Novelty to an Industry, Air Travel in the U.S. during the 1930s

By Gary L. Killion

The airline passenger of 1930 was truly a brave soul with a strong spirit of adventure. If the travel involved any distance, the passenger also had to possess a great deal of stamina to endure the noise and vibration of contemporary airline airplanes, such as the Ford, Boeing and Fokker trimotors. The turbulence in which those airplanes sometimes had to fly could also be very unpleasant. Many feared to fly because they didn't understand basic principles of flight. That lack of understanding was exacerbated by the typical news media description of an accident — the airplane 'fell' from the sky.

Cabin of a Fokker F-10 illustrating a typical airline cabin and cabin service of 1930. (Photo from the Gerald Balzer collection, AAHS archives)

Over water flights also demanded a great deal of stamina to endure the primitive flying boats. With the exception of Intra-Hawaii flights begun the year before, "over water" basically meant travel to Caribbean or Latin American destinations — transatlantic or transpacific travel by air would remain an unrealized dream for several years.

Although air mail defrayed much of the operating cost, the prospective airline passenger of 1930 had to have a degree of wealth to afford the fare. This was in the middle of a severe depression where many were unemployed and hardly had enough to survive, let alone travel. Nevertheless, enough people were attracted by air travel to support the small, but growing, airline industry. Some flew to reach their destination earlier than ground transportation would permit. Some flew for the novelty; others flew for the sheer exhilaration of looking down on the world from a commanding height.

The majority of the domestic routes were flown by subsidiaries of three large corporations — United Aircraft Corporation, North American Aviation, and Aviation Corporation (AVCO). In addition, each owned subsidiaries involved in other facets of aviation. For example, United Aircraft Corporation owned Boeing, Pratt & Whitney and Hamilton Standard — producers of aircraft, engines and propellers, respectively — as well as the airlines that would become United Air Lines. Those arrangements generally assured a ready market for the manufacturing subsidiaries and a source of competitive equipment for the airlines.

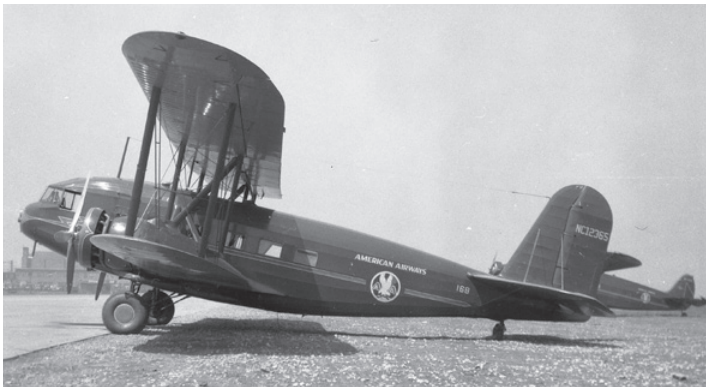
Carrying passengers alone was not profitable in the early 1930s; however, the airlines were able to survive with government subsidies in the form of air mail contracts. Although there was little direct control of the airlines, the federal government exercised almost total control indirectly through those contracts and was thus able to break up the manufacturer-operator relationships by passage of the politically-motivated Black-McKellar Act of 1934.

The competition for passengers was particularly keen among U.S. airlines and the manufacturers that supplied their airplanes. Due largely to this competition, there were advances in safety, reliability, and comfort exceeding those in decades of railroad operation. Even with the slower airplanes used then, travel by air offered significant time advantages over surface transportation.

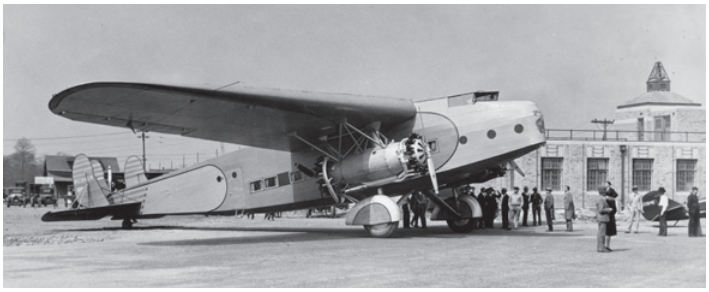
The majority of the airplanes in which a 1930 passenger could fly were archaic in comparison to those that would follow just three years later, but they were an improvement over the smaller single-engines airplanes used in the very early days of airline travel. The most numerous were the Fokker, Ford and Boeing trimotors that had just gone into into service. Each model carried about 12 to 18 passengers and cruised around 110 to 120 mph. None had retractable landing gears.

Fokker F-10s — basically trimotor developments of the earlier single-engine Super Universals — were considered equals of Ford Tri-motors until the infamous 'Knute Rockne' crash in March of 1931. Although turbulence may have been a contributing factor, the cause of the accident was attributed to deterioration of its plywood wing. The remaining aircraft were eventually permitted to go back into service; however, their further use was uneconomical due to the required structural inspections. Anthony H. G. Fokker returned to his native Netherlands, where he would become very instrumental later in the sale of DC-2s and DC-3s as the Douglas sales representative in Europe.

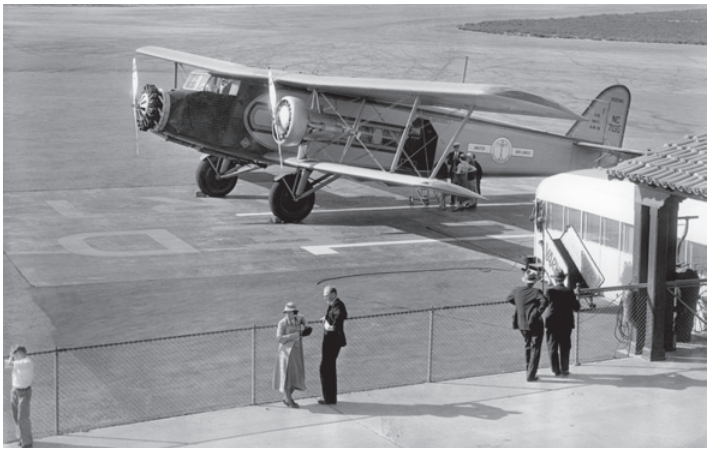
Most of the airlines in the 1930s could not have survived without U.S. Postal Service contracts to carry the mail. Here we see a Ford Tri-motor receiving mail sacks from another Ford product. (Photo from the Gerald Balzer collection, AAHS archives)



American Airways Curtiss T-32 Condor, NC12365, c/n 25. (Photo form the Gerald Balzer collection, AAHS archives)



The 1930 version of a 747 wide-body, the Fokker 32 offered two-by-two seating. Capable of seating 32 passengers it often flew with less due to performance limitations. Here we see NC342N, c/n 1207 on a ramp waiting to board passengers. (Photo from the Gearld Balzer collection, AAHS archives)



A United Air Lines Boeing 80A, NC7135, at Burbank, Calif., preparing to board passengers. (UAL photo from the Walt Bohl collection, AAHS-D020255)

Unlike the Fokker F-10s, the Ford Tri-motors utilized aluminum structure with corrugated outer surfaces, prompting the name "The Tin Goose." Apart from being an excellent design for its time, it enjoyed being produced by one of the strongest American industrial companies. A few are still flying today, just short of a century later!

