The Ford Tri-Motor design was one of the most successful early transports. Nicknamed the Tin Goose, it was one of the largest all-metal aircraft built in America up to that time. It featured corrugated aluminum covering on the fuselage, wings, tail, and on the internally braced cantilever wing. The Ford Tri-motor was an inherently stable airplane, designed to fly well on two engines and to maintain level flight on one. The first three Tri-Motors built seated the pilot in an open cockpit, as many pilots doubted that a plane could be flown without the direct “feel of the wind.”

Henry Ford is credited with founding American commercial aviation when the Ford Freight Service, comprising six aircraft, began flying between Chicago and Dearborn. Ford later went on to build the first concrete runways in the United States, as well as the first airport control tower. He funded the development of wireless communication for aviation and instituted uniforms to create a professional appearance for aircraft crews. Ford’s most famous aviation endeavor was the Ford Tri-Motor, America’s first all-metal civil aircraft.

Development history
Much of the development that led to the production of the Ford Tri-motor rests with William Bushnell Stout. His visions and contributions shaped much of the modern aviation industry. Stout’s interest in aviation began as a boy when he built small flyable models built from cork, tissue paper, rubber bands, and two feathers. This simple toy was the catalyst that drove Stout’s life long ambitions.

After serving as the chief engineer producing Packard’s Liberty engines during World War I, Stout was employed by the government to build an all-metal single-wing torpedo bomber. Using the knowledge he learned during this project, he founded the Stout Metal Airplane Company, with a focus on building civil aircraft of composite metal and wood construction.

Many factors drove metal construction. Maintenance accounted for a large portion of an aircraft’s direct operating cost. In particular, fabric needed regular replacement after every 750 to 1000 flying hours. Eliminating the periodic replacement of fabric offset the increased cost of metal aircraft coverings.

Ford supported Stout’s ideas by building an airplane factory with a landing field, and leasing it to the Stout Metal Airplane Company. Stout produced two successful aircraft designs, the Air Sedan and the Air Pullman. Both relied on a single Liberty engine for power.

Ford Motor Company purchased six Air Pullmans, and the Ford Air Service began flights in April 1925, running six days a week. With the success of the Air Pullman, Ford offered to buy out the Stout Metal Airplane Company and make it a division of Ford Motor Company. Under the agreement, Ford would manufacture planes while Stout focused on the development of new aircraft, specifically a three-engine version of the Air Pullman.

New engines
New engines were becoming available for aircraft. Wright Aeronautical began production of an air-cooled radial engine with half the horsepower of a Liberty engine. Building upon his earlier concepts, Stout prepared a design with three Wright engines, although only two were needed.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Length</td>
<td>49 ft.10 in.</td>
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<tr>
<td>Height</td>
<td>12 ft. 8 in.</td>
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<tr>
<td>Wingspan</td>
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<tr>
<td>Total wing area</td>
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<td>Fuel consumption</td>
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<td>Oil capacity</td>
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<td>Stall speed</td>
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The engines of the first Tri-Motor, called the 3AT, were integrated into the wings. Note the corrugated aluminum on wings and fuselage. Image courtesy San Diego Aerospace Museum, www.aerospacemuseum.org.
All Metal Aircraft Construction

In the words of William Bushnell Stout from his Autobiography, So Away I Went

After World War I, wood was the dominant material of construction for aircraft. However, trees grew over many years under uncontrolled conditions, so that predicting the properties of spruce and other woods was a problem. Stout noted,

“...a certain Dr. Blau, representing an aluminum company, brought a small roll of Duralumin to our plant, some of the first to be seen in this country. He could not roll it out flat on the floor, because the sheet wouldn’t lie flat. It was full of slivers and flaws, but it had something like 55,000 pounds tensile strength (as against aluminum’s 33,000), and hence great promise for airplane work. It made me start studying the possibility of metal airplanes.”

