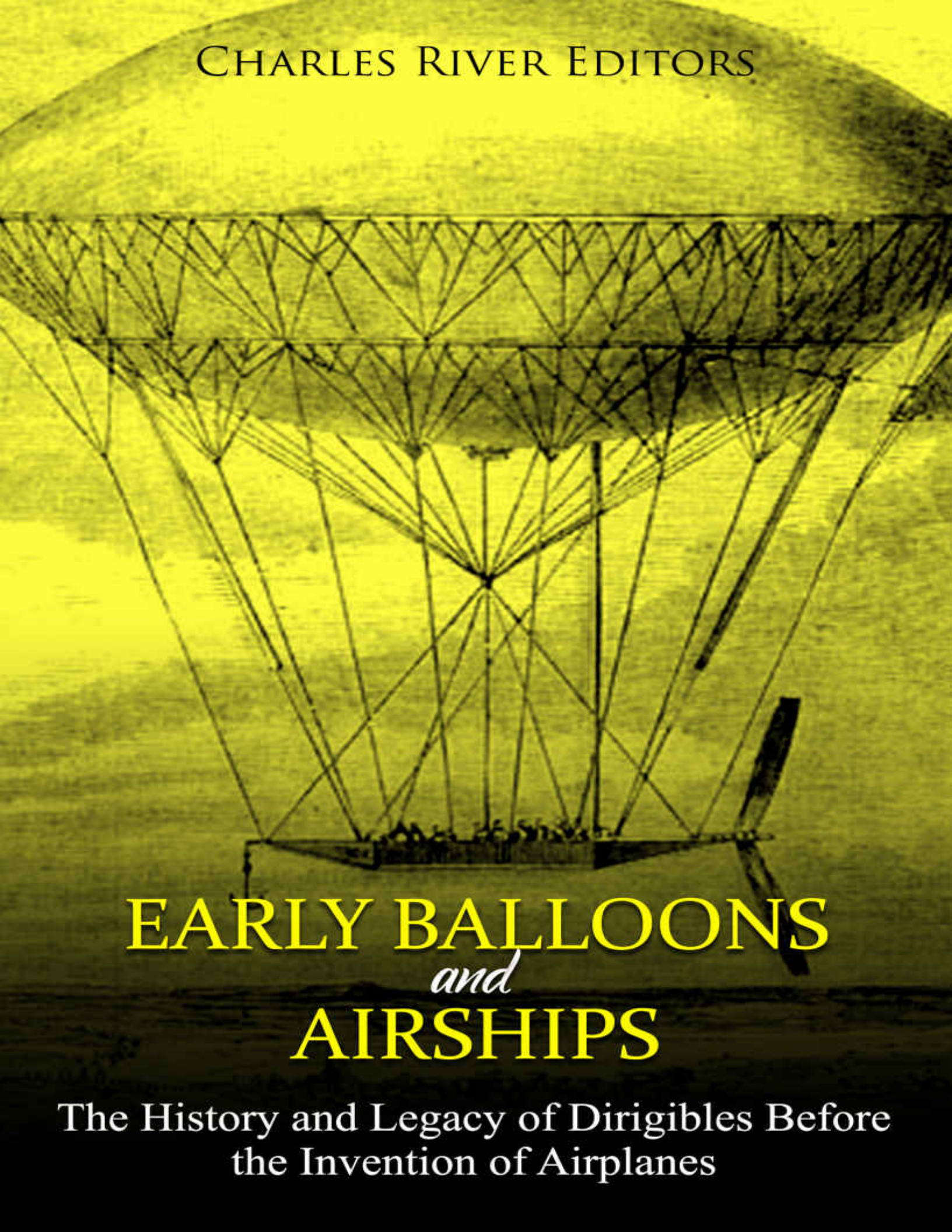


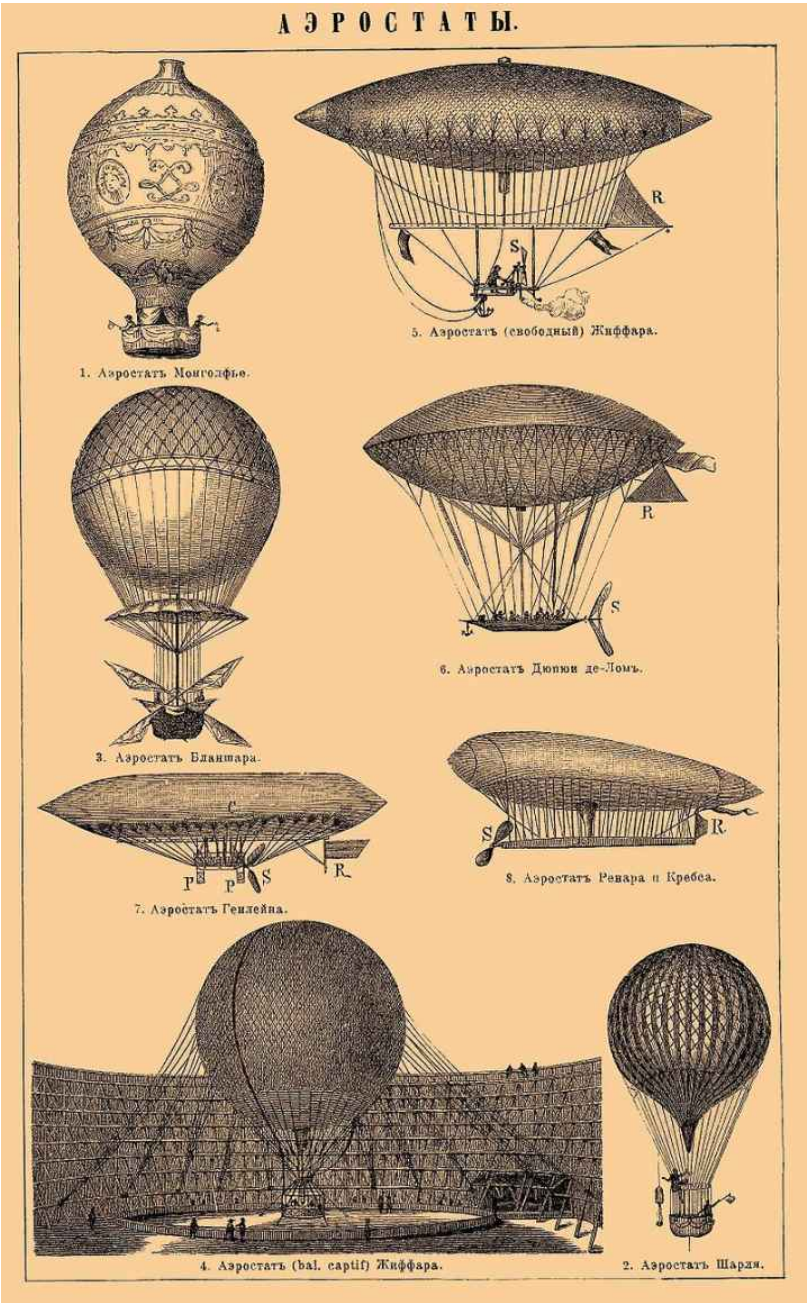
CHARLES RIVER EDITORS

EARLY BALLOONS *and* AIRSHIPS

The History and Legacy of Dirigibles Before the Invention of Airplanes

Early Balloons and Airships: The History and Legacy