The History of the Twentieth Century
Episode 48
“The Flight of Icarus
Transcript

[music: fanfare]

In December 1901, *Washington Post* political editor Henry Litchfield West made a startling prediction. In the year 1800, he noted, people traveled at the rate of about six miles per hour—the rate of a horse-drawn coach. By the year 1900, human beings were routinely traveling long distances at a rate of sixty miles per hour—the speed of a steam locomotive or a fast automobile.

That was an order of magnitude over the course of a century. Extrapolate that forward, West noted, and by the year 2000, human beings might be criss-crossing the American continent at the mind-boggling speed of six *hundred* miles per hour. People might travel, say, from Washington to Chicago in 70 or 80 minutes. “This seems incredible,” West conceded, “but is not more marvelous than it would have seemed in 1800 to suggest that the 40 miles from Washington to Baltimore could be traveled in 40 minutes.”

Welcome to the History of the Twentieth Century.

[music: opening theme]

Episode 48. The Flight of Icarus.

Henry Litchfield West had called it. The cruising speed of a passenger jet in our time is just a bit less than 600 miles per hour, and scheduled commercial flights are available today from Washington to Chicago that are under 90 minutes. Of course, it takes longer than that to board, but that’s another story.

The story of the development of the airplane is complex, because a number of scientific principles had to be worked out and engineering problems solved before the airplane as we know it today became possible.

The man who is sometimes called “the father of aviation,” Sir George Cayley, was nine years old when Paris saw the first manned balloon flights. Cayley was British, a brilliant engineer and experimenter, and his notebooks from his school days show us today that he was pondering the questions of flight from an early age.

Cayley studied the shapes of bird wings and fish to understand streamlining and the fluid dynamics of an object moving through the air. He created a whirling arm apparatus, the forerunner of the wind tunnel, that could move test objects through the air at high speeds, so he could experiment with wing shapes. It was Cayley who developed the model of lift, thrust, drag, and gravity as the four forces at work on an airfoil, a model we still use today. Cayley put this work into practice, designing and building gliders, seeking ways to get the maximum lift out of the minimum weight of materials.

Cayley was the first person to build a glider large enough to carry a human being in 1849. His basic design concept of a large wing up front, with a smaller tail for steering behind and the center of gravity of the craft below the wings for reasons of stability, became the basic design for gliders and, later, airplanes.

Cayley continued to refine his work until 1853. At that point he was 80 years old, and I guess we can forgive him for slowing down a bit. He would die just a couple weeks shy of his 84th birthday.

Cayley was the Moses who saw the Promised Land, but it was left to others to find the way. There were three basic problems that needed to be overcome. The first was finding the best airfoil design for maximum lift using materials that would be lightweight but sufficiently sturdy. The second was finding an engine powerful enough to propel the craft forward, but light enough to come along for the ride. The third was stability and maneuverability. The vehicle had to be stable, and yet the pilot had to be able to steer the thing.

The next fifty years were a long slog of trial and error. And mostly error. There was at this time no such thing as professional researchers in universities or in industry, working on the problem. It was hard to get your hands on the relevant data and review what had been learned by those who had gone before you. Aircraft experimenters tended to be wealthy gentlemen of leisure who took an interest in the problem and spent their own money to take a whack at it. These gentlemen tended to be British, or French, or American. And the trouble was, the kind of wealthy gentleman who took up this sort of project tended to be the sort of person who figured he already knew more than anyone else and was unwilling to listen to any criticism of his approach.

The result was repeated instances of people designing and building prototype airplanes with fatal design flaws that they would have and should have known about, had they taken the time to read the published literature and listen to their critics. They would confidently announce that they had solved the problem, then fail spectacularly and publicly. Or they would claim success and have the claim picked up in the newspapers, only to have their claim exposed later as boasting, if not outright fraud.

