

Santos-Dumont: The First Homebuilder

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Abstract

Brazilian-born Alberto Santos-Dumont was the first person to create and operate a practical powered flying machine, an airship that he flew around the Eiffel Tower in 1899. Repeating this in 1901 along a specified route in a specified time won him a large cash prize along with worldwide fame. Later, he was widely feted as the first to successfully fly a heavier-than-air craft, the prior success of the Wright Brothers being unknown at the time. He can also be credited as the first “homebuilder” for his worldwide release of plans for a tiny aircraft that virtually anyone could build and fly. He is little known today, but among certain circles he is still considered the true “father of aviation”.

This paper will summarize his life and many contributions to aviation including his “homebuilt” plans, and will briefly address the claim that he, not the Wright Brothers, deserves the credit for the first successful heavier-than-air flight.

Introduction

In this year of 2003, the aviation world rightly celebrates the hundredth anniversary of the magnificent achievement of the brothers Wright. They uniquely solved the little-recognized problem of lateral control, and essentially invented analytical propeller design, parametric wind tunnel testing, and the whole process of scientific aircraft conceptual design. They also correctly perceived that flying an aircraft would be a trained skill, and they taught themselves that skill over a careful three-year period prior to the first powered flight. When they flew in 1903, not only did they have the only functional aircraft; they were the only trained pilots in the world.

But, man flew long before 1903. It had been well over 100 years since the Montgolfier brothers had “slipped the surly bounds” and seen the Earth from above, and over 40 years since aviation

was first used in warfare. When Alberto Santos-Dumont reached Paris in 1891 and wished to fly, he consulted the city directory under “aeronauts” and found the addresses of several.

What mankind had not achieved was flight under power and control – going where one wished, and even returning to one’s point of departure. All successful flight was by balloon. Despite experiments decades earlier with cigar-shaped balloons carrying steam (1852) and electric motors (1883), nobody had solved the problems of propulsion, control, and safety. One went where the wind wanted one to go, and the only option for control was to rise or sink in the hopes of finding more friendly winds.



Santos-Dumont in the Cockpit of his Airship

A Childhood in Preparation

Santos-Dumont was born rich, the youngest son of a major Brazilian coffee grower. He found numerous opportunities on the plantation to indulge in his passion for machinery, “soloing” in a steam-powered tractor at age 7 and in a locomotive along 60 miles of track at age 12. He became expert at operating and repairing the massive coffee bean preparation machinery, which cleaned, dried, separated, and packed the coffee without the touch of human hands. One lesson from those days – the most troublesome machines were the sieves, which were also the only reciprocating machines, leading Santos-Dumont to a lifelong preference against “agitating” and in favor of rotating machinery¹.

Like many before and since, his interest in aviation arose from reading books (Jules Verne) and seeing an airshow (balloon ascent and parachute return in 1888). He also read of pioneering efforts in applying power to streamlined balloons, and confidently expected to find further progress in this area when first arriving in Paris. Instead he found that experiments had ceased in 1885. He decided to solve the problems himself and to develop a working airship, or “dirigible”

(“directable” in French). First, though, he needed to learn the “state-of-the-art” – construction and flight of hydrogen balloons.

Master of Balloons

He found several practicing aeronauts, and eventually talked one into teaching him the “ropes” (literally). After about 25 solo flights he was ready to have his own balloon design constructed. He immediately ran into a problem familiar to all innovators – resistance to new ideas by those most experienced in the old ways of doing things.

He wanted to, in the words of a later designer, “simplify and add lightness.” The usual basket design weighed 66 lbs – he designed one that weighed 13 lbs. His balloon net, often weighing hundreds of pounds, weighed only 4 lbs because he had it sewn to the base of the fabric rather than passed over the top. In place of the standard fabrics then in use, he insisted on using thin Japanese silk (yellow in color, for style). When experts insisted it would be too weak he tested it via dynamometer and found it would take 13 lbs per inch, nearly 30 times the required strength according to his stress calculations.

His 4100 cubic foot envelope (a fifth the volume of similar balloons) weighed just 8 pounds unvarnished, and totaled 31 pounds with three coats of varnish. Altogether his balloon was the smallest man-carrying balloon ever built² (and perhaps to this day), weighing under 50 lbs. He called it the “*Brazil*”, and literally carried it around in a suitcase. Yet, it would lift 176 lbs – luckily, he himself weighed only 110 lbs so he could carry 66 lbs of ballast.