The most obvious difference of Boeing's 80-As from the Fokker and Ford trimotors was that they were biplanes. They were intended specifically for new Boeing Air Transport routes over high altitude terrain and long distances. An immaculately restored survivor is on display in Seattle's Museum of Flight.

Curtiss took a different approach to designing an airliner — just modify an existing bomber. The resulting Condor COs were somewhat larger than the trimotors with seats for 18 passengers and were slightly faster. On the negative side, modifying the fuselage of a bomber to carry passengers resulted in a more cramped cabin. Airlines weren't very receptive to the two liquid-cooled engines inherited from the bombers either. Curtiss later created the T-32 Condor by widening its fuselage for sleeper flights, but its success was also cut short quickly by the advent of the Douglas DST.

The large Fokker F-32 went the trimotors one step farther with four of the most powerful engines available for airline aircraft at the time. Unfortunately, the '747' of its day was well ahead of its market as its 32 seats could be economically filled on very few, if any at all, routes in the world. Its tandem tractor-pusher installation also caused problems, such as providing adequate cooling of the pusher engines. Its very rapid final demise came about, however, as a result of the 'Knute Rockne' crash — it's wing would have been subject to the same plywood deterioration. It was the last Fokker model built in the U.S. for airline use.

Stinson also supplied some trimotor aircraft, but they didn't go into service until after the decade of the 1930s had begun.

It was early in this dynamic decade that a new generation of

twin-engine airplanes contributed a number of major advances in airline safety, comfort and profitability. That new generation was represented initially by the Boeing 247, then a year later by the Douglas DC-2 and Lockheed Electra. Each was a fully-cantilever low-wing airplane with a retractable landing gear and was quite streamlined for that era — quite a contrast to any previous airline airplanes.

Not the least of those advances was the beginning of the 'fail-safe' concept. Basically, fail-safe means that if something essential for safety could fail, there has to be something else that can take its place until the airplane can be landed safely. Although this concept would be extended later to structure and virtually every essential part of an airplane, it first addressed engine failures. First, the engine installation had to be such that one failure, that of a fuel system component for example, could not cause the loss of power from more than one engine. If one engine did fail at any point from takeoff to landing, there had to be sufficient performance available with the remaining operative engine (or engines) to continue the flight to a safe landing. Meeting that goal was facilitated first by new variable-pitch propellers and later by full-feathering propellers that greatly reduced the drag from a failed engine. Some of the early airline airplanes, such as the trimotors mentioned above, did have more than one engine, but their performance was insufficient to assure continued safe flight under many conditions with an inoperative engine. Some have asserted that they were actually less safe than single-engine airplanes because the probability of experiencing an engine failure at a critical time was three times as great. Fail-safe obviously ruled out any future single-engine airliners; but existing airplanes, such as Lockheed Vegas and Orions, Vultee V-1As and Northrop Deltas, were effectively eliminated in 1934 when scheduled passenger service with single-engine airplanes was prohibited at night or over inhospitable terrain. Fail-safe was inevitable, but its importance cannot be overstated — without it, travel by air would have remained a risky novelty rather than the reliable form of transportation we take for granted. In addition to the obvious improvement in safety, a secondary benefit was the improved climb and cruise performance realized under normal conditions with all engines operating.

This new generation also marked the departure of airliners from fabric-covered wooden or steel truss construction to more durable monocoque aluminum construction.

The Boeing 247 – A New Era Begins

The first of this trio, the Boeing 247, was very streamlined for its day with accommodations for 10 passengers. An anodized finish on exterior aluminum surfaces gave it a dull grey, patched appearance, which was later rectified on some airplanes with an overall coat of enamel. The first flight occurred on February 8, 1933, and Approved Type Certificate 500 was issued a month later. (The redundant 'Approved' was later dropped from references to the certificates. Type Certificate numbers were not preceded by 'A-' as sometimes quoted in error.) Two Pratt & Whitney 550hp Wasp S1H1 engines afforded a cruising speed of about 155mph.

By comparison, the last model of the Ford trimotor series,

Boeing 247 owned by the Seattle Museum of Flight and restored in the overall paint adopted by United to cover the original dull gray anodized finish. Note the original forward-sloping windshield. (Photo from the author's collection)

the 5-AT-C, was not streamlined in the least with its corrugated exterior surfaces, non-retractable landing gear, and two of its three engines mounted on struts under the wing. Consequently, it could only cruise about 120mph using three earlier 420-hp Wasp C1 engines.

One 247 flown by Roscoe Turner and Clyde Pangborn managed to place third in the 1934 MacRobertson London to Melbourne race. The winner was one of three purpose-built de Havilland Comets. All three were expected to be winners, but the other two did not fare well. One placed behind the 247, and the other failed to even complete the race! Other highly regarded entrants also failed even though designed for competition. In contrast, the 247 was a stock American airliner. With the additional fuel tanks removed from the cabin following the race, United Air Lines placed it in regular scheduled service!

Due to its promising advanced design, the 247 changed the competitive picture somewhat when the airlines learned of its pending development. In order to give its corporate family member the greatest possible advantage, Boeing refused to deliver 247s to any other airline until an entire 60-airplane order was delivered to United Air Lines. Denied timely delivery of 247s, Transcontinental & Western Air (TWA) faced the prospect of competing with United using obsolete equipment. TWA's parent corporation, North American Aviation, also owned aircraft and engine manufacturing subsidiaries, but had nothing in sight comparable to the 247. Unable to obtain competitive equipment from within its own corporate family, TWA turned to other manufacturers. The choice was a design even more advanced than the 247 — the Douglas DC-2. Although Douglas was not a subsidiary, North American did hold a financial interest in the company at the time.

The Douglas DC-2 – The First of a Long Line

Second place in the MacRobertson race was an even greater tribute to American airliner design. The KLM (Koninklijke Luchvart Maatschappi) DC-2 earning that honor was not only a stock airliner, but was carrying paying passengers!

DC-2s were somewhat larger than 247s with accommodations for 14 passengers. They were all-metal; but unlike Boeing's dull grey products, they had gleaming Alclad construction. Alclad,

Passengers deplaning TWA DC-2 "City of Wichita" with TWA DC-2 "City of Philadelphia" in the foreground. (AAHS archives, AAHS-D020187)

First Lockheed Electra after original forward sloping windshield was replaced. (Lockheed photo from the author's collection)

which was developed by Alcoa in the 1920s, enjoyed the best of both worlds with an aluminum alloy optimized for structural strength and a protective coating of pure aluminum for better corrosion resistance.

