



# Seaplanes to Spaceplanes – 100 YEARS OF BOEING INNOVATIONS

A special feature to commemorate the 100<sup>th</sup> anniversary this month of Boeing, researched and written by **Henry M Holden**

**O**NE HUNDRED years is but a blink of an eye in history, and more than the average human's lifespan. In terms of a company's longevity, however, 100 years makes Boeing a corporate Methuselah. Most of the American companies that were prosperous in 1916 have disappeared through failures or mergers.

In that 100 years, humans went from walking on Earth to walking on the moon. They went from driving automobiles to flying into space. With each decade, aviation technology crossed another frontier; the world changed, and the Boeing Company was a part of the progress.

Today when you fly on a commercial airliner, your chances are good that it will be a Boeing-made jet. It might be the ubiquitous Boeing 737, the jumbo 747, or the most advanced aircraft, the Boeing 787. Did you ever wonder where it all began?

The first aircraft Boeing built, a seaplane, the B&W, weighed 1 270 kg, had a 16,8 m wingspan, and a length of 9,5 m. It carried two people, cruised at 58 knots, and had a top speed of 65 knots with a maximum range of 320 miles and cost slightly more than \$10 000.

The Boeing 747-8, launched in November 2005, is 76,3 metres long, has a span of 68,5 m, a maximum takeoff weight of

448 000 kg, a range of 8 900 miles, a cruising speed at Mach 0,85 570 mph 495 knots and a height of 19,4 m. It carries between 400 and 600 passengers, depending on configuration, and costs \$379,1-million.

In 1914, Terah Maroney flew a Curtiss hydroplane into Seattle, and William Boeing took his first aircraft ride, and later earned his licence.

naval headquarters in Washington. Since no one in the country had much aeronautical design experience, Boeing decided his Martin TA would be a good starting point.

In July 1916, Boeing formed the Pacific Aero Products Company, and moved the operation to a shipyard he bought in 1910. Westervelt was now in charge of all aircraft construction for the navy, and he

Company. Boeing then applied for a contract. The Model C version of the B&W easily passed the navy's tests, and Boeing won a contract for 50 trainer aircraft.

When the war ended, it did not take long for the post war recession to hit Boeing's company. The surplus of aircraft and Liberty engines created for the war caused a standstill in the industry.

To promote the idea of



## THE B&W IS BORN

Boeing, and his partner, navy lieutenant G. Conrad Westervelt, studied Maroney's seaplane, and decided they could build a better aircraft.

Boeing decided to self-fund the construction of two planes. The B&W (for Boeing and Westervelt) was on paper when Westervelt was transferred to

encouraged Boeing to design a multi-purpose seaplane to meet the Navy's requirements for a Primary Trainer.

## WORLD WAR I

On April 8, 1917, the United States declared war on Germany. Westervelt now gave Boeing the inside track. Boeing changed the name to the Boeing Airplane

The B&W was the first airplane designed and built by Boeing. On June 15, 1916, Boeing took the B&W aloft for the first time. The Navy was not interested so he sold the two to New Zealand.

(Photo: Henry M. Holden)





The Boeing Company's original manufacturing plant dubbed the "Red Barn" was used during production of the Boeing Model C and Model 40. Today it contains rare artifacts, and a recreation of the factory environment. (Photo: Henry M. Holden)



commercial aviation, Boeing, and pilot Eddie Hubbard, used Boeing's personal Model C to deliver 60 letters from Vancouver to Seattle as part of the Canadian Exposition. This was the first international airmail to reach the United States.

In November 1920, the pontoon-equipped B-1, the first Boeing aircraft designed as a practical commercial aircraft, was ready for service. It served Boeing from 1920 to 1928, and carried between 25 000 and 50 000 pounds of mail a year. It wore out six engines, and required no important structural changes.

When retired, the B-1 was still capable of flight, but its historical value was greater. The B-1 never found a commercial market because of the glut of cheap war surplus aircraft at the time.

The company started to show a profit from repairing military aircraft and building biplane fighters designed by another company. By 1921,

the company had re-established itself, and Boeing received a contract to produce 200 MB-3As, an improved version of the Thomas-Morse MB-3. This order started Boeing toward a dominant position in the fighter 'plane business.

