

# [Development of the boeing 747](https://assignbuster.com/development-of-the-boeing-747/)

Boeing 747 Jumbo Jet: The aircraft that changed the world

## Introduction

In the early days of commercial airline transport, air travel saw a large increase in travellers and airport congestion rising in the 1960s. This era of commercial airline travel was led by the enormous popularity of the Boeing 707 and the Douglas DC-8, both of which had revolutionized the standard for long-distance travel[1]. With the increase ofcommercial airlinepassengers and the relatively small aircrafts available at the time, airport congestion was becoming a major problem in the industry. Juan Trippe, of Pan Am (Pan American World Airways), one of the Boeing’s most important airline customers thought this problem could be addressed by a newer and larger aircraft[2].

During the summer of 1965 on a quiet fishing trip in Alaska, Bill Allen of Boeing and Juan Trippe of Pan Am, the two biggest names in the aviation industry at the time, Trippe told Allen of his vision for a super plane. Trippe wanted an aircraft that was two and a half times larger than any other passenger aircraft that had ever existed before. Both Trippe and Allen were reaching retirement, and both wanted to leave their mark in the aviation industry. It was at this point when the birth story of theBoeing 747began and would change the aviation industry forever.

## Development

In April 1966, Trippehad signed for an order for 25 of the newly proposed super jets and for them tobe called the 747. This was one the largest aircraft orders ever to be made inhistory. This costs for this order at the time came to a total of approximatelyUS$525 million dollars which translates to a value of a staggering US$4. 2billion dollars today[3]. Allen had also agreed that Trippe could have his order in just a mere 28months. This had set an almost impossible challenge for Boeing’s engineers tocomplete.

Joe Sutter, ayoung aeronautical engineer whom graduated from the University of Washington in1943 was transferred from Boeing’s 737 development team to lead and manage theteam for the development and design of the new 747 as the Chief Engineer. Thiswas Sutter’s first big break as an engineer. With a small team of only 20members, Sutter and his team were required to go through preliminary studiesfor this aircraft which provided them with their first challenge for thedevelopment of the 747 as at the time all they knew was that the aircraft hadto be bigger, have good range and go as fast as possible. Back then, Sutter wasonly a junior engineer in the company and often faced a hostile reception fromthe more senior engineers of the company. Despite the size of the projectSutter and his team were facing and how they were working around the clock, they were still not Boeing’s number one priority. At the time, the developmentof the 747 was overshadowed by the development of a supersonic transportaircraft in which Boeing believed would be the future of the aviation industry[4]. This meant that Boeing’s best talent and resources was directed into thedevelopment of this aircraft.

A supersonictransport aircraft that was designed to travel at three times the speed ofsound and to compete with its European supersonic rival, Concorde, which wasalso in its development stage. When the supersonic transport aircraft was to becompleted and come into service, Boeing’s 747 would then be relegated toshipping freight. This influenced the design of the 747 so that it be adaptedeasily to carry freight and heavy cargo and to remain in production even if thesales of the passenger version were to decline. Because of this, the 747 wasalmost expected to be an afterthought and Boeing didn’t expect for more than 50of the 747s to be made and until the supersonic aircraft was completed, the 747was playing second fiddle the whole time. This lead to Sutter and his teambeing shoved into old premises and starved of resources making their challengeeven more difficult than before.

Initially, theshape of the 747 could have potentially ended up very different from thefamiliar shape we all know today. Trippe demanded an ocean liner of a design, with two narrow decks, one on top of the other. The first idea was to take theoriginal 707 and two of the single aisle fuselages and putting them on top eachother. This idea did not appeal to Sutter because of the poor capability ofcarrying cargo and he worried that in emergency situations, it was not feasiblefor passengers to evacuate off the top deck which would have been 25 feet (7. 62metres) off the ground. Sutter also thought the original idea looked like a“ Turkey”[5]. Sutter and his team decided that the best move would be to have a wide singledeck aircraft by having the two decks side by side which would then be theworld’s first widebody freighter aircraft. The opening of the nose was the bestway to load cargo into the aircraft which caused a problem for Sutter, where toput the cockpit? In a moment of pure genius, they decided the best move wouldbe to place it on top, this birthed the distinctive “ bulge” on the 747[6].

This causedconcern for Boeing as they were worried that Trippe, who was paying for theseaircrafts would be unhappy that he would not be receiving the double deckeraircraft he was originally hoped for. They decided to tell Trippe of the badnews but however, Sutter’s management refused to let Sutter tell Trippe as theywere concerned Sutter would go to hard on his and make Trippe furious. Instead, they sent their interior designer. They eventually convinced Trippe of the ideaby showing him a mock up of what his plane would look like. This enabled Sutterto continue the development of the first widebody aircraft in history.