The pre-production predecessor, the DC-1, first flew July 1, 1933. It is sometimes asserted that the DC-2 was inspired by the advanced design of the 247. Douglas personnel would have been aware of Boeing's design effort, but the 247 did not precede the DC-1 enough to have contributed in any way to the Douglas design. The Douglas products actually showed more of John K. Northrop's influence in their design than any similarity to the 247.

Approved Type Certificate 540 was issued June 28, 1934, for the DC-2. Most were built with Wright GR-1820-F series engines; however, at least three were powered with similarly-rated Pratt & Whitney Hornet engines. A few were delivered to the Polish airline LOT (Polskie Linie Lotnicze) with British Bristol Pegasus IV engines. Depending on which engines were installed, they achieved cruising speeds about 180 mph.

Many DC-2s were sold by the Douglas European sales representative, Anthony H. G. Fokker, and reassembled in the Netherlands following their shipment by sea from Douglas. Fokker, a prominent airliner manufacturer himself, recognized their excellence and negotiated a license to manufacture them in the Netherlands. He also negotiated a sublicense agreement with Airspeed in England. None were actually manufactured in the Netherlands or in England; however, five were assembled in Japan from components supplied by Douglas.

United did have an advantage when the 247 went into service on March 30, 1933; but the monopolistic approach soon failed for both Boeing and United. When the large United order was finally completed, airlines that once wanted 247s were no longer interested. Had Boeing and United not made that error in judgement, TWA and other airlines would have gladly ordered 247s. With no sponsoring airline, Douglas would not have built the DC-2. Possibly it might never have become a manufacturer of airline equipment. Nevertheless, the error was made; and TWA and other airlines were soon operating DC-2s, while United was burdened with a huge fleet of obsolete 247s. Consequently, only 75 were produced — the vast majority of which went to United — while 198 DC-2s were produced for U.S. airlines, foreign airlines and military services. Even more DC-2s would have been sold had they not been superseded in production by DC-3s.

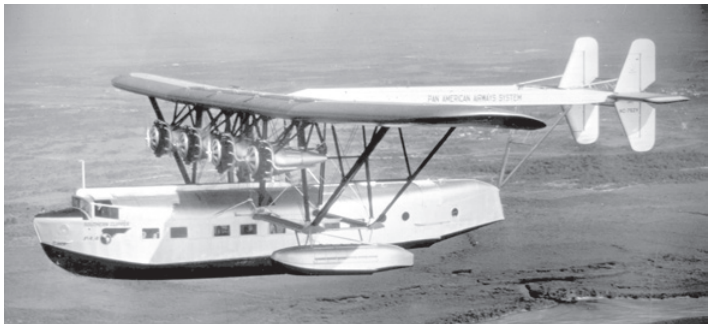
The Lockheed Electra – An Advanced Design for Routes Less Travelled

The third member of the new generation was the slightly smaller Lockheed Electra. It differed in appearance from the other two primarily by having twin vertical tail surfaces. A comparison with the 247 provides a measure of the progress made in airliner design during the brief time separating the two models. Each carried 10 passengers, but the Electra was smaller and lighter. Despite having 13% less power, the Electra was considerably faster than the 247; and its range was superior. The Electra was also slightly faster than the DC-2, again depending on which engines were installed; but the seat-mile costs of those two models were comparable. The choice was, therefore, largely dependent on the anticipated traffic volume. It is interesting to note that both models were almost as fast as the pursuit airplanes of the day.

Approved Type Certificate 551 was issued August 11, 1934. The second Electra had been delivered to Northwest Airlines a few days earlier, only to be destroyed on August 4th when the left engine failed just after takeoff from Milwaukee, Wisconsin. Fortunately, there were no fatalities to mar the Electra's early service. Due to apparent unfamiliarity with the certification process of the 1930s, one historian implied the flight was not conducted legally because the accident occurred before the type certificate was issued. During that period, all type certificates were issued by the Bureau of Air Commerce

Stinson A, NC15165, c/n 9125, restored in Pennsylvania Central colors was photographed at a 1980s Merced, Calif., fly-in. (Al Hansen photo from the AAHS archives, AAHS-P008107)

N.Y.R.B.A Line, Consolidated Commodore Havana*, NC659M, c/n 3, prior to becoming part of Pan American Airways. (AAHS archives, AAHS-P004800)*



Pan American Airways Sikorsky S-40 Southern Clipper*, NC751V, c/n 2002. (AAHS archives, AAHS-D000981)*

from its Washington, D.C., headquarters. The regional office (located in the Los Angeles area in that case) was responsible for administering the certification program and for giving so-called 'tentative approval' upon its completion. Based on the tentative approval, tentative airworthiness certificates were issued for eligible individual airplanes, enabling them to go into service. Meanwhile, the regional office would advise headquarters that tentative approval had been granted; and, assuming there were no unforeseen difficulties, the type certificate would be issued in Washington sometime later. The whole process was delegated to the regional offices a few years later, eliminating the need for tentative approvals.

Fokker represented Lockheed as well as Douglas in Europe. Within two months of the Electra's first flight, the Air Ministry of France purchased the right to produce them in that country. According to the *New York Times*, the French were influenced by Fokker's concurrent negotiations with German interests. None were actually built in France, but the fact that four major European countries were negotiating for such rights before either the DC-2 or Electra had gone into service reflected the promise held for the new generation of American airliners. Actually, neither model had any real competition at home or abroad. Altogether 148 Electras were produced.

One special Electra with cabin pressurization was delivered to the Army Air Corps as the XC-35 in August 1937 to study technical and physiological problems associated with high-altitude flight in what were termed then as "supercharged" cabins. In recognition of the contribution this test program would make toward future high-altitude flight, the Air Corps was awarded the Collier Trophy for 1937.

The Stinson A – The Last of the Trimotors

Even though it was an anachronism in some respects, a fourth model of this era, the Stinson Model A, was advanced in other respects. Stinson, a subsidiary of AVCO, had previously produced a number of 1930 vintage trimotor airliners; however, the Model A differed in being an eight-passenger low-wing design with a retractable landing gear. It would be Stinson's last airliner. Because Lycoming, the AVCO engine subsidiary, had no engine in production powerful enough for it to be a twin-engine design, it incorporated three Lycoming R-680 series engines. Like the other Stinson products of that era, the fuselage used steel truss and fabric construction. With a highly efficient tapered wing, it was capable of taking off fully loaded in only 800 feet and landing in 600! It was also extremely well priced. Approved Type Certificate 556 was issued on Sept. 25, 1934, about three months after that for the DC-2. Altogether 31 were produced. It is interesting to speculate what its market share might have been had Stinson combined its basic design attributes with modern all-metal construction.