## BOEING AIR TRANSPORT COMPANY

The US Congress played an important role in the future of Boeing. The passage of the Air Mail Act in 1925 encouraged commercial aviation by authorising the Postmaster General to contract with the private sector for an airmail service.

In January 1927, Boeing won a low-bid contract for the coveted Chicago-San Francisco mail route. Boeing gambled on an untried Wasp engine in a plane the Post Office had ignored, the Model 40.

To fly the mail, Boeing formed a new company, the Boeing Air Transport Company (BAT). This

company then contracted with the Boeing Airplane Company (BAC) to build twenty-four mail planes. Within six months, BAT had paid its debts and was making money. The passenger revenues were an added bonus over the mail revenue.

With the West Coast airmail routes practically a monopoly, Boeing turned his attention to building an aircraft specifically for passenger comfort and convenience.

The B-1 seaplane flew on 27 December 1919. It outlasted six engines in eight years of international airmail runs between Seattle, Washington, and Victoria, British Columbia. In an era with few airports, an airplane that could land on water made sense. The B-1 covered 350 000 miles (563 000 km). (Photo: Boeing Archives)

Model 40 - The Model 40 first flew July 20, 1925. The 40-B4 flew Oct. 5, 1928, and was the major production model of the mail plane series. It used the larger Hornet engine and carried four passengers and 226 kg of mail. Including the first Model 40, 77 were built between 1925 and 1932.

(Photo: Seattle Archives)







The Model 80 trimotor biplane was to be the last word in luxurious air travel. Twelve were delivered to Boeing Air Transport in 1928. The interior resembled a luxurious railway coach, with such features as hot and cold running water, forced-air ventilation, heat, and more. It had an 80-foot span, was 56.5 feet long, and carried one and one-half tons at 138 mph

(Photo: Boeing Archives)

## INTERLOCKING DIRECTORATE

The Model 80 made its first flight on July 27, 1928, and was quickly put into schedule service.

Sixteen model 80s were built, including an upgraded 18-passenger Model 80A in 1930.

The Model 80 was also one of the few aircraft that had a perfect passenger safety record. None of the Model 80s ever had a fatal accident, although several were written off after landing accidents.

This would be of great publicity value when Boeing introduced the Model 247.

In May 1930, Boeing introduced the Monomail, an all-metal cargo and mail aircraft. It was a radical departure from the traditional aircraft construction. The Monomail was a low-wing design with the first practical retractable landing gear. Boeing then converted the mail plane to a six-passenger plane, Model 221.

As the Depression dragged into the 1930s, Boeing's vision of the aircraft for business and commerce was becoming a reality. Boeing had built an aviation infrastructure that tied together aircraft and engine manufacturers, with airfields and airlines, to create an efficient, and profitable system of airmail and passenger travel that spanned the United States.

That infrastructure was a product of the United Aircraft and Transport Corp. (UATC), which Boeing formed in 1929 with Fred Renschler, then head of the Pratt & Whitney engine company.

As an aviation holding company, UATC brought together aircraft manufacturers: Boeing Aircraft, Hamilton Metal Plane, Sikorsky, Chance Vought,

Northrop, Stearman; Pratt & Whitney; propeller manufacturer Standard Steel; and airlines Boeing Air Transport, Pacific Air Transport, Stout Airlines, National Air Transport, and Varney Airlines. By 1933, UATC was flying almost half the passengers and airmail in the United States.

UATC was successful, and the aviation industry continued to grow. This attracted the attention of the Roosevelt administration in 1933. A controversial senate investigation alleged the major aviation holding companies had colluded with the former postmaster general over the distribution of airmail routes to their airlines. This meeting was dubbed the "Spoils Conference."

That same year, Boeing introduced the Model 247, called by many "the first modern commercial airplane." The model 247 was so advanced that it became the star of the Chicago World's Fair, in 1933.

However, the 247 was soon to be overshadowed by the Douglas DC-3. Douglas produced the DC-3 by the hundreds before World War II, causing Boeing to shut down production after only 75 were built.

In February 1934, Roosevelt ordered the cancellation of all airmail contracts, and authorized the Army Air Corps to fly the mail until a new Air Mail Act was finalized.

