itokawa, about 290 million kilometers (180 million miles) from Earth.

Voyager 1 (2012)

NASA's Voyager 1 probe enters **interstellar space**—the space between stars. Voyager 1 is currently the most distant human-made object in space. The mission launched in 1977 and included flyby tours of Jupiter, Saturn, Uranus and Neptune.

Comet Rendezvous (2014)

ESA's **Rosetta** probe catches up to comet 67P to study the icy dirt ball as it orbits the Sun. Rosetta is the first spacecraft to rendezvous with a comet. The mission also makes the first soft landing on a comet with its Philae lander.

Deep-Space Ride (2014)

NASA's **Orion spacecraft** blasts off for its first test flight. Orion will one day transport humans beyond the Moon and deeper into space than ever before. The uncrewed test flight orbits Earth twice and makes a bull's-eye landing in the Pacific Ocean.

Solar to Ceres (2015)

NASA's Dawn spacecraft enters orbit around the dwarf planet **Ceres**, the largest object in the asteroid belt. Dawn is the first spacecraft to orbit a dwarf planet. Its 7.5-year journey is made possible by high-efficiency ion thrusters powered by the Sun.

SMARTER

Pressure Gauge (1849)

French engineer Eugène Bourdon invents the **Bourdon tube** for measuring air pressure. Since air pressure decreases with altitude, balloonists and airship pilots begin to use the Bourdon tube to measure how high they fly.

Flight Instruments (1903)

From day one, airplane pilots use technology to aid them in flight. The Wright Flyer carries three basic flight instruments: an **anemometer** to measure wind speed, a **tachometer** to measure engine speed and a stopwatch to time the flights.

Accident Investigation (1908)

The Wright Flyer crashes, killing passenger Lt. Thomas Selfridge. Pilot Orville Wright is seriously injured. The Wrights launch the first **plane crash investigation**, to prevent another disaster. Safety continues to be a priority for aerospace innovators today.

Air-to-Ground Radio (1910)

Canadian pilot John McCurdy radios the first message from a plane to the ground, as he flies over Brooklyn, NY, USA, in a Curtiss biplane. With **radio**, pilots can transmit their positions and get instructions from the ground. This makes it easier to navigate.

Early Autopilot (1914)

American pilot Lawrence Sperry demonstrates an early form of **autopilot** at an exhibition outside Paris, France. Sperry takes his hands off the controls of his biplane in flight, while his mechanic walks onto the wing. A **gyroscope** holds the plane steady.

UAV (1918)

The world's first **unmanned aerial vehicle (UAV)** takes flight. Known as the Curtiss-Sperry Flying Bomb, it is controlled by a pilot on the ground. Two innovations make this possible: autopilot and radio. Today's UAVs build on these core technologies.

Lighting the Way (1921)

U.S. Postal Service installs rotating light beacons on towers to guide its pilots at night. The rotating lights you see at every airport today trace back to these **lighted airways**. The beacons are a big improvement over the bonfires tested earlier.

“Blind Flight” (1929)

American aviator Lt. James “Jimmy” Doolittle makes the first **“blind” flight**. He relies only on cockpit instruments and a radio—not the ability to see outside—to find his way. With these technologies, passenger planes can begin to fly at night and in bad weather.

Air Traffic Control (1935)

The U.S. opens its first **Airway Traffic Control Station**. Its main goal is to keep aircraft separated a safe distance. Controllers at the New Jersey facility monitor air traffic using radios, chalkboards, maps and small plastic markers representing planes.

RADAR Tracking (1930s)

In the lead-up to World War II, the British refine the use of **RADAR (radio detection and ranging)** to detect enemy aircraft. Allied and Axis powers use radar extensively during the war. Soon, radar is adopted around the world to track passenger aircraft.

Electronic Autopilot (1942)

The **electronic autopilot (C-1)** by Minneapolis-Honeywell takes autopilot to new levels of precision. The C-1 helps reduce pilot fatigue and helps reduce bombing errors in military aircraft. It proves critically important to the Allied efforts in World War II.

Air Traffic Computers (1950s)

As more planes take to the skies, there is more data for **air traffic controllers** to manage. The introduction of computers in the 1950s and 60s helps controllers process this data faster. Display screens replace the old system of maps and markers.

Black Box (1958)

Australian scientist David Warren invents the **cockpit voice recorder** and **flight data recorder**. Though usually orange, they are known as the **black box**. These devices help investigators find the cause of plane crashes to prevent future accidents.

Communications Satellite (1960)

NASA launches the first communications satellite, **Echo 1**, into orbit. The satellite is a giant metallic balloon. Radio signals are bounced off it to send messages to other places on Earth. This lays the foundation for today's satellite TV and mobile phones.

Apollo Guidance Computer (1968)

The Apollo Guidance Computer **guides Apollo 8 around the Moon**. It is the first computer to guide a crewed spacecraft outside Earth orbit. The AGC guides all Apollo Moon missions—with far less memory and processing speed than your mobile phone!

Digital Fly-by-Wire (1972)

NASA tests **digital fly-by-wire (DFBW)**. With DFBW, computers translate the pilot's input into precise digital commands to control an aircraft or spacecraft. This replaces less accurate mechanical connections. DFBW makes flight safer and more efficient.

Heads-Up Display (1975)

Cockpits get a new tool that makes the pilot's job easier, and flying safer. The head-up display (HUD) **projects flight data** onto the windshield, so pilots can keep their eyes on the sky. France's Dassault Mercure is the first commercial aircraft with a HUD.

Glass Cockpit (1982)

Boeing's 767 is the first passenger airliner with a sleek new **glass cockpit**. Originally developed by NASA, glass cockpits feature digital displays instead of the numerous gauges found in a traditional cockpit. This streamlines the job of the pilot.

GPS (1993)

The U.S. Air Force completes the **global positioning system (GPS)** satellite network. With GPS, it is possible to find one's precise location anywhere on Earth. Originally designed for the military, GPS is later made available to civilians for navigating.

Computer Design (1994)

The Boeing 777-200 takes off for its first flight. It is the first commercial aircraft designed entirely on a computer. Gone are the days of drafting tables and costly mockups. With **digital tools**, designers can dream up and test ideas faster and more efficiently.

Satellite Tracking (2000s)

Air traffic control systems around the world begin **shifting from radar** to more precise satellite tracking. Aircraft can obtain their exact positions in real time via satellites in Earth orbit. The data is then shared with ground controllers and other aircraft.

Collision Avoidance (2009)

NASA and the U.S. Air Force flight-test their new **Automatic Ground Collision Avoidance System**. The system is designed to take control of a plane and fly it to safety if the pilot makes an error or passes out and the plane is in danger of crashing.

Smart Helmet (2014)

This is no ordinary pilot's helmet. The **helmet-mounted display system** for Lockheed Martin's F-35 fighter jet projects data onto the pilot's visor. All the data pilots need is always there before them, no matter which way they turn their head.

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