Conquering the Oceans

The flying boats in which a 1930 passenger could fly over water were also archaic in comparison to those that would follow later. Newly-introduced Consolidated Commodores, to be joined shortly by Sikorsky S-40s, could serve Caribbean destinations and, with numerous stops, could also reach Buenos Aires. There were, however, no commercial airplanes available then with sufficient range to cross the Atlantic or Pacific. A new generation of seaplanes, concurrent with the new generation of landplanes, was needed.

Although this new generation would be insignificant in the number of passengers served, they would be extremely important because they pioneered world routes that couldn't be served with existing landplanes or other flying boats. Airline service to foreign lands by an American airline meant only one — Pan American Airways and its subsidiaries. Having largely conquered the obstacles to Caribbean and South American service, Pan American set its sights on its biggest challenges of all — transatlantic and transpacific service. The primary challenge in crossing the Atlantic was weather — especially during the winter months. For the Pacific, it was distance. The 2,400-mile segment from the U.S. West Coast to Honolulu was the longest in the world having no intermediate place to refuel.

The Sikorsky S-42 – A New Era in Seaplanes

Pan American ordered a fleet of 10 Sikorsky S-42 flying boats on October 1, 1932. The high aspect-ratio wing of the

Pan American Airways Sikorsky S-42B Bermuda Clipper*, NC16735, c/n 4208. (H.E. Gilliand Jr. collection, AAHS-51705)*

This view of Pan American Martin 130 Philippine Clipper*, NC14715, c/n 557, clearly shows the raised cabin cross-section that provided a more aerodynamic wing-fuselage configuration. (AAHS archive, AAHS-D020825)*

S-42 was placed well above the fuselage on a streamlined pylon to be free from any sea spray. The tail surfaces were on another pylon at the aft end of the fuselage. Four wing-mounted 700-hp Pratt & Whitney Hornet engines enabled a cruising speed of about 150 mph. Seating was provided for 32 passengers in four separate water-tight compartments.

Although the first was completed in December 1933, flight testing had to wait until the following March reportedly because the adjacent Housatonic River was frozen. Approved Type Certificate 544 was issued the following July, and the S-42s were placed in service between Miami and Rio de Janeiro.

After the first three were built, the S-42 was superseded by an improved model, the S-42A, which incorporated later 750-hp Hornet engines and a wing that was four feet greater in span. Much, if not all, of the 17-ST aluminum alloy used in the S-42 was replaced with stronger and lighter 24-ST alloy. The changes enabled the passenger capacity of the S-42As to be increased to 37 seated or 14 in berths. Finally, the last were delivered as S-42Bs with increased fuel capacity for South Pacific service from Honolulu to New Zealand.

The Martin 130 – Conquering the Pacific

About the same time, Pan American also placed an order for three large, streamlined (for that era) Martin 130 flying boats. In lieu of using struts or a pylon to place the wing above the sea spray, the fuselage was deeper so that it could be mounted directly on top. Unlike the wingtip floats typically installed on flying boats, they had small stub wings, known as sponsons, at water level. Sometimes referred to as 'sea wings', the sponsons provided space for fuel as well as lateral stability while on the water. Four 830-hp Pratt & Whitney Twin Wasp S2A4-G engines enabled a maximum takeoff weight of 51,000lb, later increased to 52,520lb with 950-hp engines. The cruising speed was about 163 mph; however, they were frequently flown slower to increase their range.

The 130 first flew on December 30, 1934, and Approved Type Certificate 585 was issued the following October. It was approved for a maximum of 46 seated passengers or 22 in berths, but lacked sufficient payload to carry more than a few when sufficient fuel was provided for the long flights from San Francisco to Honolulu. Martin later developed the Model 156 that differed by having more wing area and power. It would have enabled more passengers to be carried on that segment, but Pan American decided to wait for Boeing 314s instead.

Due to reticence on the part of the British to approve transatlantic service until competitive British flying boats were also available, neither new model could be used to inaugurate Atlantic service. Instead, the Martin flying boats would be used to conquer the Pacific. They could fly all the way to the Philippines without obstruction from any foreign government.

The Pacific Infrastructure

Establishing reliable and sustainable Pacific airline service involved much more than just having airplanes that could fly from one refueling stop to the next. Except for the long flight to get there from California, well-populated Honolulu was no challenge. Guam also had pre-existing facilities due to an established U.S. Navy presence. The other two refueling points, Midway Island and Wake Island, were another matter, however.

Both were tiny atolls from which adjacent coral had to be removed to enable safe landing and takeoff areas. Water desalinization means had to be devised, and soil had to be brought to Wake from Guam in order for it to have any vegetation. Hotel and dining facilities were essential for the crew and passengers; and docking, fuel and maintenance provisions were required for the flying boats. Personnel had to be stationed at each stop to meet the needs of both passengers and airplanes. Not the least of the considerations was accurate

Wake Island showing the Pan American facilities, a Boeing 314 at the dock and seven Consolidated PBYs at mooring stations in the bay. Photo was taken May 25, 1941. (Photo from the Naval History and Heritage Command, 80-G-411112)

weather forecasting. Once all those needs were met, a reliable means of continuously resupplying the islands was needed.

Pan American used the Model 130 to inaugurate the first transpacific air mail service on November 22, 1935, and passenger service, albeit with very limited capacity, followed on October 1, 1936.

The Sikorsky S-43 – The 'DC-2' of Amphibians

Pan American's Sikorsky S-42s and Martin 130s would receive considerable acclaim for their ocean conquering exploits, but Sikorsky also developed a modern replacement for its earlier flying boats. The S-43s were amphibians with two Pratt & Whitney Hornet or Wright Cyclone engines and accommodations for as many as 16 passengers. They were intended primarily for use on shorter routes, over land or water, that weren't necessarily served on both ends by adequate airports. Later S-43Bs had two smaller vertical tail surfaces—probably to afford better water handling in cross winds than with the larger single fin and rudder. The S-43Ws were similar except they had Wright Cyclone engines.

Approved Type certificate 593 was issued December 24, 1935. After shipment by freighter from the West Coast, the first of four was quickly placed in service a few days later by Hawaiian Airlines' predecessor, Inter-Island Airways. Although no scheduled water landings were contemplated, the airline felt

Probably the last S-43 in scheduled service, this Avalon Air Transport Sikorsky S-43 was at Long Beach in December 1958 just prior to its demise at Catalina a few months later. (Photo from the author's collection)

that capability would be a good safety measure. When they were replaced in passenger service by the airline's first DC-3s, they were converted to carry inter-island cargo and served in that capacity through the war years.

Pan American and its affiliates also used about a dozen, referred to as 'Baby Clippers', to feed traffic to longer-range aircraft, particularly from locations along rivers. Other airlines around the world also operated small numbers of S-43s. Seventeen were delivered to the U.S. Navy with the military model designation JRS-1, and the U.S. Army had five OA-8s. Altogether 53 were built.