One such case was the American-born British inventor Hiram Maxim, whom we have already met, as he was the inventor of the Maxim gun. He decided to take up the project and confidently announced in advance that five years of his time and £100,000 of his money (about ten million

US dollars in today's world) would solve the problem of heavier than air flight. He actually spent about £20,000 pounds to build a large steam-powered machine designed to carry three people that managed to leap off the track that was meant to restrain it during a test flight, throwing debris that damaged the propeller and ending the flight. And that was as far as Maxim got. Financial reversals and then business disputes led to his company being taken over by Vickers, and he was done with flying machines.

And then there was the American Samuel Pierport Langley. Born in Boston in 1834, Langley had become a prominent astronomer and physicist and in 1887, at the age of 52, he had become Secretary of the Smithsonian Institution. "Secretary" is what they call they head of the Smithsonian, for some reason. Anyway, Langley had accomplished all this in spite of the fact that he had actually had no formal education beyond high school.

Like Maxim, Langley was a self-made man, another fellow used to solving problems on his own that other people thought impossible. By the time he was appointed to run the Smithsonian, he had already taken an interest in the problem of heavier than air flight. He began by experimenting with model aircraft powered by rubber bands. By the 1890s, he had graduated to model craft powered by tiny, ingenious steam engines. Langley called his experimental aircraft "aerodromes," because he didn't know as much Greek as he thought he did. "Aerodrome" comes from two Greek words that actually make it mean something closer to "air*port*," rather than "air*craft*," but whatever.

Langley used a catapult device mounted on top of a houseboat in the Potomac River near Washington to launch his test flights. The air above the Potomac was still, which was helpful, and landing in the river made it possible to build a craft with no landing gear, which saved on the weight. In 1896, Langley successfully flew a steam-powered model with a 13-foot wingspan over the river, a craft he called Aerodrome Number Five. It flew one hundred feet in the air over a distance of more than half a mile. A follow-up craft, Aerodrome Number Six, of course, flew even farther.

One of Langley's earliest boosters was the Assistant Secretary of the Navy Theodore Roosevelt, who recommended Langley to his boss, Secretary Long. By 1898, with the Spanish-American War in full swing, the War Department was sufficiently convinced to offer Langley a $50,000 grant to build a flying machine capable of carrying a person. He also got a grant from the Smithsonian and some private money, the equivalent of about one and a half million dollars in total, in today's currency.

With that grant, Langley switched to the newfangled internal combustion engine, from which he could get more power. His earlier models flew, albeit erratically. After five years and burning through his grant money, the now 69-year old Langley attempted to launch a piloted craft off the houseboat in October, 1903, only to have the craft snag on the catapult and tumble into the river.

The press had a field day. The New York Times opined that "The ridiculous fiasco which attended the attempt at aerial navigation in the Langley flying machines was not unexpected…no doubt the problem [of flight] has attractions for those it interests, but to the ordinary man it would seem as if [the] effort might be employed more profitably."

Langley repaired his machine and made a final attempt on December 8, 1903. Hunks of ice were floating in the frigid Potomac when his pilot climbed into the machine on top of the houseboat, and I have to pause here to ask how anyone expected this pilot to survive. He was in an open framework inside an experimental flying machine set to launch over a freezing cold river with no landing gear. Am I missing something here? And even if everything goes as well as can be hoped, isn't the pilot going to end up in freezing cold water, inside a tangle of machinery? Okay, they gave him a life jacket to make sure he could float, but, um, I'm not sure I can watch this. In fact, what happened was that this time Langley's machine launched smoothly from the catapult, took to the air…and disintegrated. The pilot and the wreckage plunged into the freezing water, and he got tangled up in it. I am happy to report that at least the pilot was able to free himself from the wreckage and survive the experiment. Langley's reputation, however, did not.