Assigning airmail to the army was a disaster. Only half the routes were covered, and in five months there were 66 accidents,

with 12 fatalities. The public outrage forced Roosevelt to return airmail operations to the airlines. In 1941, a US court ruled that there had been no fraud or collusion in the awarding of airmail contracts. Boeing and the other airline executives were cleared of any wrongdoing.

In June 1934, the Air Mail Act dissolved the holding companies and broke aircraft operations from manufacturing. Aircraft manufacturers could no longer own mail-carrying operators.

Boeing had anticipated this and had started the breakup of UATC, rather than wait for the government to do it. The breakup saw the creation of three major companies: United Airlines (responsible for passenger transportation) Boeing Airplane Company (responsible for manufacturing) and United Aircraft (responsible for manufacturing in the eastern United States comprised of Pratt & Whitney, Chance Vought, Sikorsky, and Hamilton Standard, now known as United Technologies Corp. Stearman Aircraft joined with Boeing Aircraft and Boeing Aircraft of Canada under a new entity, the Boeing Airplane Company, which continues today as The Boeing Company.

In September 1934, Boeing retired, but before he did, he wanted to ensure the company was prepared for the future. He handpicked Clairmont Egtvedt one of his top engineers to lead the company.

Egtvedt defined Boeing's



The Model 221 was a converted Monomail with room for six passengers. It had the first practical retractable landing gear. No sooner had the Monomail gone into service when its successor, the Model 247 airliner, was ready for production. (Photo: Boeing Archives)





The Boeing sub-sonic B-47 Stratojet, introduced in 1951, featured the first swept wing design to accommodate its six jet engines. It was the first Boeing design tested in a wind tunnel. The aircraft was designed to be the foundation of the Strategic Air Command's long-range missions. It entered service toward the end of the Korean War but never saw active combat. (Photo: Henry M. Holden)

future as he pursued a new strategy, building the "big Boeings."

This would be a major departure for the company known for its manufacture of small fighter planes. Without this change in course, World War II may have turned out differently for the company. The expertise they developed in building the big bombers would be vital in the later development of passenger jetliners.

## MODEL 307 STRATOLINER

Under Egtvedt's leadership the Boeing Model 307 became the world's first high-altitude commercial transport. The 307 first flew on December 31, 1938, and TWA put it into service on the transcontinental route on July 8, 1940.

With its pressurized cabin the aircraft flew above the weather at an altitude of 20 000 feet, higher than any other transport at the time. The nearly 3,6-metre-wide cabin had space for 33 passengers and comfortable berths for overnight travellers.

Boeing built 10 Stratoliners. In 1940, the 307s started flying routes to Latin America, and New York to Los Angeles. Production stopped when war began and five were drafted into the Air Transport Command as C-75 military transports.

## BIG BOMBERS

In 1934, Boeing was competing against Douglas and Martin for a contract to build 200 bombers. Boeing answered with the company-funded XP 17, its XP-9 bomber design with two additional engines.

The XP17, Model 299 was the first of the big Boeing bombers. Its four engines allowed it to exceed the army's requirements and expectations. Pilot error caused a Model 299 to crash and

Boeing to lose the contract. However, the army ordered 13 Y1B-17s, the predecessor to the B-17.

Model 299, was developed in parallel with a civil version of the same aircraft. The Model 307, Stratoliner, was a straight forward conversion from the B-17 bomber. It had the wings and tail surfaces of the B-17C.

The B-17 was almost 22 metres long and had a wingspan of more than 30 metres. The ten .50 calibre machine guns and

4 000 - 5 000 pound bomb load earned it the title of "Flying Fortress." It could fly 255 knots, with a range of up to 3 320 miles exceeding the competition's performance.

The Flying Fortress became an icon of American air power, and Boeing became a household name. The B-17 evolved through numerous design advances and 12 731 were built.

Near the end of World War II, Boeing produced the B 29, an advanced aircraft that had a



The B-17 Flying Fortress became an icon of American air power, and with it Boeing became a household name. The B-17 Flying Fortress evolved through numerous design advances and 12 731 were built. In 1954, Time magazine said, "In combat, Boeing's two fortresses were unexcelled."