Santos-Dumont in the “Brazil”

He made many flights over Paris and the surrounding countryside in the *Brazil*, and then built a larger balloon of the same design so that he could take his friends along. This balloon, the *America*, stayed aloft 22 hours on one occasion. Says Santos-Dumont of the importance of

experience, “I am filled with amazement when I see inventors who have never set foot in the basket drawing up on paper – and even executing in whole or in part – fantastic airships... Such inventors are afraid of nothing, because they have no idea of the difficulties of the problem¹.”

Power for Flight

Like the Wright Brothers a few years later, Santos-Dumont needed power and found it in the new internal combustion gasoline motor. He found his in a playboy’s toy – tricycle automobiles that were run and raced by the wealthy young. As he needed more power he modified his single-cylinder motor to a tandem twin arrangement, and cut away all unneeded weight until he had a 66-lb motor that produced 3½ horsepower. Just for fun, he put the modified motor back in his tricycle and unofficially entered the 1897 Paris-Amsterdam race. He easily ran along with the leaders, having the highest power-to-weight ratio, but dropped out early to avoid damaging his precious motor. The winning pace was about 25 miles per hour, which he could readily exceed.

It was unknown whether such a motor would run properly when suspended from a balloon, or whether it would shake itself and the balloon to pieces if operated above the damping influence of the ground. His simple test – he suspended his tricycle from a large tree, climbed on, and started the motor. He found that it ran even more smoothly.

The overall form required for a powered airship was well known – an elongated cigar shape rather than the round sphere of a balloon. Santos-Dumont drew up plans for the envelope and gave them to a balloon construction company. To save weight, he had the suspension cords sewn directly to the envelope using small rods to spread the loads, rather than the traditional over-the-top ropes. He used his thin yellow silk, and also dispensed with the usual outer covering to save more weight. The construction company refused to build it that way until Santos-Dumont threatened to cut and sew it himself.

With the envelope under construction, he focused on the rest. The basket was built much like his balloon baskets – light and small. The motor was mounted on the back of the basket with a shaft extending outward, ending in a paddle-bladed pusher propeller. He measured its static thrust as 25 pounds – not bad for 3½ horsepower. A modern propeller would put out a static thrust of about 55 lbs* on that much power.

He built a rudder (silk on steel frame) which was added to the back of the envelope, and devised an effective longitudinal control system that was not dependent on airspeed. He simply hung weights on long ropes from the front and rear of the airship, with smaller ropes leading to the basket. By pulling in one or the other he could cause the airship to tip nose-up or nose-down.

The final challenge – what to do about the expansion of the lifting gas when ascending, and its inevitable contraction when descending? On the way up the excess gas can be vented out, but when descending, the lesser gas will not keep the envelope taut and the streamlined cigar shape would be lost. The solution – an air pump providing pressure to an air-filled balloon-within-a-balloon, now called a ballonet. On the way up the lifting gas expands, forcing some air out of the

* Calculated using the *RDS-Professional* aircraft design software, based on methods in Raymer’s *Aircraft Design: A Conceptual Approach*

ballonet. On the way down the air pumped into the ballonet applies pressure to the shrinking hydrogen, keeping the envelope taut.



Man's First Flight under Power and Control (Santos-Dumont No. 1)

First Flights

His first flight was ignoble. He had reluctantly heeded the advice of the professional aeronauts who advised him to start on the upwind side of the clearing. Nobody had believed that the propeller would be powerful enough to overcome the wind. His propeller promptly pushed him, against the wind, into a tree.

Two days later on 20 September, 1898, he took to the air in what was probably the world's first powered flight under full control, climbing, descending, and turning at will before a crowd of ecstatic Parisians. With perhaps too much enthusiasm, he climbed to 1300 feet and circled around Paris. Says Santos-Dumont, "I cannot describe the delight, the wonder, and the intoxication of this free diagonal movement onward and upward, or onward or downward, combined at will with brusque changes of direction horizontally when the airship answers to the touch of the rudder!"

Then he began to descend and quickly learned that his ballonet air pump was too small to make up for the contraction of the lifting gas. The envelope lost internal pressure allowing the weight

of the basket to bend it in the middle into a “V” shape, which could tear the envelope in half with fatal consequences. Luckily, the ground was reached without injury.

He quickly built another airship, slightly larger, and with a new rotary (not “agitating”) air pump. On its first flight the envelope again folded in half – this time because he went up in a light rain rather than waste the expensive hydrogen already pumped into the envelope. The cold water had contracted the gas.

Design Development and Worldwide Fame

Airship *Number 3* was built much shorter to avoid the fold-up problem. It needed neither ballonet nor air pump. He also added a 33-foot bamboo pole to spread the basket load lengthwise along the envelope – a primitive keel. In November 1899 he flew this with great success all around Paris, circling the Eiffel Tower many times. And, he landed with great aplomb and no damage.