Friend of the podcast Lord Kelvin, the most famous scientist of this age, had been dismissing flying machines for some time. In 1896, he said, "I have not the smallest molecule of faith in aerial navigation, other than ballooning, or of expectation of good results from any of the trials we hear of." Some of his skepticism may have come from the fact that two years earlier, Samuel Langley had visited London and briefed the British Association for the Advancement of Science on his work. Lord Kelvin was there for that presentation, and promptly pointed out errors in Langley's calculations. That doesn't instill much confidence, does it? And the most prominent astronomer of the time, the Canadian-born American Simon Newcomb, wrote in 1903, "May not our mechanicians…be ultimately forced to admit that aerial flight is one of the great class of problems with which man can never cope, and give up all attempts to grapple with it?"

It's tempting to laugh at those famous scientists today, but before you do, take a moment to consider Maxim, and Langley, and other experimenters of this period that I haven't mentioned who were repeatedly announcing that they had cracked the problem of flight, and then failing dramatically and publicly when they tried to prove it. And, in fact, experimenters like Maxim and Langley had more knowledgeable scientists, like Lord Kelvin, calling their attention to problems in their work, and they were ignoring them.

What were they doing wrong? Well, there were a couple of things. First, the idea of beginning with a scale model and working your way up to a craft capable of carrying a pilot sounds good in principle, but in practice, you can run afoul of the square-cube law. In my own modest experience as an engineer, I've been amazed at how many otherwise smart people have trouble grasping why it is that you can build a model machine on a tabletop that works just fine, but when you scale it up to the size of a car or a house, it doesn't work anymore. That's because when you double the dimensions of a machine, the surface areas increase by two squared, which is four, but the volumes increase by two cubed, which is eight.

And this is where Langley went wrong. If you double the dimensions of your model, it has four times the wing surface, but eight times the weight. If your machine hangs down from the wings, as Cayley's experiments recommended, the structural supports are four times stronger, but the machine is eight times heavier. And that's why Langley's machine disintegrated. The structural supports couldn't hold it together. Experimenters like Langley favored light materials, like wood and cloth, to build their flying machines, to save on weight, and they were able to build machines that were plenty sturdy as scale models, but fell apart when you enlarged them.

And there was another problem. Airfoils need to be moving pretty fast to generate lift. Any object moving quickly through the air is likely to be unstable, unless it is carefully streamlined. On the other hand, streamlining is great for flying in a straight line, but that's all it's good for, as anyone who ever folded a paper airplane can tell you. But even if you can get your flying machine off the ground, it's not worth much unless your pilot can steer it. To steer it, you need a vertical rudder for left-right steering, what we today call "yaw," and a horizontal elevator for up-down steering, what we today call "pitch." Unfortunately, there's a tension between control and stability. If you use your rudder and elevator to steer, you risk losing stability. So your aircraft has to be carefully engineered to be maneuverable without going into uncontrollable gyrations and crashing every time you try to make a turn. And you can't solve these problems with a model. You're going to have to get out there and fly a real machine. But how can you do that if you don't know how to build one that won't go unstable and crash on you?

One answer is, build a glider. And in the late nineteenth century, the man they called the Glider King was a German named Otto Lilienthal. He was born in Prussia in 1848. Beginning in 1891, when he was 43 years old, Lilienthal built and flew an experimental one-man glider, quite similar to the hang gliders we all know today. He studied bird wings, built gliding rigs, and spent his weekends jumping off hilltops. Lilienthal worked out how to steer his gliders by shifting his weight, how to catch updrafts to gain altitude, and over the next five years he flew thousands of times, averaging about ten seconds a flight, though sometimes covering hundreds of feet of distance.

Unfortunately, Lilienthal's glider design had him riding higher than does a modern hang glider pilot, which is a less stable position. On August 9, 1896, during a test flight, Lilienthal's glider pitched forward and began a rapid descent. The angle was too steep for him to pull out from merely by shifting his weight around, and he plunged fifty feet to the ground, head first, which broke his neck and killed him.