The Douglas DST/DC-3 – The Road to Profitability

Returning to the domestic airline scene, the new DC-2s and Electras had revolutionized airline travel worldwide, but the most significant change in air travel was yet to occur—the advent of the Douglas DC-3. American, a strong proponent of night time sleeper service, approached Douglas with the idea that the DC-2 would be excellent for such service if it had a fuselage wide enough to accommodate berths. Douglas was reluctant to make any change to the DC-2, apparently thinking it was 'good enough as is', but finally agreed to produce a new sleeper model on a commitment from American for 20 airplanes. Once that decision had been made, the Douglas design team worked closely with their counterparts at American to create an outstanding airplane. New Wright Cyclone G series engines promised to provide much more power than the older F series in the DC-2s. In order to take advantage of the greater power, Douglas and American elected to make changes that were more extensive than originally envisioned. Not the least was increasing the wing area by lengthening each outer wing panel five feet.

The fuselage was widened, but with a more rounded cross section than originally considered. The enlarged cross-section not only provided room for berths, but also increased seating capacity

American Airlines DST Flagship San Francisco *cruises above the clouds in this 1930s photo. The DST can be easily identified by the "eyebrow" windows above the "Flagship Sleeper" logo. (AAHS archives, AAHS-P006022)*

DST accommodations were first class. Here we see the convertible seating arrangement in both seating and bunking configurations. (American Airlines photo from the Glenn Moss collections, AAHS archives)

for aircraft with day accommodations. One side of the aisle could now have seven two-seat units — a 50% increase in revenue with very little increase in direct operating cost.

Apart from those self-evident, many subtle changes were made to accommodate the additional power and higher operating weights it enabled. Some were also made to correct deficiencies identified through service experience with DC-2s. The fin and rudder were borrowed from the B-18 bomber to correct the DC-2's inadequate directional stability. Unfortunately, the DC-3 still suffered from "rudder lock." (Although rarely encountered in actual DC-3 service, rudder-lock is a condition where the rudder stalls at high deflection angles and, with a reversal of pedal forces, floats to the rudder stop.) As a result of flight testing, it was found necessary to add a small dorsal fin.

Other deficiencies included a poor braking system, difficult cabin temperature control and a deluge in the cockpit while being flown through a rainstorm. Moving the landing lights to the wings enabled an additional baggage compartment to be installed in the nose.

Approved Type Certificates 607 and 618 were issued on May 21 and August 27, 1936, for the DST and DC-3, respectively, and American placed the DST in service June 25, 1936, between New York and Chicago. No one could possibly have imagined then just how many airline flights would follow with the new aircraft! American was the first, but eventually every major U.S. airline, with the exception of National Airlines, would operate DST/DC-3 aircraft.

The competition between Wright and Pratt & Whitney continued with new Twin Wasp engines comparable to the Cyclone G series initially used in the DST/DC-3 aircraft. Models DSTA and DC-3A were, therefore, offered with Twin Wasp SB3G engines. United was quick to order a fleet of Pratt & Whitney-powered airplanes to replace its very obsolete 247s and begin a relationship with Douglas lasting about half a century through the DC-10 years.

The Brooklyn Dodgers set a first in baseball history by using a DC-3 chartered from American for air travel the entire last three weeks of the 1940 season. Although seemingly far-fetched then, that prompted speculation that it might be possible for Pacific coast teams to join the major leagues someday!

The DC-3B was a Wright-powered, half-day plane, half-sleeper, configured model ordered only by TWA.

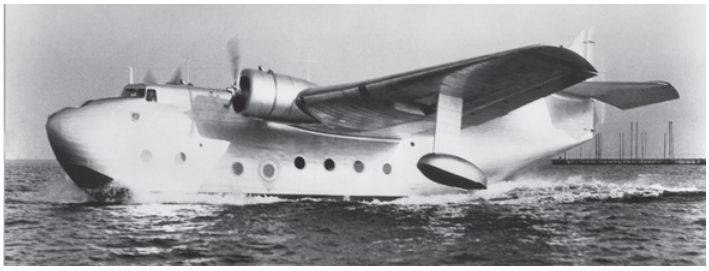
It is not incorrect to refer to all of these aircraft today as DC-3s or DC-3As. By the end WWII, most, if not all, surviving DSTs, DSTAs and DC-3Bs had been converted to standard day plane interiors and, for all practical purposes, had become the same as the corresponding DC-3 model. In order to simplify the situation, Douglas and the Civil Aeronautics Administration (CAA) mutually agreed that, henceforth, all prewar airplanes with Wright engines would be identified as DC-3s and operated under Type Certificate 618 regardless of the interior installed. Similarly, all with Pratt & Whitney engines would be operated as DC-3As under Type Certificate 669. Although generally written since that time with a hyphen separating 'DC' and '3', the official model designations are DC3 or DC3A with a suffix indicating the engine model.

Depending on how one counts airline-ordered aircraft impressed by U.S. military forces upon completion, there were about 450 DST/DC-3 series airplanes produced before WWII precluded further civil production. Of course, that number was overshadowed by the thousands of military variants produced during the war. Those were added to Type Certificate 669 later as DC-3Cs or DC-3Ds. (Because Douglas chose to certificate surplus C-47s as DC-3Cs, they must be reidentified as DC-3Cs to be eligible for civil use. It is, therefore, technically incorrect to refer to a civil airplane as a C-47 even though it may have an all-cargo interior.)

Many of the prewar aircraft were sold in Europe by Fokker. Douglas also negotiated license agreements in 1936 for Russian production and 1939 for Japanese production. Those resulted in many additional Lisunov Li-2 and Showa L2D variants, respectively. Unfortunately, the similarly of the Japanese airplanes to Allied C-47s caused a number of wartime recognition errors.

The Douglas Flying Boat

Douglas had never built a modern twin-engine flying boat for airline use, but it hoped to achieve success with its Model DF, a twin-engine aircraft about the size of a DC-3. To its dismay, Douglas found that its only viable customer, Pan American, was not interested. Saving the program from a complete loss, two each were sold to Russia and Japan without investing in additional development and certification expenses.



Douglas DF taxiing. (Douglas photo from the AAHS archives, AAHS-P006079)

The Lockheed Super Electra – The 'Fastest Transport in the World'

Considering the outstanding success Douglas was having, Lockheed and Boeing both wisely avoided producing models that would be in direct competition with DC-3s. Lockheed chose to develop an 11-passenger model smaller than the DC-3, but larger and faster than its Electra predecessor. The Super Electra did, however, retain the Electra's twin vertical tail configuration.