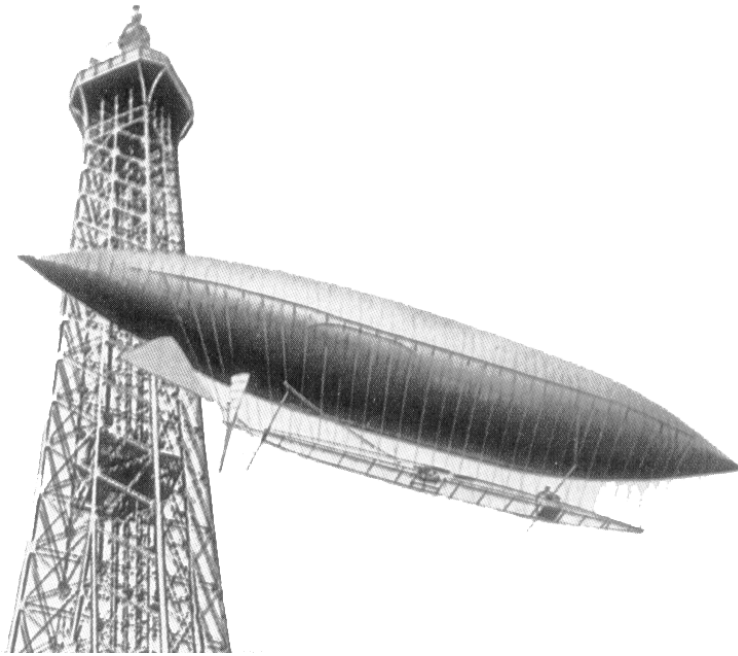
To avoid wasting the hydrogen after every day’s flight, he built what may be the first purpose-built hanger. It was 100 feet long, 23 feet wide, and 36 feet high. He could park his airship inside overnight – a great advance.

His next design returned to the longer, more-streamline shape, and again used a ballonet and air pump. Also, he replaced the bamboo pole with an open-framework keel. This vehicle was unique among his designs in having a tractor propeller at its front, which he disliked due to the air blown on himself. *Number 4* (1900) was famous especially for its pilot’s station – a bicycle seat rather than a basket. This caught the public’s fancy – they could see their “Petite Santos” suspended in his airship, and he responded to their cheers by throwing down his necktie. He flew *Number 4* almost daily in mid 1900, and demonstrated it to many including Samuel Langley of the Smithsonian Institution.

Later that year he built *Number 5* with a new four-cylinder motor (14 hp with 120 lbs of static thrust), larger envelope, and a true fuselage. This was constructed of triangulated wood with aluminum joints and piano wire for bracing, much like a WWI aircraft. While almost 60 feet long and carrying the pilot, motor, propeller, and rudder, this fuselage weighed only 90 lbs. To reduce drag he used thin piano wire for all suspension cables – another first. This design flew perfectly, and he flew it for more than 30 miles around Paris. When one of the rudder control ropes broke, he descended into the Tracadero Gardens, borrowed a ladder, fixed the rope, and continued back to his hanger.

After many successful flights he tried for the Deutsch Prize, which was 100,000 francs for a flight along a specified seven-mile course in less than 30 minutes including a rounding of the Eiffel Tower. He had already flown further routes. However, a leaking gas valve caused him to fall – nearly into the Eiffel Tower, but missing that, he dropped into the courtyard of a hotel where he hung, far in the air, until firemen could rescue him. He was lucky – others had been killed trying for the prize.

As the accident had destroyed *Number 5*, he built *Number 6* along similar lines but with an ellipsoidal shape and more attention to the automatic gas valves. In this airship, and with all of Paris watching, he won the Deutsch Prize and worldwide fame. It was 1901.



Rounding the Eiffel Tower in No. 6

Santos-Dumont received honors from all over the world, and congratulations from engineering pioneers such as Edison and Marconi. He was invited by C.S. Rolls to be the first guest of honor at the newly formed British Aero Club, and was honored by newspapers with fanciful titles such as “Conqueror of the Air.” Visiting the United States, he met with President Roosevelt, Thomas Edison, and Admiral Dewey, and served as an advisor to the 1904 St. Louis Exposition on aeronautical matters. The Prince of Monaco built him a 180-foot long hanger on the ocean so that he could continue his research during the winter. Another honor – he, a Brazilian, was made a Chevalier in the French Legion d’Honneur.