of Dirigibles Before the Invention of Airplanes

By Charles River Editors



An encyclopedia's illustration of dirigibles before the invention of planes

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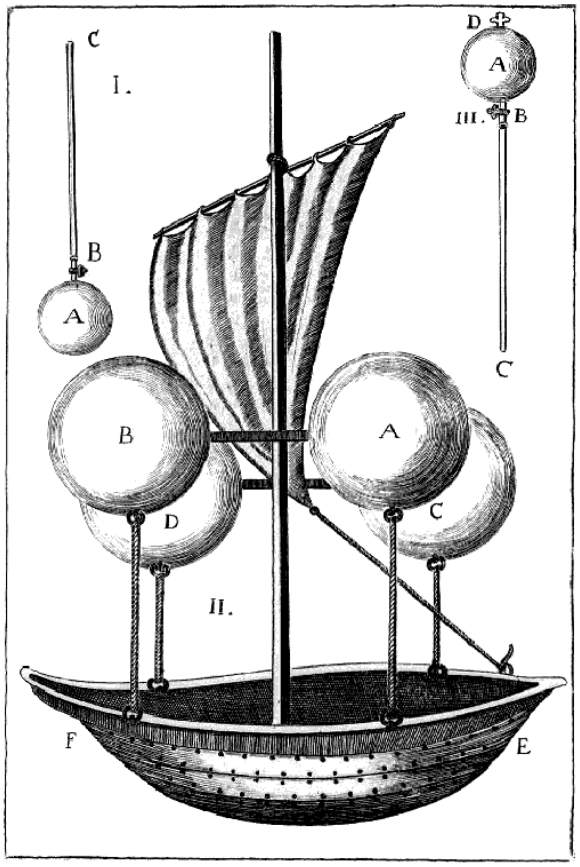
Introduction