Lilienthal's death, one more prominent failure among those experimenting with flight, added to the sense of discouragement. But while all these setbacks were garnering public attention, two bicycle shop partners in Dayton, Ohio were collecting every last scrap of information they could get their hands on about earlier experiments, and, working quietly, in obscurity, even in secrecy, away from public and press attention, were inching closer and closer to the answer.

[music: Overture to *The Flying Dutchman*]

The British writer and thinker HG Wells was a little less optimistic than Henry Litchfield West was in the article I quoted at the top of the episdode. In 1902, Wells wrote, “Few people, I fancy, who know the work of Langley, Lillienthal, Pilcher, Maxim, and Chanute but will be inclined to believe that long before the year 2000, and very probably before 1950, a successful aeroplane will have soared and come home safe and sound.”

We met some of those aviation pioneers already, but we also saw that in spite of their best efforts, the problem remained stubbornly unsolved, and the pioneers themselves tended to end up humiliated or dead. The newspapers still took interest in anyone who claimed to be experimenting with flight, but the facts never seemed to live up to the hype, and the public was becoming jaded. Remember “Darius Green and His Flying Machine?”

The nineteenth century just did not have organized science as we know it today. Yes, there were academic theoreticians, like Lord Kelvin and Simon Newcomb, who, as we have seen, are becoming as impatient as everyone else with these inventors. But the network of peer-reviewed professional journals and university libraries and academic conferences that would develop in the twentieth century was just getting going then. And of course the internet is still a long way away. It would take a lot of effort for a prospective aircraft inventor-experimenter just to collect all the available information on past trials and results. That’s assuming they have the patience even to try. As we have seen, many approached the problem with arrogance, blithely taking for granted that they could succeed where so many others had failed because they were just that awesome.

Henry Litchfield West and HG Wells would have had no way of knowing it, but even as they were writing the words I have quoted, a pair of inventor brothers in Dayton, Ohio were well on their way to cracking the problem using exactly the approach that would become the norm in the twentieth century: by first collecting all available data on past trials and then engaging in lots of patient, careful, incremental experimentation.

Wilbur Wright was born on April 16, 1867. Orville Wright was born on August 19, 1871. They were two of seven children born to Milton Wright and Susan Koerner. Milton Wright was a bishop in the Church of the United Brethren, which today is part of the United Methodist Church. In that capacity, Milton Wright traveled frequently, and the family moved frequently, although they would eventually settle down in Dayton. The Wright children were raised in a strict, but tightly-knit household. Wilbur and Orville, four years apart in age, would always be close, but they show evidence of having difficulty forming relationships outside their family. Neither brother ever married. When their sister married, Orville took it as a betrayal and refused to talk to her for many years afterward, so yeah, that’s kind of weird.

Bishop Wright was often away from his children, and was in the habit of bringing them presents when he returned from his church-related trips. In 1878, when Wilbur was 11 and Orville was 7, their father returned home with one of those propeller toys I talked about in last week's episode. This one was powered by a rubber band. The boys were enchanted by the toy and played with it until it broke. They then taught themselves how to build a new one. They experimented with making the toy bigger, and bigger, and ran afoul of the square cube law, although this would teach them a valuable lesson that would elude other would-be inventors later on, as we have already seen. Later in life, the Wright brothers would point to this moment, when their father gave them this toy, as what set them on the path to building an airplane.

In 1886, 18-year old Wilbur would be hit in the face with a hockey stick during a game, which would lead to the loss of his front teeth. He had been planning to attend Yale University and for that reason was the pride of his family, but the injury seems to have had a serious emotional effect on him. He became withdrawn. Over the next several years, he scarcely ever left the family home, and he abandoned his plan to attend Yale.

Three years later, in 1889, Orville dropped out of high school before the start of his senior year. He and Wilbur had built their own printing press, and Orville opened a print shop. Wilbur assisted him. They published a newspaper for a few months, but then focused their business on commercial printing.