(Photo: Henry M. Holden collection)





Introduced in 1955, the B-52 was the first swept wing long-range heavy bomber in history. In 1957, three B-52s completed a 24 325 mile nonstop flight around the world in 45 hours, and 19 minutes, averaging 520 mph. The B-52 is the longest serving bomber in the U.S. Air Force with more than 60 years of service. (Photo: U.S. Air Force)

pressurized cabin (a feature that hailed from the civilian Model 307 Stratoliner), electronic fire control system, and remote control machine gun turrets.

The Army Air Force used the Superfortress in the Pacific theatre. Boeing built 3 970 B-29s. In 1954, *Time* magazine said: "In combat, Boeing's two fortresses were unexcelled."

## POST WAR

In 1945, *Nations Business* magazine reported: "World War II was over, and Boeing, except for a few small jobs was out of business." Their 1945 sales had been nearly \$421-million, but dropped to \$13-million in 1946. Profits turned to losses and the magazine added "With military orders a fraction of the wartime volume, Boeing's force shifted to the commercial airliners market that had been static during the war."

Building on the company's developments in military aircraft, William Allen, the company's president directed the manufacture of a commercial version of the four engine C-97 military cargo aircraft.

Boeing re-entered the commercial market with the

Stratocruiser (Model 377), a long-range airliner. It was the first Boeing commercial transport since the Stratoliner, and like its military counterpart, the C-97, was based on the B-29 bomber.

The Stratocruiser entered scheduled transAtlantic service from New York to London in 1949.

The Stratocruiser set a new standard for luxury air travel with its extra-wide passenger cabin. A spiral staircase led to a lower deck lounge, where flight attendants prepared hot meals in a state-of-the-art galley.

As a sleeper, the Stratocruiser was equipped with 28 upper-and-lower bunk units.

Boeing built 56 Stratocruisers between 1947 and 1950. In 1949, Pan American placed the first order for 20, worth \$24-million, and began service between San Francisco, Calif., and Honolulu, Hawaii. Despite its accoutrements, it was not a financial success.

## ENTER THE B-52

Boeing used the company's bomber heritage to build the eight-engine, all jet B-52 introduced in 1955. Two B-52

prototypes cost a reported \$2-million each. At 158 760 kg (350 000 pounds), it was the heaviest bomber in the world. Now, with more than 60 years of service, the B-52 has a 31 752 kg payload capacity, can climb to 50 000 feet and fly at 565 knots.

The company continues to support and maintain the aircraft in the 21st century. After World War II, the British paved the way for commercial jets with the de Havilland Comet. Metal fatigue that led to catastrophic accidents grounded the Comet, and interest in the jet disappeared.

## BOEING BUILDS PASSENGER JETS

Boeing's civil aviation department had only two noteworthy airliners; the 314 Clipper, and 307 Stratoliner. In 1949, Boeing began studies for a new jet transport, knowing that it must be aimed at both the military and civil markets.

In 1950, the company's share of the passenger market was less than 1%. Boeing's president, William Allen, gambled on a vision that the future of commercial aviation was jets. In 1952, the company committed

\$16-million dollars to building the pioneering 367-80, nicknamed the "Dash 80." That amount represented almost all the profit the company had made since the end of the World War II. The Dash-80 name derives from the fact that it was the 80th variation that Boeing designers drafted.

The Dash-80 prototype led to the commercial 707 and the military KC-135 tanker. Both planes shared the basic design of the Dash-80. Its width, and the 30.5-metre length made it the largest passenger cabin in the air.

Location of passenger doors on the left side, at the front and at the rear of the cabin, became standard for Boeing jets.

The 707 was commercially successful by evolving through eight civilian variants with the capacity from 140 to 219 passengers, and a range of 2 500 to 5 750 nm. It dominated passenger air transport in the 1960s and remained in service throughout the 1970s.

It established Boeing's dominance in commercial aviation and as one of the largest manufacturers of passenger aircraft. The later 720, 727, 737, and 757 share elements of the 707's fuselage design.

## 727 TRI-JET

Against advice of many inside the company, on December 5, 1960, Boeing announced the three-engine 727, with 40 orders each from United Airlines and Eastern Air Lines. It would become the



first commercial aircraft to break the 1 000-sales mark, but it started out as a risky proposition.