A picture of Francesco Lana de Terzi's design in 1670

The Wright Brothers initially underestimated the difficulties involved in flying, and they were apparently surprised by the fact that so many others were working on solving the “problem of human flight” already. Decades before their own historic plane would end up in the National Air & Space Museum, Wilbur and Orville asked the Smithsonian for reading materials and brushed up on everything from the works of their contemporaries to Leonardo Da Vinci. Undeterred by the work, and the fact that several would-be pioneers died in crashes trying to control gliders, the Wright Brothers tested out gliding at Kitty Hawk in North Carolina for several years, working to perfect pilot control before trying powered flight.

In December 1903, the brothers had done enough scientific work with concepts like lift to help their aeronautical designs, and they had the technical know-how to work with engines. On December 17, the brothers took turns making history's first successful powered flights. The fourth and final flight lasted nearly a minute and covered nearly 900 feet. The Wright Flyer I had just made history, and minutes later it would be permanently damaged after wind gusts tipped it over; it would never fly again.

A decade later, aircraft appeared in the skies over the battlefields of World War I, but they did not represent a complete novelty in warfare either, at least not during the early months of World War I. While airplanes had never before appeared above the field of war, other aerial vehicles had already been in use for decades, and balloons had carried soldiers above the landscape for centuries to provide a high observation point superior to most geological features. The French used a balloon for this purpose at the Battle of Fleurus in 1794, and by the American Civil War, military hydrogen balloons saw frequent use, filled from wagons generating hydrogen from iron filings and sulfuric acid. The balloonist Thaddeus Lowe persuaded President Abraham Lincoln to use the airships for observation, communicating troop movements to the ground with a telegraph wire. Lowe himself reported, "A hawk hovering above a chicken yard could not have caused more commotion than did my balloons when they appeared before Yorktown." (Holmes, 2013, 251). The Confederates agreed with this assessment: "At Yorktown, when almost daily ascensions were made, our camp, batteries, field works and all defenses were plain to the vision of the occupants of the balloons. […] The balloon ascensions excited us more than all the outpost attacks."

Indeed, with advances in dirigible technology, many military thinkers and even aeronautical enthusiasts believed that blimps would remain the chief military aerial asset more or less forever. These men thought airplanes would play a secondary role at best, and that they might even prove a uselessly expensive gimmick soon to fade back into obscurity, leaving the majestic bulk of the dirigible as sole master of the skies.

Early Balloons and Airships: The History of the City's Underground Ossuaries and Burial Network looks at the development of the first balloons

and airships, and how they were primarily used. Along with pictures depicting important people, places, and events, you will learn about the first airships like never before.

Technical Requirements

Understanding balloons and airships does not require much technical knowledge, but a few terms and concepts are important to keep in mind.

Balloons and airships are lighter than air vehicles (LAV) lifted by the differential density of gas contained inside some kind of covering envelope and the air pressure outside. The lifting agents include hot air, hydrogen, and helium. The envelope may be paper, treated silk, or any other substance that can contain the lifting gas, and large airships contain smaller containers of gas with their own envelopes inside a larger envelope. In essence, the envelope acts as a kind of skin, and the lifting gas are the contents.

Aeronauts, their passengers, and equipment would hang under the balloon in a gondola suspended by ropes from the balloon. The gondola was traditionally made of wickerwork. A ballast might be carried and would be fastened around the gondola for fast release; dropping the weight (often sand in a bag) would make the balloon rise. In a hot air balloon, the heat source would be suspended below the balloon and above the gondola. Some balloons had a release cord that could let gas out of the balloon, a procedure that could be used in emergencies to lower altitude or to land.

Large balloons could lift sizable gondolas, which might be little more than baskets that were the size of small cabins. Airships eventually would be lifted by internal ballonets, allowing things undreamed of in balloons, like dining facilities and sleeping cabins actually inside the airship rather than in a gondola.