You may recall from episode 20, that in 1887, two years before the Wrights would open their print shop, a Scottish-born veterinarian living in Northern Ireland named John Dunlop invented an inflatable tire that made bicycles much more comfortable and practical. The fact that bicycles were often known colloquially as "boneshakers" prior to Dunlop's invention gives you some idea of how important it was. At this time, the most common form of bicycle was the so-called penny farthing. These are the bicycles that have a really big wheel up front, that the cyclist rides on top of, and a much smaller wheel behind. You've probably seen pictures of them. By the early 1890s, the penny farthing was giving way to a new design, one with two equal-size wheels, with the cyclist sitting in between them and powering the rear wheel by means of pedals and a chain. In 1890, they called one of these newfangled bicycles a "safety bicycle," because falling off of it was much less dangerous than falling off a penny farthing. Today, we call them "bicycles."

Anyway, safety bicycles really caught on, and in 1892, the Wrights took advantage of the craze to open a shop where they sold and repaired safety bicycles. By 1896, the business was doing so well that the brothers added a manufacturing facility, where they began to make their own brand of bicycle. 1896 was also the year of the death of Otto Lillienthal. The Wrights had been following his glider experiments, and the news hit them pretty hard. 1896 was also the year that Samuel Langley demonstrated a model steam-powered aircraft, and the French-born American engineer Octave Chanute, who would later become a friend and advisor to the Wrights, was getting a great deal of press attention in the United States for *his* glider experiments.

The Wrights set about methodically collecting and studying every scrap of information available on the work that had been done before them. They agreed with Lillienthal, Chanute and Pilcher that experimenting with gliders was the way to go, as opposed to the Maxim, Ader, and Langley approach of focusing on powerful engines. Mindful of the death of Lillienthal, and of Percy Pilcher, a British glider experimenter who was killed in 1899, they concluded that the biggest unsolved problem of flight was how to control the vehicle, and this would be the area where the Wrights would make their biggest contribution.

You see, Lillienthal had died because he could only control his glider by shifting his body weight. A practical flying machine was going to need a much more sophisticated system of control. Now, ever since Sir George Cayley, experimenters had realized that a flying craft would need a vertical rudder, like a ship's rudder, for turning the nose of the craft right or left, and a horizontal version of a rudder, called an *elevator*, to turn the nose of the aircraft up or down. And that is why virtually every airplane you've ever seen has a tail with a rudder and an elevator on it.

On the face of it, pitch and yaw control should be all you need to navigate through a three-dimensional environment, and that is how everyone figured it until Wilbur Wright noticed one day in 1899 that when a flying bird makes a turn, it banks, rolling its body into the turn. It's probably significant here that the Wrights sold bicycles in their day job, since cyclists also lean when they go into a turn. By 1900, they were ready to build a glider large enough to carry a person, using fabric, wood, and wire to save on weight. They incorporated their control ideas into the craft, using wing warping, that is, twisting the wood and fabric wings a little bit in opposite directions, to provide what we now call *roll*, which was a crucial improvement.

The Wrights, at Chanute's suggestion, collected information from the US Weather Bureau on wind conditions across the American coasts, looking for someplace with strong, consistent winds. Having a soft, sandy surface to land on isn't a bad idea, either, when you're experimenting with gliders. They were looking for someplace that met their wind criteria and was as close to Dayton, Ohio as possible. The location they hit upon was Kitty Hawk, on the outer banks of North Carolina.

They spent the first half of 1900 building a glider capable of carrying one of them—about 150 pounds, because people were smaller then. It was a biplane design, with the elevator in the front and no rudder or tail. If you've ever seen the Wright Flyer or a picture of it, you've probably noticed that the elevator is up front. That's the smaller horizontal wings up front that control the pitch. The Wrights would be attached to this design concept for the next ten years, even though it makes the glider less stable, because it also makes it easier to pull out of a dive. (Because Lillienthal's death was still much on their minds.) Also, they felt that the front elevator gave the pilot some measure of protection. There was no tail. With a front elevator and with wing warping to produce a roll, the Wrights believed, incorrectly, as it turns out, that they would not need a rudder for yaw control.