Yet another form of honor – his high shirt collars and vertically striped suits, worn to disguise his shortness, became the fashion rage of Paris and the world, as did his Panama hat. The special watch that his friend Louis Cartier devised so that he could check the time while flying became quite popular – it was the first wrist watch ever produced and was available well into the 1930’s. (The Cartier company still makes a Santos-Dumont model – if you have to ask, you can’t afford one). And lastly, he received the enthusiastic attention of what were then called the “fairer sex”. According to some reports, women would throw their undergarments at him as he cruised his airship past their bedroom windows. But, he himself reports an indifference towards such relationships, and he never married.

Santos-Dumont built several more airships, including a small “racing” airship (never raced, because there were no competitors), a large “Omnibus” airship capable of carrying 10 passengers, and a small runabout (*Number 9*). In this he would often fly into town, descend to the

roof of a restaurant, dine, and fly back to his hanger. On one occasion he cruised all the way up the Champs Elysees at below treetop height, early in the morning when the streets were empty. He started to fly it through the Arc de Triomphe, but felt it would be disrespectful. Instead, he stopped at his own house for coffee, then remounted and flew back to his hanger.

On another occasion, he was convinced by a New York society woman from an old Cuba family to instruct her and then let her fly, alone, in his airship *Number 9*. It was the first ever ascent by a woman in a powered flying machine, and it was solo. She flew for about half a mile, from Neuilly to Bagatelle. The date was 29 June 1903. He kept her photograph on his desk for years – she was young and beautiful, but no romantic involvement is recorded.

He also demonstrated his *Number 9* airship before the Grand Review of the French Army on Bastille Day, 1903, and received a letter from the Minister of War stating “It was impossible not to acknowledge the progress which you have given to aerial navigation. It seems that, thanks to you, such navigation must henceforward lend itself to practical applications, especially from the military point of view. I consider that, in this respect, it may render very substantial services in time of war.” Santos-Dumont volunteered his airships to the service of France in time of war excepting, of course, in the unlikely event of war between France and a country of the Americas.

Heavier-than-Air

Sometime in 1904-1905, and ignorant – like everyone else - of the success of the Wright Brothers, he turned his attention to the problem of heavier-than-air flight. He had mastered flight in lighter-than-air machines and realized, probably better than most, their limitations of frailty, sensitivity to wind, awkward ground handling, expense of operation, and sheer bulk. And, he was apparently somewhat bored of it.

He started with the box kites of childhood and conceived a design with a main wing like a number of box kites joined at their sides, plus a single “canard” box kite up front to be used for both pitch and yaw control. Like most would-be aviators of the day, he assumed that an airplane should be boat-like in the lateral axis – highly stable in roll, with control via a rudder. Thus, he used substantial dihedral on the wing and had no roll control equivalent to modern ailerons. The engine and propeller were in the rear, like most of his airships. For takeoff and landing, it had wheeled landing gear. To construct it he hired Gabriel Voisin, later to become a famous aircraft manufacturer in his own right.

He began tests in 1905, with his design suspended from wires and pulled by – a donkey. This proved nothing other than providing amusement to bystanders. Next, he built an airship-airplane hybrid (*Number 14*) so that he could experience flight with wings, but learned little and found that the airplane portion tended to pull ahead of the airship portion. He broke apart the hybrid and rebuilt the airplane portion. He called it “*Number 14–Again*”, or “*14-bis*”. This he was determined to fly.

He decided to attempt the Archdeacon Prize, established by the Paris Aero Club for the first heavier-than-air flight of 100 meters. They too did not realize that the Wright Brothers, by 1905, were easily exceeding this on a regular basis in their experiments at Huffman Prairie. Santos-

Dumont made no private trial flights, instead calling out the prize officials for his very first attempt. A large crowd had also gathered, to see what the Conqueror of the Air would do next. His calculations were correct, and *14-bis* got off the ground on the first attempt but stalled and settled to the ground, breaking the propeller. He considered this a great success and felt that, with a little work on the longitudinal control, he would succeed.

On October 23, 1906, he was ready again and called out the officials along with the press. A thousand people showed up. After several trail runs, he gave it full power. The plane easily took off and flew for about 200 feet (60 meters) and landed without damage. Although he hadn't made the 100-meter prize requirement, the crowd went wild and the headlines around the world said, "Man has Conquered the Air." It was Alberto Santos-Dumont – again. October 23 is still celebrated as "Aviator's Day" in Brazil.

He repeated his flight a few weeks later, again missing the prize distance, but proving that the first flight wasn't a fluke. However, the reporters described his flight as a "graceful curve" indicating that he was unable to prevent an unwanted turn. This is characteristic of an airplane with too much lateral stability and too little roll control. In fact, he had none.