The 727 was designed to service smaller airports with shorter runways than those used by Boeing 707s.

Another US company competing was Douglas, with the DC-9. Boeing also faced overseas competition from de Havilland's Trident, Sud Aviation's Caravelle and British Aircraft Corporation's. BAC 1-11.

The 727 was the first Boeing jetliner to undergo demanding fatigue testing, the first to have completely powered flight controls, the first to use triple-slotted flaps and the first to have an auxiliary power unit (APU). The APU, eliminated the need for ground power or starting equipment in the airports of developing countries.

Originally Boeing planned to build 250. However, it proved so popular especially the larger 727-200 model, introduced in 1967, which carried up to 189 passengers, that a total of 1 832 were built.

In September 1984, the 22-year production ended. The once "risky proposition" had become one of the best selling commercial jets in history.

## 737 – THE BABY BOEING

In 1965, the Boeing name was synonymous with big multi-engine jet aircraft, so when the company announced its new commercial twinjet, the 737, it quickly earned the nickname "Baby Boeing."

The 737 has grown into a family of ten passenger models with various passenger capacities. The 737-100 made its first flight in April 1967.

The smaller, short-range twinjet was the logical to complement the 707 and the

727, but the 737 faced heavy competition from the Douglas DC-9 and BAC's 1-11. To get the plane to the market quickly, Boeing installed the same upper lobe fuselage as the 707 and 727 so that the same upper deck cargo pallets could be used for all three jets.

Initially the 737 was called the "square" aircraft because it was as long as it was wide. Its technology made the flight engineer redundant; which led the two-person flight deck becoming standard among air carriers.

In July 2012, the 737 became the first commercial jet aircraft to surpass the 10 000 ordered, and by 2014, Boeing was building 42 737s every month, and planned to increase the rate to 52 per month in 2018, to meet continuing demand.

Today, Boeing estimates that, on average, more than 2 000 737s are in the air at any given time, with one jet taking off or landing somewhere in the world every two seconds.



"Baby Boeing." The Museum of Flight's 737-100, the prototype, made its first flight on April 9, 1967. Boeing used the 737 as a flight test aircraft before it became NASA's Transport Systems Research Vehicle in 1974. The Boeing 737 is now legendary as the best-selling commercial aircraft in aviation history with 13 237 orders and 8 845 delivered as of Dec. 2015. The back log in orders, 4 392, are for the Next Gen and the MAX variants. (Photo: Henry M. Halden)

## 747 JUMBO JET

Failing to win the C-5A military transport contract, Boeing began development of a large, advanced commercial aircraft to take advantage of the high-bypass engine technology developed for the C-5A. It would be a completely new aircraft, and other than the engines, the designers resolutely avoided using any hardware developed for the C-5A.

The 747 was the first wide body jet ever produced. The original version of the 747 was two and a half times the size of the Boeing 707. The incentive for creating the giant 747 came from reductions in fares, a surge in air-passenger traffic, and increasingly crowded skies.

First flown commercially in 1970, the 747 held the passenger capacity record for 37 years, but its beginning wasn't a sure thing.



The prototype 747 is 225 feet (68,5 metres) long; the tail is as tall as a six-story building. Pressurized, it carried a ton of air. The cargo hold had room for 3 400 pieces of baggage and could be unloaded in seven minutes. The total wing area was larger than a basketball court. Today it sits in the Museum of Flight in Seattle. (Photo: Henry M. Halden)





This aircraft is a specially modified 747-400 that transports the large composite structures, including huge fuselage sections of the 787 Dreamliner. The massive cargo is loaded and unloaded from a hinged rear fuselage. The last of the series of four was delivered Feb. 16, 2010. (Photo: Henry M. Holden)

## FINANCIAL HARD TIMES

In 1968, Boeing's earnings fell from \$83-million to approximately \$10-million the following year. Over the next 22 months the workforce dropped from 108 000 employees to 62 800. Rising fuel costs, and falling passenger revenue created the perfect storm.

With the recession of 1969–70, and the company's \$2-billion debt, it struggled to build the 747.

The aircraft was stalled in production for three months because of engine problems. Another struggle was that, in 1970, the company began a 17-month period without a single new order from any US airline.