The pilot would lie down on the bottom wing, for aerodynamic reasons, and the glider had no landing gear, though the brothers would soon find that they could bring it in to a safe gliding stop on the sand, so they weren't too worried about that.

In October, they took the 1900 glider to Kitty Hawk and tested it in the stiff ocean breezes, first, unmanned with men holding it down with ropes, and after that checked out, Wilbur took it on a few free glides. Although the glider developed less lift than they were hoping for, things went pretty well otherwise, and the brothers returned to Dayton full of ideas on how to improve and refine the design.

They built a new glider in early 1901, with a 30% increase in wingspan to improve lift, and returned with it to Kitty Hawk in July of that year. But the 1901 glider would prove a huge disappointment. The lift it produced was only a fraction of what they had expected, and when they gave their wing-warping concept a more thorough testing, they discovered that when the pilot rolled the glider in one direction, the nose of the craft pulled in the opposite direction, which made the craft unstable. This phenomenon is known today as *adverse yaw*. In contrast to the previous year, the brothers returned to Dayton very discouraged. Wilbur remarked to Orville that at this rate it would take a thousand years to develop a flying machine.

As it turned out, his estimate was off by 998 years.

The Wrights built a wind tunnel in their shop to experiment with different wing shapes to address the lift problem. They concluded that the accepted formula then in use to calculate the lift of an airfoil was wrong. Quite a bit wrong, in fact, and it was wrong in the direction of predicting more lift than you actually get. And so, the 1902 glider would have 50% more wingspan than the 1901 glider, and an improved shape. And by the way, the fact that the accepted lift equation was so far wrong…that might help to explain the woes of so many of these other aviation pioneers.

They addressed the problem of adverse yaw by adding a tail with a rudder, because it turns out that an aircraft pilot needs *both* roll control *and* yaw control in order to execute a controlled turn. Tests done at Kitty Hawk in September and October of that year were a huge success; the 1902 glider had ample lift and made elegant, controlled turns. The brothers were so sure of themselves by this time that they went ahead and filed a patent in March 1903 on the 1902 glider design. Because, really, perfecting lift and turn control was a more important advance than adding an engine.

But the next step was indeed to add an engine. They calculated they would need an internal combustion engine no heavier than 180 pounds that provided no less than eight horsepower. They wrote to various manufacturers, but no one had an engine to offer that met their specs. So they built one in their own workshop. The Wright engine would weigh in at 179 pounds, and provide 12 horsepower. So, significantly above spec. Then they had to make their own wooden propellers. There was no generally accepted propeller design at the time, so the brothers turned to their wind tunnel and developed their own. The finished propellers were made of wood, eight feet long, and their design holds up pretty well even by today's standards. And yes, I said propellers, plural, because the Wright Flyer would have one engine with two propellers, driven by chains, because who knows chains like bicycle manufacturers? The propellers were rigged to turn in opposite directions, so the torques they generated would cancel each other out.

In Kitty Hawk that fall, they suffered many frustrations and delays because they had used hollow propeller shafts to save on weight, but they kept breaking, which requires a return trip to Dayton to manufacture solid replacements. Finally, on December 17, 1903, just nine days after Samuel Langley's aerodrome had disintegrated over the Potomac in a very public display, Orville Wright took his craft on a successful flight of 120 feet in 12 seconds. There would be three more successful flights that day, the fourth and longest piloted by Wilbur, who flew 852 feet in 59 seconds.

[music: "Flight of the Bumblebee"]

So, yeah, their longest flight that day was twelve seconds shorter than that piece of music I just played.

