The Monoplane

The flying wires can be seen in this photo of a Blériot

The first successful airplanes were biplane designs, with the Wright brothers' planes being the earliest example. The biplane is an aircraft with two sets of wings, an upper set and a lower set, separated by struts and wires and connected to the upper and lower parts of the fuselage. The reason for this was structural. Airplanes were initially quite fragile, built more like butterflies than hawks.

The reason that airplanes were so fragile had to do with the difficulty of flight in those early days. For the first decade or so of flight, because of low-powered engines and designs that created a lot of drag (because nobody understood drag, nor the other stresses of flight, all that well), airplanes could barely make it into the air at all. Planes therefore were constructed of the lightest materials, such as fabric and wood, and built in such a way that they used as little of the heaviest materials as possible. As a result, their wings were not capable of supporting much weight or handling wind gusts without crumpling in flight, like an umbrella in the wind. Early airplanes had more than one wing because this reduced the "wing loading," or amount of weight that the wing had to support in flight. With an upper and lower set of wings, the wings had to support less weight and the structural fittings between them, such as struts and wires, could reinforce them. The truss system also solved the dilemma of how to maintain structural strength while also allowing the wing flexibility necessary for the wing warping used in the Wright brothers' airplanes.

But a lot of people had caught the aviation bug after the Wright brothers took flight in the early part of the 20th century and there were hundreds of entrepreneurs trying to build their own planes. Some of them experimented with monoplane designs—or planes with only one set of wings that extended out from the fuselage—because this seemed like an inherently logical design that reduced drag. After all, a bird only has two wings, so why should an airplane have more? But these monoplanes invariably failed. Many of them folded up as soon as they started to lift off the ground. The first person to succeed was Louis Blériot, a Frenchman born in 1872 who had an engineering degree and manufactured headlamps and accessories for automobiles.

Blériot started experimenting with different airplane designs even before the Wright brothers proved powered flight was possible, and between then and 1908 he built a series of different airplanes. Some were biplanes; others were monoplanes. Most were flops. By 1908, he had built his eleventh airplane design, which he dubbed the Blériot XI. It was a monoplane, with a fuselage that was little more than an open wooden frame covered by fabric with an engine and propeller in the front. The pilot controlled the plane by twisting the wings, a design feature borrowed from the Wright brothers.

Blériot attached the wings to either side of the fuselage, but he reinforced them with wires that ran from the wings to vertical poles that stuck out of the top and bottom of the fuselage. The Blériot XI had two sets of wires. The flying wires went from below the wings to the bottom of the poles and prevented the wings from folding up when the plane was flying. The landing wires went from the topside of the wings to the top of the poles and held the wings up, preventing them from collapsing when the plane was on the ground and the wings were simply dead weight. It was an awkward and rickety-looking craft, but that was also true for most biplanes of the day. Blériot exhibited his plane at the Exposition Intérnationale de la Locomotion Aérienne in Paris and it created a great deal of excitement. Soon he was manufacturing relatively large numbers of them and selling them to several armies,

including France and Great Britain, and to anybody who had the money and the courage to fly. For a period, especially after Blériot crossed the English Channel in 1909 in his Blériot XI, his plane became the most popular in the world. Other monoplane designs followed.

Because of the lower drag of a monoplane, it could fly faster than a biplane equipped with the same type of engine. During the early days of flying, pilots earned fame and fortune by winning races and so the Blériot XI was a popular and well-known plane because it was speedier than most other aircraft. But by 1911 or so, the plane was also earning an unwanted reputation for its nasty habit of folding up its wings in flight, causing it to come fluttering to the ground with all the grace of a sparrow tied to a brick.

Alarmed by the number of crashes, French military aviation officials began to propose strengthening the structure of their Blériot XI monoplanes. Blériot himself conducted structural evaluations that consisted of turning the airplane upside down and putting sandbags on the wings to simulate the lift, proving that the wings could support many times the weight that they needed to fly. But the problem with these tests was that they were both overly simplistic and also did not simulate the kinds of stresses that affected an airplane's wings. They were static tests that treated the wings as if they did not move and as if the stresses on them were constant. But wings do move in flight and the stresses on them change. Such stresses are called dynamic loads. Wings do not simply experience lift, they also experience forces from many directions during the course of a flight. Wind gusts could push back on wings, and manoeuvers could push down on them. Wings could also twist from these forces as well. Blériot's tests did not simulate any of this.

In the wake of the increase in monoplane crashes in 1912, Blériot proposed that the problem was not with the flying wires underneath the wings but the landing wires above them. The wings were failing when the planes were pulling out of a dive, when the airflow was pushing down on the wings. Blériot proposed that increasing the strength of the relatively weak landing wires could solve this problem. But not everybody was convinced of his explanation and the number of airplane crashes increased. At one point, the British army realized that the only planes in its fleet that were crashing were the monoplanes. Sales of monoplanes dropped.

Over the next several years, various experts on structures in France, Britain, and elsewhere studied the problems with the Blériot XI and other monoplane designs and gradually developed a set of complex theories explaining how wings acted in flight. They determined that numerous complex forces interacted on the wings. Because it was difficult to make all of the calculations necessary to determine how a wing would perform and how it would fail, not many monoplanes were constructed during this time.

The Taube was one of the monoplanes that served in World War I. They were faster than most multi-wing airplanes.

By the beginning of World War I, though, a number of monoplanes were in service. The pre-war *Monocoque Deperdussin* set a speed record of 108 miles per hour (174 kilometres per hour), winning the 1912 Gordon Bennett Cup in Chicago. Most World War I monoplanes were designated as "fighting scouts" because of their higher speeds compared to multi-wing airplanes. These included the graceful Taube built by the German firm Rumpler and the Fokker Eindecker (German for "monoplane"). Morane-Saulnier also built a successful monoplane fighter that had the advantage of allowing the pilot to fire his machine gun through the plane's propeller. These planes all had external bracing, but other monoplane designers began using internal braces inside their wings. Despite this, the vast majority of the airplanes that saw service during World War I were biplanes or even triplanes like the JN-4 Jenny, Spad, and Sopwith Camel.

The Fokker Eindecker was one of the monoplanes used during World War I.

The war spurred a great deal of innovation by airplane designers, who suddenly had more money and more pressure forcing them to design faster and more maneuverable planes. This also affected monoplanes. Designers soon found effective ways to brace the wings internally, by fitting additional structures inside the wings that connected them to the fuselage, a design called "cantilevered wings". They also developed a much better understanding of the forces that affected a wing in flight. Finally, they began building metal-skinned airplanes, and took advantage of more powerful engines then becoming available.

In 1915, Hugo Junkers, a German engineer, working in cooperation with two other engineers, designed the Junkers J-1, an all-steel low-wing monoplane. The center section of the fuselage and the center section of the wing were built as an integral unit. The plane was covered with sheets of steel welded to the tubular structure. Although it was fast for its day, its weight made it less maneuverable. Some people called it the "Tin Donkey." Junkers followed with numerous other low-wing monoplanes and over time monoplanes became the norm.