He now realized the need for roll control from these flights, and added his own aileron-like devices to provide it. These were separate panels like rudders, mounted horizontally between the wings and actuated by wires sewn into the back of his jacket (or attached to rings placed over his arms – accounts vary). Like the Wright's wing warping, lateral shifting of the pilot's body would move the roll control mechanism. These probably were the first ailerons. Note that our modern word "aileron" is based on the French word for "little wing" – perhaps the word was created for Santos-Dumont's novel roll-control devices.

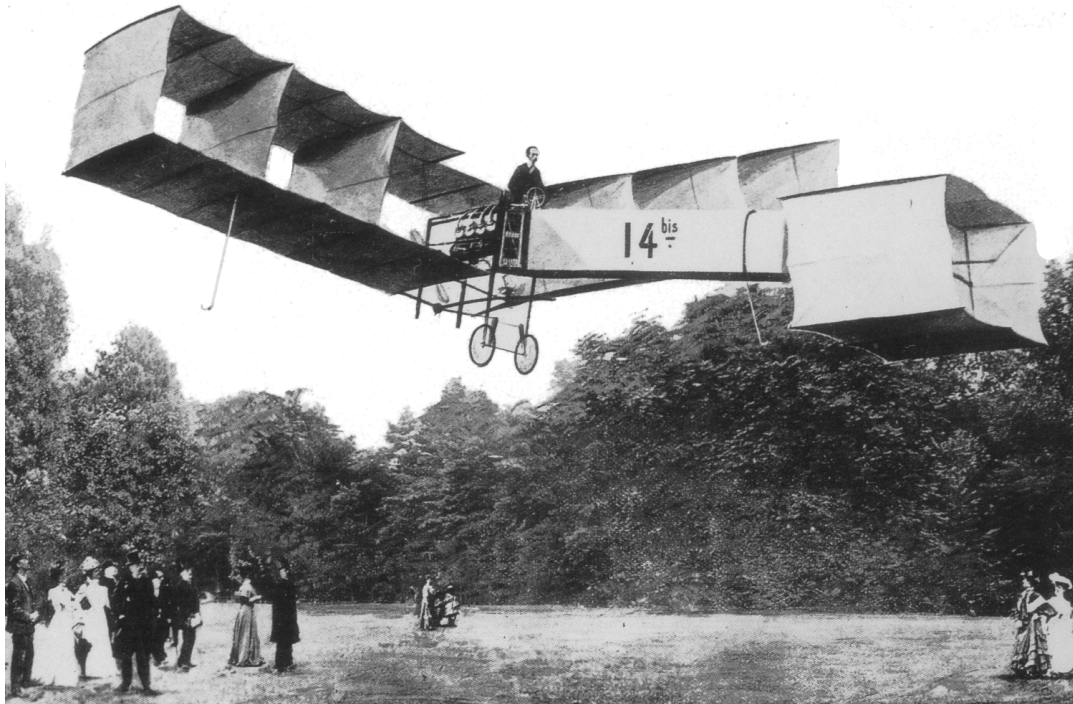
Glenn Curtis flew with what were called ailerons in 1908. These were actually separate wings suspended between his biplane wings – just like Santos-Dumont's. Curtis, along with Alexander Bell, obtained a U.S. patent on ailerons in 1911 but it was ultimately overturned in favor of the Wright's prior patent on the whole concept of lateral control. The first to fly with modern trailing-edge ailerons was Frenchman Henri Farman.

Ready to try again to claim the prize, Santos-Dumont called out the officials, and again the press and a large crowd gathered. There was another would-be pilot ready to try for the prize – Louis Beriot, in a large biplane. He went first, and crashed without lifting off. Then Santos-Dumont flew a total of 720 feet (220 meters) in 21 seconds, using his ailerons to recover from an unwanted turn. The prize was won, in a manned aircraft that took off on wheels under its own power, flew with three-axis control, and landed without damage.

He was carried off the field on the shoulders of the crowd, and all of Paris celebrated. Europe and much of the rest of the world believed that Santos-Dumont was the first man to fly a heavier-than-air aircraft. His fame was incredible – perhaps even greater than Lindberg or the original astronauts, with a little bit of Elvis' style thrown in!

At the Bagatelle field where he flew, an obelisk was later erected stating "Here on 12th November 1906, under the control of the Aero Club of France, Santos-Dumont established the

first aviation record in the world.” Note the careful wording – by this time, suspicions had begun that perhaps his was not the first *flight* after all. There were these brothers from Ohio.....