In contrast to the press attention other aviation pioneers attracted, the Wrights, who shunned the press, had only five eyewitnesses present on the day of their triumph. They did send out a press announcement afterward, but it attracted little attention. Some newspapers thought the flights were too short to mean anything. Others questioned whether the Wrights were telling the truth.

This would be their last visit to North Carolina. In 1904, the year of the World's Fair in St. Louis, they declined an opportunity to demonstrate their machine at the exposition. They secured the use of a cow pasture outside Dayton, and used that for further experiments. They would occasionally allow reporters to watch, although not photograph, their test flights. By October 5, 1905, they were able to fly their newest machine for more than thirty minutes at a time, in front of family and friends. The *Dayton Daily News* published an account of that flight the next day, on page nine, right next to a report on cattle prices.

By this time, the Wright brothers would be satisfied with their design, and they would not fly again for over two years. They were not wealthy men, and they had not gotten any grants or government support, as Langley had. They had sunk thousands of dollars of their own money into their airplane, and they were determined to earn something back on the investment, and they were terrified that someone else was going to steal their idea.

They sent proposals to the governments of the United States, Britain, France, and Germany, offering to manufacture and sell flying machines, but they found little interest at first, because of their strict terms. They would not demonstrate their flying machine, or even show a photograph of it in flight, until they had a signed contract in hand. The United States government, having already sunk $50,000 into Langley's aerodromes with nothing to show for it but an oil slick on the Potomac, was reluctant to accept those terms.

The Europeans were even more skeptical, most of all the French, but there was active experimentation in flying machines going on in Europe, particularly in France during this period, all of which was unsuccessful. Still, there was great enthusiasm for the project. The Aero-Club de France was founded in 1898. It promoted aeronautical research, published an aeronautical journal called *L'Aerophile,* and offered prizes and medals for accomplishments in the field. Last week I mentioned the Brazilian expatriate Alberto Santos-Dumont, who flew the first dirigible airship around Paris in 1900. It was the Aero-Club that had sponsored the prize that Santos-Dumont was going for.

France was the home of the Montgolfier brothers, who had built the first lighter than air craft 120 years earlier, and most French, especially those involved in the Aero-Club, were confident that the first flying machine would be built in France.

But by 1903, word of the Wright brothers' glider experiments had made it to France, and reports of their work were being published in *L'Aerophile.* The nervous founder of the Aero-Club asked the organization, "Will the homeland of Montgolfier have the shame of allowing this ultimate discovery of aerial science—which is certainly imminent…to be realized abroad?"

The Aero-Club began offering prizes for achievements in powered flight, although French results continued to be disappointing. And then came the disturbing news that the Wrights had managed the first powered flight in America. Or so they claimed.

This news came as a shock to the French, in much the same way that the news of Sputnik would shock Americans 53 years later. How could the finest French minds be bested by a couple of bicycle salesmen from Dayton, Ohio?

And here is where the Wrights' secretive ways did them no favors. With nothing but second-hand reports trickling into Europe, not even a photograph, many there were ready to call the Wrights frauds. As late as 1906, the Paris edition of the *Herald-Tribune* ran an article about the Wright brothers' claims under the headline "Flyers Or Liars?"

The first powered flight in Europe would be made in 1906 and it would be made by our old friend, Alberto Santos-Dumont, who would win the Aero-Club prize again for a powered flight consisting of a couple of hops totaling over 100 meters at an elevation of about 3 meters, at the Chateau de Bagatelle in Paris. It wasn't as good as the Wright machine, but Santos-Dumont was willing to show *his* machine to the public. He won the prize, and the Aero-Club threw down the gauntlet. If the Wrights failed to bring out their flying machine and show it before a crowd, as Santos-Dumont was willing to do, they ran the risk of losing their claim to be the first.

Two years later, in 1908, Wilbur Wright would come to Paris and would demonstrate the Wright machine before amazed crowds. The Wrights' wing-warping technology would allow their craft to make incredible turns and demonstrate conclusively that they had the better craft, and today no one disputes that the Wrights deserve the credit for the first flying machine.