However, manufacturing an aircraft of aluminum alloys was a new endeavor. Few people had worked with aluminum, and no one understood how to form and fabricate components of the newly developed high-strength alloys.

The metal itself, as a structural material, was unknown. The shapes needed to make structural foundations for the plane had not been devised. The riveters and fastening methods did not exist. No one knew about the fatigue life or corrosion resistance of the materials. We knew only that the metal was expensive to buy and work.

First we worked with the aluminum company for suitable metal. Then what to do with it. Our budget was tight and could stand very little production machinery. We designed so as to build the plane largely with bent forms made on a tinner’s brake. We rolled sections out by hand over chilled cast iron rollers. We had no precedent.

Little was known of heat-treating dural, so we had to buy the metal heat-treated and work it cold. This meant using only thin gages. Thick gages would break if they were bent in their heat-treated form. It is surprising, as I look back, that we accomplished so much with so little, in establishing the foundations of all future airplane construction.

Our shapes and structural approaches were used for twenty years after by other metal-airplane builders, either by copying or, as is more likely, by the application of straight engineering assumptions which naturally brought them similar results.

Metal construction was a new idea not trusted by either the military or civilian aviation industries. Stout recorded his struggles with military inspectors when developing the ST Navy Torpedo Bomber in the 1920’s.

They saw the nose section of the wing made of curved corrugated metal, with almost no structure inside. This piece, said the committee, takes the most load, and needs more reinforcement. Better stop work until we load it for strength.

So all work on the plane stopped for almost a week while the staff designed a test jig, set up on a big girder running to the roof of our shop twenty-five feet above. Here we mounted the nose piece. As I remember, with its factor of safety of six, as then required, we worked to carry a load of 800 pounds on the section we set up. The actual load in use would be 235.

We piled 235 pounds of sandbags. No distortion.

We piled 800 pounds of sandbags. No failure.

Then on went the sandbags until the pile reached the roof and went over 2500 pounds — and still no failure.

So the shop started work again and the officials began to respect metal structures.
to keep the plane airborne. The third engine provided a safety margin if one engine should fail.

Stout's original Tri-Motor design integrated two engines into a high mounted wing with a single engine mounted in the nose. The pilot was seated above the passenger cabin. The Tri-Motor followed the same general layout as the earlier Air Pullman, retaining the corrugated duralumin covering and dural framework. This initial concept flew in November of 1925. The landing speed was 60 miles per hour, which was too fast and dangerous for grass landing strips. Stout looked to concrete runways as a solution to this problem.

However, Henry Ford supported slowing the aircraft down for landing. The Tri-Motor design was modified, changing Stout's integrated engine wing design in favor of a design concept developed by Tony Fokker of Fokker Aircraft Corporation.

In the Ford design, engines were mounted on struts beneath the wings, a move that slowed the landing speed to 50 miles per hour. The new design, called the 4-AT (for Air Transport), was nicknamed The Tin Goose, and it flew on June 11, 1926. However, the change in engine location also reduced performance, slowing cruising speed by ten miles per hour and cutting the amount of weight it could carry by 10%. Regardless, the design was easy to fly, durable, and easy to maintain.

**Tri-Motor production**

The 4-AT proved quite successful as a passenger and mail transport, and was bought by several airlines. Ford sold a total of 78 4-AT's, making it the first commercial metal airplane produced in quantity in the United States. In 1928, Ford's aircraft division enlarged the Tri-motor and installed more powerful Pratt & Whitney Wasp engines. This new model was designated the 5-AT, and 116 were produced through 1932.

The Ford Tri-Motor became the most common of the large transport planes by 1930. Some were built for very specialized jobs. For example, one was manufactured with floats, and deployed by the Canadian government to fight forest fires.

Unfortunately, Ford did not make a profit on the planes, and by the early 1930's, Detroit was feeling the effects of the great depression. Production of the Tri-Motor ceased in 1933. A total of 198 planes had been manufactured.

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