First Lockheed Super Electra before aerodynamically balanced rudders were installed (Lockheed photo from the author's collection)

From a design standpoint, it was much more advanced than the DC-3. It pioneered the use of integral fuel tank construction in which the wing skin, ribs and spars were sealed to form the fuel tanks, thereby eliminating the weight and cost of separate tanks installed in the wings. Boeing 247s had no wing flaps, and DC-3s had only split flaps that are basically drag-producing devices. The Super Electra, on the other hand, was the first civil model to use Fowler flaps. Fowler flaps translate aft of the wing trailing edge when deployed, effectively increasing the wing area as well as the coefficient of lift. It could, therefore, be designed with a wing that was much more efficient in cruise while still providing acceptable takeoff and landing performance. That feature and two 800-hp Pratt & Whitney Hornet S1EG engines enabled the Super Electra to uphold the Lockheed tradition of building fast airline aircraft. In that regard, the Department of Commerce formally recognized the Super Electra as the "fastest transport in the world." Later variants with more powerful Wright engines were even faster.

Lockheed believed that a significant number of customers would find the greater speed of Super Electras more advantageous for their routes than the additional seating capacity of DC-3s. Also, an operator could purchase four Super Electras for about the same price as three DC-3s.

Following completion of development and certification flight testing, Approved Type Certificate 657 was issued November 15, 1937, for the Model 14-H. Three additional type certificates would be issued for models powered by various Wright Cyclone engines.

Northwest was the first to place the Super Electra in service, only to lose one about two months later on a peak near Bozeman, Montana. The subsequent investigation revealed that the airplane had not simply flown into the mountain, but it had suffered a structural failure due to flutter of the vertical tail surfaces. That was quickly corrected with aerodynamically balanced rudders, enabling the Super Electras to be returned to service later the same month.

With the minor exception of one sold to Santa Maria Airlines, Northwest proved to be the only U.S. airline customer. The Super Electras found a ready market with foreign airlines; however, the outbreak of WWII and conquest by Axis forces curtailed their further use by many of their original owners. One of British Airways' Super Electras was used by Prime Minister Neville Chamberlain for his ill-fated trip to Germany to appease Adolph Hitler. Aer Lingus also purchased two, but soon found it had no place to operate them due to the war. With operating conditions similar to those of Northwest, Trans-Canada Airlines chose a fleet of Super Electras.

Howard Hughes first considered using the DC-1 for his record flight around the world in July, 1938, but chose a Wright Cyclone-powered 14-N2 Super Electra instead. After leaving New York's Floyd Bennett Field on a Sunday evening, Hughes was back the following Thursday afternoon to a welcoming crowd of about 20,000 after flying 14,824 miles in 91 hours. Although not a flight around the world at its greatest circumference, it was a great achievement for its time. In recognition of the feat, Hughes was awarded the 1938 Collier Trophy — marking two consecutive years in which Lockheed aircraft were involved in this prestigious award. His airplane did not fare so well, however. It was acquired for the war effort by the Royal Air Force and crashed at Nairobi in November 1940, on the delivery flight.

After two more accidents — one of which occurred due to pilot error — Northwest elected to retire its Super Electra fleet prematurely in 1939. In fairness, it must be noted that the additional passenger capacity of the DC-3s that replaced them was probably a significant factor in the airline's decision. Super Electras did gain a poor reputation insofar as accidents were concerned, but they occurred for the most part in the early years when flight crews were not accustomed to flying high-performance airplanes. Any later accidents should be attributed to wartime operating conditions and not to an unsafe design. In that regard, Trans-Canada successfully continued flying Super Electras until well after the war.

Lockheed first investigated adapting the basic Super Electra design as a bomber during its development period in 1937 and was well-prepared when the British Purchasing Commission came looking for American aircraft the following year. The result was the Hudson bomber that served the British so well in the early days of the war. Their operation under wartime conditions by qualified crews also belied the belief that the Super Electra was an accident-prone airplane.

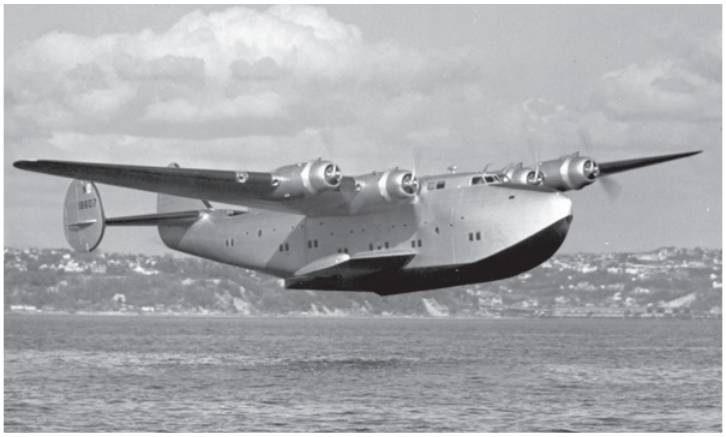
Following successful negotiations with Douglas to build DC-2s, the Japanese acquired a similar agreement to produce Super Electras in Japan. Thirty Lockheed-built examples preceded many more Mitsubishi Kensei-powered aircraft built by Tachikawa and Kawasaki. Most undoubtedly went to the Japanese military and were identified by the Allies as *Thelmas* during WWII. Photos do, however, exist of some Japanese-built examples with civil registrations.

Lockheed built 111 Super Electras, making a total of 230 if Japanese production is included.

The Douglas DC-4E – A False Start

While the DC-3/DST was being developed, United approached Douglas in the belief that the airlines would soon need much bigger aircraft with one-stop transcontinental range. Douglas was unwilling to embark on the project until United, American, Eastern Air Lines, TWA and Pan American each contributed $100,000 (1936 dollars) toward the new model. The resulting DC-4 was about half again as large dimensionally and twice as heavy as the DC-3 with four 1,450-hp Pratt & Whitney R-2180-S1AG Twin Hornet engines. In a day plane configuration, it had seating for 42 passengers. Unlike the

Douglas DC-4E on the ramp at Santa Monica during final construction. (AAHS archives, AAHS-S009762)



The first Boeing 314A NC18607 taking off from Elliot Bay. It was diverted from Pan American's order and delivered to BOAC as G-AGBZ Bristol *to contribute to the British war effort. (Photo from AAHS archives, AAHS-D021016-a)*

DC-3, it incorporated many advanced features, such as a tricycle landing gear, power-boosted controls, cabin pressurization, AC electrical system, underwing pressure refueling and an auxiliary power unit. Unfortunately, it was simply too far ahead of its time. Service testing conducted by United in 1938 showed that the complex systems required excessive maintenance and that its performance with those engines and 65,000 lb maximum weight was decidedly less than spectacular.

TWA and Pan American decided to end their participation in the DC-4 program and order Boeing's new 307 Stratoliners. Douglas, and the three remaining airlines mutually agreed to abandon it in favor of a new, slightly smaller and less complex design. (Pan American did, however, order three of the new design on behalf of affiliate Panagra.) The DC-4 was then reidentified as the 'DC-4E' (for experimental) so that 'DC-4' could be reassigned to the new design. Douglas was able to partially recoup the investment by selling the DC-4E to the Japanese government later that year. Company personnel said facetiously that it was 'DC-4E' for 'extinct'!