*14bis in Flight**

The First Homebuilder

He flew the *14-bis* one more time, for another 200 meters, then retired it. He next designed three never-flown aircraft - a plywood airplane (another first?), a helicopter, and a flying boat. Then he began work on a tiny monoplane – the *Demoiselle*.

This was first flown in 1907. By today’s standards it would be called an ultralight, weighing about 250 lbs empty. The pilot sat under the wing, with the engine above and in front of him, mounted at the wing leading edge. The wing had only 108 square feet of area (yellow silk, of course) and its ribs were of bamboo, as were the supports for the tails. The tails were unusual – the vertical and horizontal surfaces were a single unit, moved together for pitch and yaw. Santos-Dumont went through several versions of the *Demoiselle*, testing and perfecting it. He often flew later versions to visit friends, landing on the lawns of their estates. Photographs show the *Demoiselle*[†] loaded in the back of his open car, on the way to a flight.

* This author suspects that this often-printed photo is a fake, judging by the people under the flight path, the lack of a clear area behind the plane, and the white outline visible on the bottom of the canard. Probably this is an actual photo of the plane on the ground, cut out and superimposed to make a dramatic scene. A later painting based on this photo added many more people plus an automobile and a man on a prancing horse! Other photos of this flight appear authentic, but aren’t as dramatic or as clear.

[†] The *Demoiselle* is perhaps best known today for its appearance in the 1965 movie *Those Magnificent Men in their Flying Machines* – the little plane flown by the amorous Frenchman.



Demoiselle

In August 1908, Wilbur Wright visited France with the newest version of their *Flyer*. They had cautiously waited until after their patent was granted before demonstrating their design to other aviators. After initial skepticism, the French aviators had to admit that Wright's effortless maneuvering and long flights had far surpassed their best efforts. One flight lasted over two hours, at a time when others were still measuring flights in minutes or seconds. A newspaper quoted Louis Bleriot as saying "We are beaten – we are nothing." Crowds came to watch Wright and he became the new flying celebrity.

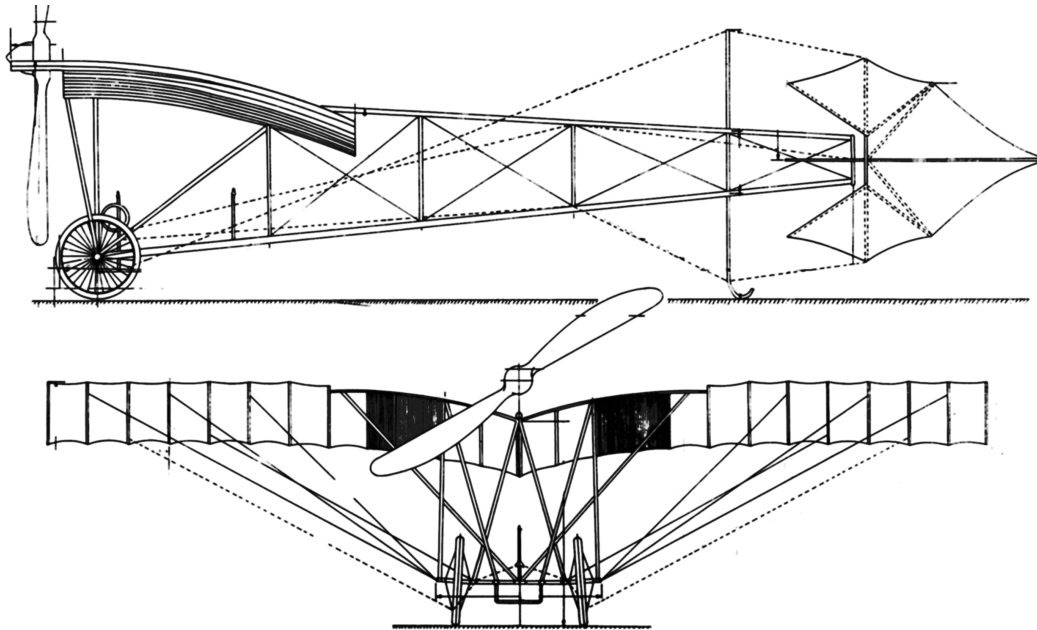
The incredible performance of the 1908 design gave increasing credit to the Wright's claim of controlled flight five years earlier – almost three years before Santos-Dumont. In fact, Wilbur's newfound fame and acceptance in France led, finally, to fame in the U.S.A. where the Wright's claims had previously been ridiculed or ignored.