The lifting capacity of any particular LAV depends on the lifting agent and the size of the envelope. The larger the envelope (which is expressed in terms of cubic feet or cubic meters), the more gas it can hold, and therefore the greater the lifting capacity. A number of factors affect air density, and therefore the lifting capacity of LAVs. These include the ambient air temperature, the altitude of the launch site above sea level, wind strength and weather, humidity, and whether it is day or night. Hydrogen has the most lifting power, followed by helium, and then with much less lifting power, hot air.

A perfect day for launching a balloon would be sunny, relatively dry, and windless. Summer days would have been preferred early because the longer period of daylight allowed more ballooning possibilities. Night flights did not occur for some years, and bad days for an ascent would be any day with strong wind or threatening storms. Lightning potentially endangered hydrogen-filled balloons.

At sea level and 60 degrees Fahrenheit, a thousand cubic feet of air weighs 75 pounds. Fill a balloon with a thousand cubic feet of helium, which weighs 10 pounds, and there are 65 pounds of lift. With a thousand cubic feet of hydrogen, which weighs five pounds, there are 70 pounds of lift. A thousand cubic feet of air heated to 212 degrees Fahrenheit provides 17 pounds of lift (Godfrey 225). A feature of hot air balloons is that the lifting capacity lessens as the air cools, so hot air balloons need a heat source below the balloon that can be used by the aeronaut in flight to continually supply the balloon with hot air.

An additional lifting agent became available as the 19th century advanced. This was coal gas, produced by heating coal to a high temperature in the absence of air. The gas was piped to consumers to burn for lighting and for streetlights. It was inferior to hydrogen in lifting power, but it was a good deal cheaper, and balloonists could obtain it from any city with a gas works. Gas works were increasingly common in the 19th century, and in due time coal or town gas were widely available and commonly used as a convenient and cheaper replacement for hydrogen.

Many of the books and articles that mention coal gas also use the term “town gas.” Town gas was piped to city residents to use for lighting, but town gas referred to any manufactured gas sold to residents. Town gas may or may not be coal gas. Both contained a mixture of gases, including methane and hydrogen. Hydrogen, town gas, and coal gas all are highly flammable and were the principal source of danger for balloonists until the age of helium.

There are three kinds of LAVs, defined by rigidity. Non-rigid LAVs do not have any internal or external shaped structure, and the early balloons were non-rigid. They tend to be circular or egg shaped.

Semi-rigid balloons do not have any internal structure, but the envelope may have some rigid external structural elements, and the envelope may be shaped to facilitate better navigation. Semi-rigid airships may be tethered, like the World War II barrage balloons, or they may have power sources such as the engines on blimps.

A rigid airship has the envelope shaped over an internal framework (usually a light metal alloy) and often has a number of internal gas containers, called “balloonets,” each with its own envelope. Rigid airships tend to be large, and zeppelins are the best example. Semi-rigid and rigid airships initially used hydrogen, but that has been replaced by nonflammable helium (Stockbridge et al 173).

Non-rigid balloons do not have a power source for directed flight. Balloons are often tethered to cables, and if they are unmanned, they are called “aerostats.” Balloon tethers might be ropes or metal cables, but the weight of the cable could add a good deal of weight. Tethers were sometimes attached to a mobile base, such as a railroad engine or a barge, or even a group of soldiers on the ground.

Manned balloons in free flight are largely at the mercy of wind and weather conditions, and there is little control over flight direction other than manipulating weight and gas volume and using what knowledge of prevailing wind directions an aeronaut might possess.. Many balloons carried a form of ballast, such as sand in bags, attached to the side of the gondola. Should the balloon start losing altitude, dropping some of the ballast would lessen the weight, and the balloon would rise. Letting some gas escape from the envelope would make the balloon descend.

The history of balloons up till the late 19th century primarily involved non-rigid balloons, either tethered or in free flight. The lifting agent was hot air, hydrogen, or coal and town gas. Hot air was supplied by some sort of burner located below the balloon envelope, which was usually open at the bottom for the balloon to receive more hot air. This provided the advantage of giving some control over height.