The nextchallenge for Sutter and his team was to turn a wooden mock up of the aircraftinto a real flying machine. Using wind tunnels, they evaluated the aircraft andits performance in aerodynamic situations. Only the first flight could tell ifthe aircraft could really fly. This part was still critical because if they hadgotten the design wrong during the wind tunnel testing, the consequences couldhave been disastrous. Sutter’s team drew up seventy-five thousand drawings, allof which detailed how every part fitted in the prototype of the aircraft. Soon, Sutter and his team were running out of space. This lead to the construction ofBoeing’s Everett factory. This factory is the largest building in the world interms of volume and was initially built specifically to produce the Boeing 747[7].

The firstprototype of the 747 was made up of 4. 5 million parts, over 100 miles (160kilometres) of wiring and nearly 75 tonnes (75000 kilograms) of aluminium. Theexpenses for this prototype was costly and Boeing was faced with anotherchallenge when new orders for the aircraft were made by 25 other airlines meantthat production models needed to be started. The 747 was costing over US$6million a day, despite this amount, there was no “ real” money being received byBoeing as the airline companies only agreed to pay upon delivery of thefinished aircraft. This caused a cash crisis for Boeing[8]. To deal with this crisis, Sutter was summoned to a high-level meeting and wasfaced with the decision of losing his job or being forced to cut over athousand engineers, which at this point was over a quarter of his workforce. Sutter took a leap of faith and refused to back down or let any of his workforce go. Sutter eventually won the standoff. Boeing had no option but to continuewith the project. At this point, Sutter and his team had to speed up theproduction of the prototype as the scheduled press-launch day was fastapproaching. This was a problem as the prototype had more parts on the floorthan in the actual aircraft. Sutter and his team managed to put together thefirst 747 prototype 2 days before the scheduled show day and on September 30, 1968, the 747-prototype rolled out of the Everett assembly building in front ofthe world’s press and representatives of 26 airlines that had ordered theaircraft[9]. For Bill Allen, this was a relief for him as there was something to show forthe press, Pan Am and the representatives of the other airline companies.

This was theaircraft sensation of the decade. However, behind all the excitement, theaircraft still could not fly, and the engines mounted to the aircraft werepurely decorative and not functional. From this point, Sutter and his team onlyhad 54 days before the prototype was scheduled for its first flight and theyhad a major crisis on their hands with the engines as commercial jet engine atthe time had the enough power to lift even half the weight of the 747. Jetengine manufacturers, Pratt & Whitney had developed a new, untested enginethat could provide enough power to lift the 747. This engine was the Pratt& Whitney JT9D, a high-bypass turbo fan engine which was an entirely newconcept which promised good fuel efficiency, low noise and phenomenal thrust[10]. Fundamentally, this engine was a jet engine which drove a massive fan on thefront. The secret to the design was the massive 8-foot (2. 4 metre) fan on thefront. This allowed for more air to pass through the central turbine andbypassed more than five times as much air around the outside. This bypassingair added an extra 70% more thrust and softened the roar of the turbine at theexhaust, allowing for a quieter engine. Pratt & Whitney promised to makethe Boeing 747 quieter than aircrafts half its size and two and a half timesmore powerful. However, when tests of the engine came around, it had seemedthat Pratt & Whitney were promising too much. During testing of the engine, Pratt & Whitney faced the problem of the engine suddenly combusting intoflames. For a while, no one could figure out the problem with the engine. During the time, a total of 6 multi-million-dollar engines were written off.

Despite all this, Boeing could not wait any longer and had to prove to the world that the 747could fly. On February 9, 1969 and two months behind schedule, the first flightof the prototype 747 was conducted[11]. Test pilots Jack Waddell and Brien Wygle conducted the first test flight of theprototype. Despite a minor problem with one of the wing flaps, Waddell andWygle confirmed that the 747 handled very well. Now that they had proven thatthe 747 prototypes could fly, they now had to prove to the aviation authoritiesthat the aircraft was also safe enough to carry passengers.

With just 11months left, Sutter and his team had to begin putting the aircraft throughseries of harsh tests regardless of the weather conditions. This includedslamming on the brakes at high speeds on the runway, which caused the wheels toburst into flames. The standby crew had to wait an anxious five minutes beforethey could extinguish the flames. Test pilot, Waddell deliberately flew theaircraft into death defying storms as well as scraping the tail along therunway to simulate a too steep of a take-off. Above all, the aviationauthorities wanted to check that the 747 could be evacuated in less than 90seconds as the 747 would be carrying more passengers than ever before as asingle fatal accident could kill more than four hundred passengers. Soon after, the 747 was passing the tests with flying colours due to Sutter’s ingenuity toinstall unparalleled safety features. These features included three back upsystems that would enable the aircraft to remain airborne even if only one wasworking. To Sutter, the safety of the aircraft and of the passengers was themost important features to him during the designing phase of the 747. The verythought of the aircraft crashing due to inadequate safety design is what wouldkeep Sutter up during the night. This set the bar for the safety standard ofaircrafts in the industry and the same standard can be seen followed closely byaircrafts made today.