Santos-Dumont's reaction is not recorded, but he must have been disbelieving at first, then disappointed as the evidence grew that these fellow-Americans had beaten him to heavier-than-air flight. However, many still doubted that the Wrights had truly flown as early as 1903, and to this day many in France and Brazil believe that the 1903 flights used a catapult (untrue) or that the 1903 *Flyer* was incapable of flying without the help of a strong headwind.

Interestingly enough, 1908 was probably the last year in which the Wright's airplanes were decidedly superior to the European's. While they spent their time in sales demonstrations and patent fights, the French and others pressed on with technology development. This early French dominance is visible in today's aviation terminology – words such as fuselage, empennage, longeron, aileron, and decalage display French heritage.

Santos-Dumont continued the development of the *Demoiselle*, and when perfected, made the plans freely available to all. They were published world-wide. In the United States they were published in *Popular Mechanics* magazine (1910), introduced as follows: "From time to time,

vague descriptions of the manner of constructing aeroplanes have been given to the public. All over the United States there are thousands of persons who are intensely interested in the subject of aerial flight, but until now nothing of a tangible nature has been presented on which work could be started with a reasonable prospect of success. It is a great satisfaction therefore, to be able to present the working drawings of the wonderful monoplane invented by M. Santos-Dumont.”



Demoiselle Plans – Side & Front Views

This author believes Santos-Dumont should be called the “first homebuilder” because he was the first to release buildable plans that “homebuilders” could use to construct an airplane that would actually fly.

At least 10 were built in Europe and probably many more in the USA³. It was claimed that the plane could be constructed in about 15 days⁴. Perhaps this was true, or perhaps this was another first – the now-common underestimation of homebuilt construction time. The design was put into production by at least one company, which tried to patent it since Santos-Dumont had declined to do so.

Who Was First to Fly?

Who? That, of course, depends upon what one means by “to fly.” Ascending into the air, going where one wishes under power and control, and returning to Earth when and where one chooses – the first was Santos-Dumont in his 1898 airship.

If flight via lighter-than-air technology is excluded from your definition, then the picture is less clear. Several early pioneers had managed to get a manned, powered flying machine to briefly leave the ground. They were lucky that they didn’t fly higher because they had no real understanding of stability and control.

If your definition is a sustained flight of a heavier-than-air powered machine over a long enough distance that more than luck is involved, then perhaps the steam-powered models of John Stringfellow (1848) or Samuel Langley (1896) were the first. Nobody today would claim that the Global Hawk is not a functional flying machine even though it is unmanned. But, they had no lateral control so the attainment of manned flight was more than a simple scaling-up of their designs, as Langley learned to his sorrow.

By the definition of a manned aircraft that left the ground under its own power, flew for a non-trivial distance under full three-axis control, and landed without damage, then the flights of Wilbur and Orville Wright in 1903 were clearly the first. This is evident in their journals and in their clear technical understanding of the means of attaining three-axis control and in their correct calculations and designs for their propulsion and structures. Quite simply, they knew what they were doing by then, did it in front of witnesses (few, admittedly), and produced ample photographic documentation. Furthermore, they didn't stop in 1903 – by the 1906 date of Santos-Dumont's flight, they had flown at Huffman Prairie numerous times in front of hundreds of witnesses, making dozens of complete circuits of the field on flights lasting over 30 minutes.

Several objections to the Wright Brothers primacy are raised – they used a catapult or track, their power-to-weight ratio was too low, they were secretive, and they hadn't been recognized by any legitimate aviation organization.

In their first flights they did use a wooden track (not a catapult). Quite simply, they needed some sort of hard surface to gain speed on the sands of Kitty Hawk, and a track was both easy to construct and helpful in keeping the plane going straight. However, the plane accelerated under its own power and flew a substantial distance in the face of a 20-mph headwind. Their best flight on that first day was almost 1 minute, travelling 852 feet along the ground at an airspeed of 31 mph, which works out to the still-air equivalent of over half a mile.

On their return to Ohio, they did construct and use a catapult after several dozen flights using just the track. This was done more for safety than anything else. Their 1904 and 1905 machines could take off without the catapult, but the small flying field and shifting winds of Ohio made it safer to use a catapult. In fact, they didn't bother using the catapult if a steady headwind was present. The 1904 machine once flew for 21 miles over 39 minutes, long enough to prove that the catapult had nothing to do with its sustained flight capabilities.

While in Paris in 1908, Wilbur was denied a record for altitude because of the use of the catapult. Somewhat angrily, he repeated the record flight without the catapult – and without wheels, sliding along on the skids until takeoff speed was reached! In 1909 they added bicycle-like wheels (a subject they knew something about), but the legend that their plane was incapable of flight without the catapult had already firmly established itself.