Actually, the world had not seen the last of the DC-4E with its sale to Japan. Following a postwar DC-4 crash, the press requested a photo of that model. A somewhat devious Douglas public relations department responded with a photo of the DC-4E. To the non-aviation oriented public, the DC-4E with its three vertical tail surfaces looked more like a Lockheed Constellation than a Douglas airliner!

The Boeing 314 Clipper – the Ultimate Flying Boat Airliner

Meanwhile, the model that would eventually prove to be the ultimate in airline flying boats was taking shape in Seattle. Pan American began preliminary discussions with Boeing in 1935 shortly after the Martin 130 was first flown and followed up with an order for six 314s on July 21, 1936. Reportedly, Pan American specifically requested that they be named "Boeing Clippers" — undoubtedly to ensure that the public understood that they were *Pan American's* ocean conquering airplanes and not just any airline's new airplanes!

Although considerably larger, the Boeing Clippers followed the same basic configuration of the Martin aircraft. The four 1,500-hp Wright GR-2600-A2 Double Cyclone engines could be accessed in flight through the huge wing, which had been adapted from that of Boeing's XB-15 bomber.

Accommodations were provided for as many as 40 passengers in a sleeper configuration or a maximum of 74 seated passengers. The first airplane was launched in the adjacent Duwamish River and towed downstream to a shipyard area on Elliot Bay. There it was prepared for its first flight. Following the necessary development and certification testing, Approved Type Certificate 704 was issued January 25, 1939. Transatlantic mail and passenger services were begun the following May 20 and June 28, respectively. At the time, it was the largest airplane—flying boat or land plane—in airline service in the world.

Pan American later ordered six additional airplanes identified as Model 314As, with a number of improvements, including 1,600-hp Double Cyclone engines and increased fuel capacity. Three of these were diverted to British Overseas Airways Corp. (BOAC) to contribute to the war effort. Pan American's older airplanes were subsequently modified to the 314A configuration.

Outstanding as they were, WWII (on the European and Asian ends if not immediately at home) prevented the Boeing Clippers from earning the success as civil airliners they deserved. Instead, they routinely performed many essential military flights, including the transatlantic portions of President Roosevelt's historic secret trip to meet with British Prime Minister Winston Churchill at Casablanca in 1943.

After very brief service following the end of the war, the era of large flying boat airliners came to a sudden end. Notwithstanding their great accomplishments in pioneering transpacific and transatlantic service, flying boats were inherently susceptible to many operational hazards, such as unseen floating objects and extremely rough seas. They were also susceptible to major storm damage, or even total destruction, while moored. Being loaded, unloaded and serviced in rough water was not a particularly pleasant experience for passengers or crew.

Martin considered trying to regain its eminence in commercial flying boats and was still advertising in late 1946 for engineers to develop a Pratt & Whitney Wasp Major-powered civil version of the giant JRM-1 Mars. That proved to be wishful thinking, however. With adequate airfields completed during the war and a new generation of long range landplanes available, flying boats were no longer needed or wanted.

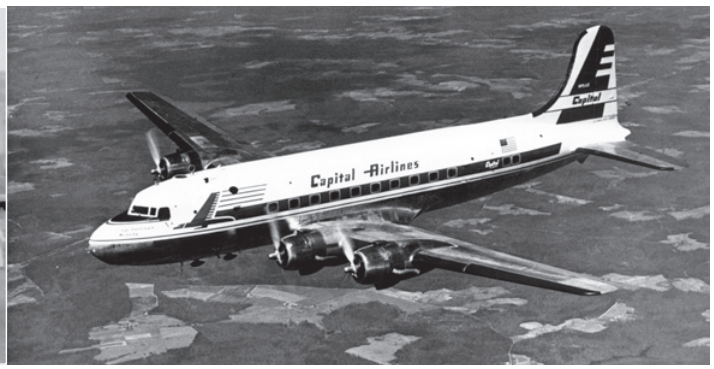
Began in the 1930s But Too Late to See Service in That Decade

Although they did not go into service until 1940 or later, seven additional models begun before the 1930s decade ended are worthy of brief discussion because they were a prelude to the big expansion of air travel after WWII.

As noted earlier, Pan American and TWA elected to end their participation in the original Douglas DC-4 program in favor of the Boeing 307 Stratoliner. Basically, it combined the wing, engines and empennage of the B-17 Flying Fortress with a pressurized passenger fuselage. Although WWII precluded production of more than 10, they served faithfully on military contract flights.

Similarly, production of Vought Sikorsky's VS-44A flying boats was limited to three examples delivered to Pan

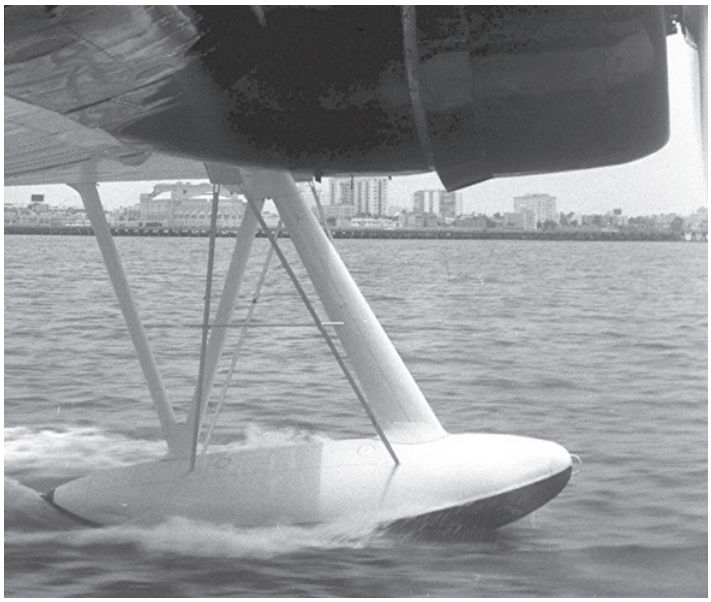
TWA Boeing 307B, N19903, c/n 1999, being prepared for its next flight. This is a postwar photo after TWA's planes had been completely rebuilt by Boeing with surplus B-17G wings, engines & other components (Al Eldridge collection from the AAHS archives, AAHS-52762)



This Douglas C-54, one of the first converted for civil use, was delivered to Capital Airline's predecessor Pennsylvania Central Airlines. (Capital photo from the author's collection)

American's new competitor, American Export Airlines. They, too, were deprived of earning the success as civil airliners they deserved. Transatlantic service did begin in 1942, but it was exclusively for military or other essential purposes. On June 22 of that year a VS-44A flying from Foynes, Ireland, to New York completed the first nonstop transatlantic passenger flight.