However, Sutterand his team face what is considered every aircraft designer’s worst nightmare– “ flutter”. At certain speeds, wind tunnel tests showed that flutter causedviolent vibrations that can shake an entire aircraft apart. Test pilots Waddelland Wygle had to deliberately put the aircraft into the danger zone (whenflutter would occur) for short periods of time to learn more about thecondition of flutter. After a month a repeated testing and gathering of informationof flutter, they had worked out a solution to the problem. They found that byusing small heavyweights at the tip of the wing were able to dampen thevibrations caused by flutter.

During this time, airline companies were investing millions into new facilities to prepare forthe arrival of the 747. However, this would have been all for nothing if theengine faults and problems were still unsolved. And with only months leftbefore the 747 were due to go into service, production models of the 747 were pilingup outside of the Everett factory. These models usually had concrete blockshanging off their wings in where the engines should have been mounted[12]. This was to prevent the aircraft from tipping up on their tails as they waitedfor their completed engines. With all these models grounded, Boeing was closerto bankruptcy than ever before. The team knew the engine problems were serious, but they also felt that Pratt & Whitney were not taking it seriouslyenough. To solve this problem, test pilots Waddell & Wygell decided to takethe president of Pratt & Whitney on a test flight and show them theproblem. Waddell blew the first engine and then the second to prove it justwasn’t a rogue engine. As he was about to do the third, the president of Pratt &Whitney finally understood how serious the problem was. Because of the this, Pratt & Whitney worked harder to find the cause of the problem. The causeof the problem was due to the large front fan distorting the inner enginecasing under certain conditions so that it no longer made a snug fit around thespinning turbine blades which caused the air and fuel mixture to break up andexplode. This was solved by simply stiffening the casing[13]. At long last, engineers raced to fit the new engines and the 747 could finallygo into service.

## Conclusion

The Boeing 747was built in just a mere 28 months and against all the odds and difficulties. The engineers apart of the team responsible will take pride that their creationwill be looked at with wonder, well into the future!

[1]“ Boeing 707 Multimedia Image Gallery” retrieved August 28, 2018, from https://web. archive. org/web/20120111124513/http://www. boeing. com/companyoffices/gallery/images/commercial/707-03. html

[2]“ Innovators: Juan Trippe” retrieved August 28, 2018, from http://www. pbs. org/wgbh/theymadeamerica/whomade/trippe\_hi. html

[3]“ 1965 Dollars in 2018” retrieved August 28, 2018, from http://www. in2013dollars. com/1965-dollars-in-2018? amount= 525000000

[4]“ Air travel: A supersonic future?” retrieved August 28, 2018, from http://news. bbc. co. uk/2/hi/uk\_news/852087. stm

[5]“ Boeing 747 Double Decker Early Proposal” retrieved August 28, 2018, from https://web. archive. org/web/20150512211307/http://airwaysnews. com/html/museums/boeing-archives-bellevue-washington-usa/boeing-747-double-decker-early-proposed-design-model-mid-to-late-1960s/19091

[6]“ Boeing 747 Early Proposed Designs” retrieved August 29, 2018, fromhttps://web. archive. org/web/20150616121707/http://airwaysnews. com/html/museums/boeing-archives-bellevue-washington-usa/boeing-747-anteater-early-proposed-designs-model-mid-to-late-1960s/19088

[7]“ Boeing Major Construction Facilities” retrieved, August 29, 2018, from https://web. archive. org/web/20071115211523/http://www. boeing. com/commercial/facilities/index. html

[8]“ The Boeing 747” retrieved August 29, 2018, from https://web. archive. org/web/20121007143215/http://www. centennialofflight. gov/essay/Aerospace/Boeing\_747/Aero21. htm

[9]“ All but off the ground” retrieved August 29, 2018, from http://content. time. com/time/magazine/article/0, 9171, 838835, 00. html

[10]“ Aero Engines 1968” retrieved August 30, 2018, from https://www. flightglobal. com/FlightPDFArchive/1968/1968%20-%200022. PDF

[11]“ Queen of the Skies” retrieved August 30, 2018, from, https://web. archive. org/web/20041207091236/http://www. boeing. com/news/releases/2004/q1/nr\_040209g. html

[12]“ The Trouble with Jumbo” retrieved August 30, 2018, from, http://content. time. com/time/magazine/article/0, 9171, 844949, 00. html

[13]“ JT9D Engine” retrieved August 31, 2018, from, http://www. pw. utc. com/products-and-services/products/commercial-engines/JT9D-Engine/