Suggestions are sometimes offered that the 1903 *Flyer* surely couldn't fly because its power loading (W/P) was too high relative to other early aircraft. The 1903 *Flyer* had 12 hp and a takeoff weight of about 820 pounds, giving it a power loading of 68 pounds of aircraft per available horsepower. When it won the prize, Santos-Dumont's *14bis* had a 50 hp engine and

weighed about 800 lbs, for a power loading of 16 lbs/hp. This is about one-fourth the power loading of the *Flyer* (a smaller power loading implies a larger engine). For comparison, a modern general aviation aircraft⁵ typically has a power loading of 14, almost the same as *14bis*.

These comparisons are missing one important point – the Wright’s propellers were so far superior to others that they provided roughly twice the thrust per horsepower. This has been verified by recent tests. So, their effective power loading was about double that of the *14bis* - marginal by today’s standards, but sufficient to fly. Later Wright machines had much better power loadings.

Concerning their being secretive – events seem to justify it. Curtis and others blatantly “borrowed” their ideas. Langley himself allowed his failed machine to be secretly modified and publicly flown by Curtis as “proof” that the Wright’s patented ideas were not so important or original.

In an early example of the current difficulties between the legal and aviation communities, their lawyer did not fully understand the true nature of their invention – lateral roll control via changing the amount of lift on the left and right side of the airplane. Instead, he patented only the wing warping mechanization they employed to accomplish that fundamental idea. This led others such as Curtis to invent other devices for accomplishing that same lateral control, leading to protracted patent fights.

But even with their legitimate concerns for protecting their inventions, the Wrights had invited the public at Kitty Hawk to witness their efforts. There were some citizens watching, even in that remote location (chosen for its steady winds, needed for their early glider experiments). Most were from the local lifesaving squad, and helped to carry the plane to its takeoff location. The Wrights also invited the public to their flights in Dayton beginning in 1904.

As to the press, about 30 showed up for the first demonstration in 1904 but technical difficulties with the motor prevented a flight. A second attempt produced only a short hopping flight, reported with ridicule in the few newspapers that carried it. Further flights in 1904 were quite successful, but few members of the press bothered to show up.

In 1905 the Wrights flew before hundreds of people covering 30 circuits of the field at Huffman Prairie, a total of 24 miles in 39 minutes. In all, there were at least six public flights by the Wrights prior to Santos-Dumont’s flight⁶.

As to the lack of a legitimate aviation organization certifying their first flights: in 1903 there were no organizations certifying flying records because there was as yet no flying. Record keeping started in 1906 with the first record – Santos-Dumont’s. The only legitimate organizations in the United States that might have been called out to witness their flights were the Smithsonian Institution, headed at that time by competitor Samuel Langley, and the Aerial Experiment Association, not founded until 1907 and by competitor Glenn Curtis among others.

The End

The ending of the Santos-Dumont story is not so good. As the world finally accepted that the Wright's had flown first, the name of Santos-Dumont went into eclipse. His prior triumphs in lighter-than-air flight, which should have been enough to ensure his fame forever, were largely forgotten – probably due to the embarrassment of the misplaced enthusiasm for his “first” heavier-than-air flights. Today, “Zeppelin” is the name associated with early airship flight – but Santos-Dumont was first.

In 1910, about the time that his “first to fly” title had completely withered away, he was diagnosed with Multiple Sclerosis. He closed up his flying shop and spent his declining years traveling about and living in reclusion. He continued to innovate, creating what may have been the first artificial horizon, but was never again a major aeronautical figure. He became increasingly depressed at the use of aviation in warfare – he had idealistically thought that warfare would be impossible once aggressors could be overflown at will. Alberto Santos-Dumont died in 1932, not of his disease but by his own hand. Brazil mourned, and we should too.

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¹ Santos-Dumont, A., *My Airships*, University Press of the Pacific, Honolulu, 2002 (Reprint of 1973 Dover Publications translation edition, originally published in 1904 as *Dans l'Air*)

² Winters, N., *Man Flies – the Story of Alberto Santos-Dumont*, The Ecco Press, Hopewell, New Jersey, 1997

³ Rhodes, T., *The First Ultralight*, EAA Experimenter Magazine, Dec. 1999

⁴ de Matos, B., *Celebrating the Evolution of Flight – Brazil*, Aeronautical World (Geocities Website), Oct. 2002

⁵ Raymer, D., *AIRCRAFT DESIGN: A Conceptual Approach*, American Institute of Aeronautics and Astronautics, Washington, D.C., Third Edition 1999

⁶ anon, *First-To-Fly*, Wright Brothers Aeronautical Company and Museum of Pioneer Aviation (website), 2002