In March 1971, the US Senate rejected the funding to develop the SST, the supersonic 2 707 transport with commercial and military applications, forcing the company to discontinue the project. Some had predicted the SST would replace the 747.

The concept of supersonic travel had received wide negative press. Environmental groups protested about the noise of the jet's sonic boom, and the impact of high amounts of fuel it burned had on the ozone layer.

By 1977, the company was pulling out of the recession. The 747 began to sell well with 300 in the skies, and another 100 orders placed by the decade's end.

On June 28, 2014, Boeing delivered the 1 500th 747 to Lufthansa. The 747 was the first wide-body airplane in history to reach this milestone.

## 757 AND 767

With its earnings up by 75 % in 1979, and an order backlog worth \$11-billion, CEO Thornton Wilson announced the development of two new airliners concurrently, 757 and 767. Boeing could finance the \$3-billion development cost of its new aircraft out of its own earnings.

The twin-engine, medium-range 757 rolled out in 1982. It was the replacement for the 727 tri-jet. It was 80% more fuel efficient than the older 727 and was still able to perform the 727's short-field capability.

Both shared the same technological advances in propulsion, avionics and materials. The pioneering computerized flight decks, or "glass cockpits," are nearly identical, so pilots could easily qualify to fly both.

On November 28, 2005, Boeing ended 757 production because the increased capabilities of the newest 737s and the new 787 fulfilled the 757 market's needs.

## MODEL 777

The Model 777, introduced in June 1995, was the first new Boeing aircraft in more than a decade. It was the first jetliner to be 100% digitally designed using three-dimensional computer graphics. Throughout the design process, the aircraft was "pre-assembled" on the computer, eliminating the need for a costly, full-scale mock-up.

In August 1997, Boeing merged with McDonnell Douglas

in a 13-billion-dollar stock swap under the name The Boeing Company.

However, this name had been Boeing's official name created on May 21, 1961. The McDonnell Douglas MD-95 was renamed the Boeing 717. Boeing introduced a new corporate identity incorporating the Boeing logo type and a stylised version of the McDonnell Douglas symbol, which was derived from the Douglas Aircraft logo from the 1970s.

## BOEING IN SPACE

From the early days of the space programme, Boeing was part of the most successful, daring, and dangerous project ever conceived by man, to land a man on the Moon and return him safely to Earth.

In 1929, William Boeing said, "Science and hard work can lick what appeared to be insurmountable difficulties." Project Apollo would prove Boeing right.

Boeing became the technical coordinator of the Apollo project following the fatal fire in the command module during preparations for the first Apollo flight in 1967.

Boeing's contribution to the Apollo programme was not a money maker, and its cost would contribute to the company's financial stress during the 1970s.

Long before the Eagle landed on the moon, Boeing was tasked to find safe landing sites for the Apollo command modules. Boeing built crewless lunar orbiters to circle and photograph the moon's surface.

Five were built and had to operate precisely because photos could only be taken under the proper lighting and

temperature conditions. Amazingly, just 50 years earlier the company was building open cockpit biplanes made of wood and fabric.

In October 1972, Boeing launched its "72" – a scientific satellite, which circled the earth 26 075 times during its first five years of sun synchronous circular orbit. It eventually logged more than 37 300 637 miles. This was important to later satellite development.

Boeing built lunar roving vehicles to explore the terrain of the moon. Virtually all of the Project Apollo's spacecraft and launch vehicles, including the Saturn V rocket, Apollo command and service modules, and lunar rovers, were designed, developed, and built by Boeing, and Northrop American Rockwell. Later other aerospace manufacturers became part of it.

Boeing was in charge of building Stage One of the Atlas V rocket. North American Aviation, and Douglas Aircraft were responsible for Stage Two and Three.

An important project during the early 1980s was the Space Shuttle, to which Boeing contributed with its experience in space rockets acquired during the Apollo era. Boeing was the first contractor for the International Space Station programme.

Boeing will enter its second century officially on July 15. What the future holds for it is anyone's guess, but it is a pound-to-a-penny bet that it will survive all threats to its well being and end its 100<sup>th</sup> year stronger than ever. →

(See Page 26 of this issue for a thumbnail sketch of William Boeing's life in this month's Personality Corner).