But their secretive ways would be their undoing. By keeping it all quiet and their company small, they all but insured the Wright Company could not be innovative. The Wrights were not interested in further developing their design; they were interested in making something back on their investment through manufacturing and royalties. But there were too many other people working on airplanes by then, with too many new ideas, and they left the Wright brothers behind. The Wrights would cling to their own quirky design, keeping the elevator up front when everyone else was moving it to the tail of the plane, and hanging on to wing warping when everyone else was moving on to ailerons, flaps behind the wings, as the preferred method of inducing roll.

You have to wonder if their seeming inability to build relationships outside the family bears on their inability to build up a strong business, to hire on new designers and engineers to develop and improve their designs.

Instead, they adopted a strategy of litigation, suing builders of rival airplanes in courts in the US and in several European countries. In 1909, their hated rival, aviation pioneer Glenn Curtiss, would begin manufacturing his own airplanes, which would lead to a long drawn-out patent fight with the Wrights, which would do much to tarnish their reputations. They had been seen as the hero-inventors who had cracked the problem of flight. Now they were being depicted as greedy and litigious men who didn’t want to see anyone else fly unless they got a piece of the action.

Curtiss would also strike back at the Wrights by questioning their claim to have developed the first flying machine, suggesting that Samuel Langley deserved that honor. Langley himself had passed away in 1906, but his successor at the Smithsonian was eager to restore Langley’s reputation and embraced this idea that Langley deserved the credit. The Smithsonian would support Curtiss’s position in the patent litigation. This led to Orville Wright sending their 1903 flying machine off to London to be displayed at the Science Museum. Only in 1948, after the Smithsonian recanted and agreed that the Wrights were first, would the machine be repatriated to the US and put on display at the Smithsonian, where it remains to this day.

The patent litigation would have the effect of stifling further progress in airplane development in the United States for several crucial years, and the infant American airplane industry would give up its lead to Europe. The Aero-Club would have its revenge, and it would not be until the late 1940s that the United States would reclaim the title of the world’s leading nation in the field of aviation.

And the stress would also take its toll on Wilbur Wright, who would pass away in 1912. A bitter Orville would blame the endless lawsuits for his brother’s death, and he would sell his own stake in the Wright Company in 1915. Ironically, the Wright brothers’ company and Curtiss Aeroplane would merge in 1929 to form Curtiss-Wright, which would become the largest aircraft manufacturer in the United States by mid-century.

We'll have to stop there for today, but I hope you'll join me next week, on *The History of the Twentieth Century*, as we turn our attention to the Austro-Hungarian Empire. All the way back in episode one, I identified ten nations as "great powers," and since then, I have given you background information on most of them, but we haven't gotten to Austria yet, and I think we should, because, spoiler alert, I have a hunch Austria is soon going to play a major role in world affairs. That's next week, on *The History of the Twentieth Century*.

Oh, and one more thing. Also in 1903, the year of Langley's failure and the Wrights' great success, an eccentric school teacher living in the small and remote town of Kaluga in the Russian Empire, on the other side of the world, where there was nothing better to do than read the works of Jules Verne, published a book entitled *The Exploration of Outer Space by Means of Rocket Devices*. In that book, Konstantin Eduardovich Tsiolkovsky worked out the mathematics of rocket thrust, showing that oxygen-hydrogen combustion was the best choice for propelling a rocket, and calculating the velocity needed to launch a body into earth orbit—about five miles per second—and also demonstrating mathematically that a multistage rocket powered by hydrogen and oxygen was capable of launching a payload into Earth orbit.

This book, and his follow-up work on escape velocity and exploration of the solar system, attracted a great deal of attention in Russia, but nowhere else. Russia is a backward country, after all, and respected Western scientists would continue to maintain for decades to come that space flight was an impossibility.

[music: closing theme]