The sole surviving American flying boat airliner awaiting another short 'ocean crossing' to Catalina Island in July 1960. (From the author's collection)



Although taken two decades later, this would be similar to a passenger's view of the beginning of a long transatlantic trip in a VS-44A. Edo supplied the same floats to Martin for PBM Mariners. (From the author's collection)

Thanks to the efforts of Dick Probert of Avalon Air Transport (later Catalina Airlines) to rescue a VS-44A from becoming derelict in Peru in 1957, the sole survivor of American flying boat airliners served the airline's short flights from Long Beach, Calif., to Catalina Island for another decade. Referred to as the *Mother Goose* (in light of the airline's fleet of much smaller Grumman Goose), it was reported to have made over 8,000 more "ocean crossings" — albeit much shorter crossings than the nonstop transatlantic flight mentioned above!

The Douglas DC-5 proved to be the company's least known airliner. A product of the El Segundo Division, the 16-passenger design combined the attributes of the DC-3 with a high-wing and tricycle landing gear. Early orders by Pennsylvania-Central Airlines, British Airways and Pan American's Colombian subsidiary were later cancelled, but four delivered to KLM served well in the Caribbean and Dutch East Indies. U.S. Navy and Marine orders for seven, plus the personal airplane of William E. Boeing, completed the total of 12 built. Undoubtedly the DC-5 would have fared much better had WWII not interfered.

Lockheed's Model 18 Lodestar was basically a Super Electra with the aft fuselage stretched 64 inches to accommodate 14 passengers. In fact, the first three were converted Super Electras. Like their predecessors, they were intended for routes on which their greater speed was more advantageous than the

Western Airlines Lockheed 18-08 Lodestar. (Western photo from the author's collection)

slightly greater passenger capacity of DC-3s. Due to their speed, Lodestars were very popular for executive transportation after the war, particularly with Bill Lear's Learstar conversions.

The 61 Douglas DC-4s ordered by airlines after the DC-4E was abandoned almost met the same fate as other promising designs due to an initial short-sighted military procurement decision. Wiser thinking prevailed, however; and they were completed as C-54 military transports. They and 1,102 more proved to be indispensable in delivering men and essential supplies from the U.S. for the war effort. Without them, the Allies would have been dependent on time-consuming surface deliveries through submarine-infested waters. Return flights also performed an essential service — returning wounded servicemen rapidly to the U.S. Only three C-54s were lost in 79,642 ocean crossings. They were finally able to go into airline service after the war but, with few exceptions, were soon relegated to secondary routes when faster pressurized Douglas DC-6s and Lockheed Constellations became available.

Due to their much greater passenger capacity, performance and cabin pressurization, some have speculated that Curtiss CW-20s would have replaced DC-3s had WWII not intervened. The prototype was first flown on March 26, 1940, but like the DC-4, the CW-20 was deprived of going into airline service as a new design. Instead, it was rushed into production as the unpressurized military C-46 before at least one major problem and numerous typical introductory problems were corrected. Curtiss was preoccupied with producing combat aircraft, so Eastern, which had a contract to fly C-46s in support of the war effort, was faced with correcting the problems. Those were eliminated or at least alleviated, and C-46s went on to earn an excellent reputation — particularly flying desperately needed supplies over the difficult Himalayan Mountains (the 'Hump') from India to China. In addition to the prototype, 3,182 military examples were produced by the end of hostilities.

Eastern and National both ordered a 36-passenger postwar model, the CW-20E; but the orders were cancelled before any were produced. Although a few surplus C-46s were used in passenger service by U.S. charter operators and foreign airlines, the major U.S. airlines were not interested in them for passenger service. They were, however, highly regarded by all-cargo airlines due to their huge cabins and attractive costs.

Curtiss C-46 used by Delta Air Lines for cargo service. (Delta photo from the author's collection)

The Lockheed 49 Constellation began in 1938 with design studies for a very advanced 32-passenger aircraft known then as the Model 44 Excalibur. By early 1940, when orders were placed by TWA and Pan American, it had been enlarged and renamed. WWII precluded deliveries to either airline then, but it became the standard for postwar intercontinental travel and literally forced Douglas to reluctantly develop its DC-4 into the competitive DC-6.

The 1930s come to a Close

In the history of airline travel, two decades stand out. The 1960s decade is certainly one due to changes afforded by the jet age, but the 1930s decade is outstanding because of its pioneering nature. By the time it ended, passengers had benefitted from many significant changes, including comfort, speed, cost and, most important of all, safety. Over three fourths of the airplanes in U.S. airline service by the end of the decade were Douglas DC-3s.

This view of a Capital Airlines Lockheed 049 Constellation shows its graceful lines. (Capital photo from the author's collection)

The change most noticeable to a passenger would have been greater comfort. Although noise and vibration were almost eliminated in the jet age, the improvements in that regard from the trimotors of 1930 to the DC-3s and others a decade later were very significant. Passenger accommodations had progressed from wicker seats to comfortable, well-upholstered seats. Effective heating systems had relieved passengers from enduring cold, poorly insulated cabins. Flight attendants served warm tasty meals and other amenities. Travel time was typically reduced by about one third on a given route.

The fail-safe concept made airliners much safer and more reliable. Typical fabric-covered steel or wood frame construction of 1930 had been replaced by durable monocoque and semi-monocoque aluminum. (Some DC-3s are still flying after more than 80 years of service!) Improved weather reporting and maintenance standards also contributed to improved safety levels. Unfortunately, many travelers remained afraid to fly by 1940 because they still failed to understand the basic principles of flight. All those advances fell on their deaf ears.

Airlines were still dependent on airmail subsidies, but greatly reduced operating costs did permit both cheaper fares and lower subsidy levels. The fares for domestic travel remained beyond the reach of some, but travel by air was no longer an option only for the very wealthy. Although affordable intercontinental travel would have to wait for long-range landplanes, transpacific and transatlantic flights were available then to the very rich.

Many people who couldn't consider travelling earlier because of the depression could now do so. Trains were still the primary means for travel of any significant distance. The airlines were ready to challenge the railroads, but the intervention of WWII the following year (at least for the U.S.) put all non-essential travel on hold, regardless of the mode used. Despite that delay, tremendous technological advances made for the war effort enabled improvements in air travel to proceed rapidly once the war was over. All the safe wartime ocean crossings gave the airlines confidence that long overwater flights would be safe with landplanes. Fortunately, much of the fear of flying that prevailed in 1940 had been forgotten when the airlines resumed service after the war. ✈

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About the Author

Gary Killion grew up on a farm beneath the airway from Des Moines to Omaha with United's DC-3s and DC-4s passing over at low altitude on let down to or climb out from the latter. His love of aviation began with a ride in a Culver Cadet at the age of seven, which led to an airman's certificate a decade later, a degree in aeronautical engineering from Iowa State College and a 40-year career with the Federal Aviation Administration. In addition to two books, *The Convair Twins 240-640* and *The Martin Liners*, he is the author of a number of rulemaking actions that have significantly enhanced the safety of airline travel. He resides with his wife of 54 years, the former Lois Campbell, in Sammamish, Washington.

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