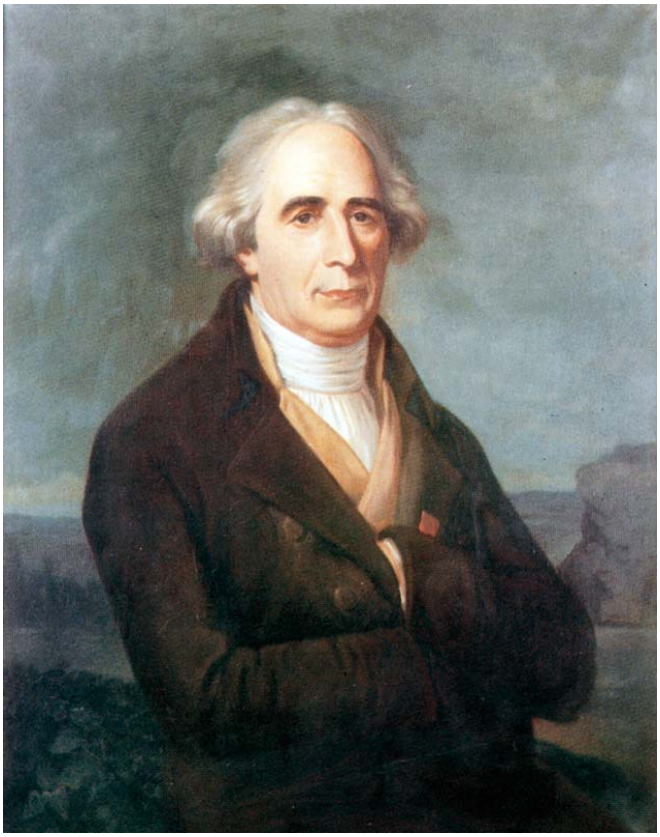
In the 1800s, people who went up in balloons were commonly called balloonists or aeronauts, and the craze that occasionally emerged over

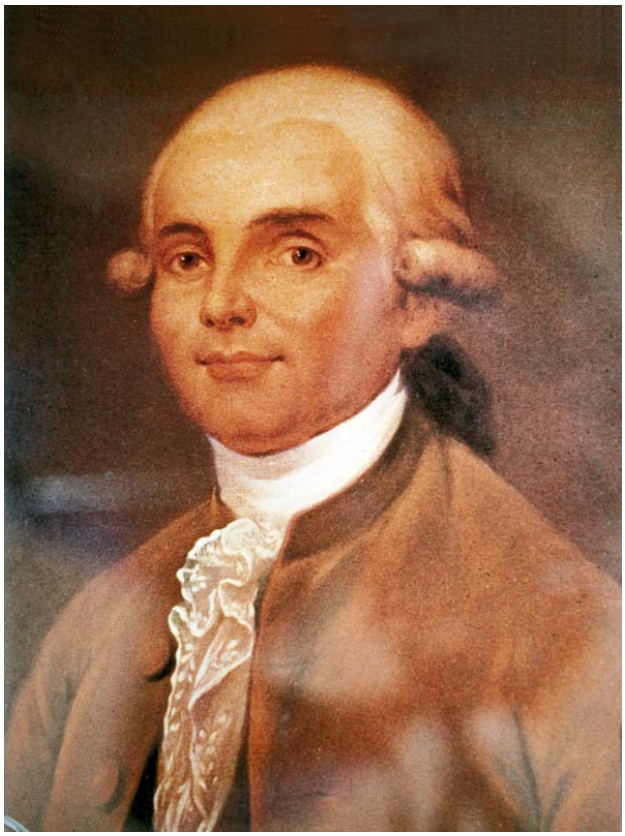
balloons was sometimes called balloonomania.

The Beginnings of Ballooning

From its modern beginnings in France in the 1780s, the interest in balloons rapidly spread throughout Europe and across the Atlantic. Indeed, despite the technological limitations in producing hydrogen and in developing durable and effective materials for creating envelopes, balloons became very popular curiosities and entertainments.

The history of balloons actually went back further than the Montgolfier brothers and their competitors in the 1780s. It is possible that small balloons were made from European paper or other materials, using hot air, a thousand years before the Montgolfier brothers' invention. Roger Bacon, the English polymath and Dominican, wrote in the 1200s that the air covered the earth like an ocean, and people could sail on the air. He thought that hollow, thin copper globes could be filled with ethereal air or floating fire, and then they could sail in the air (Nilson and Hartman 279).





The Montgolfier brothers

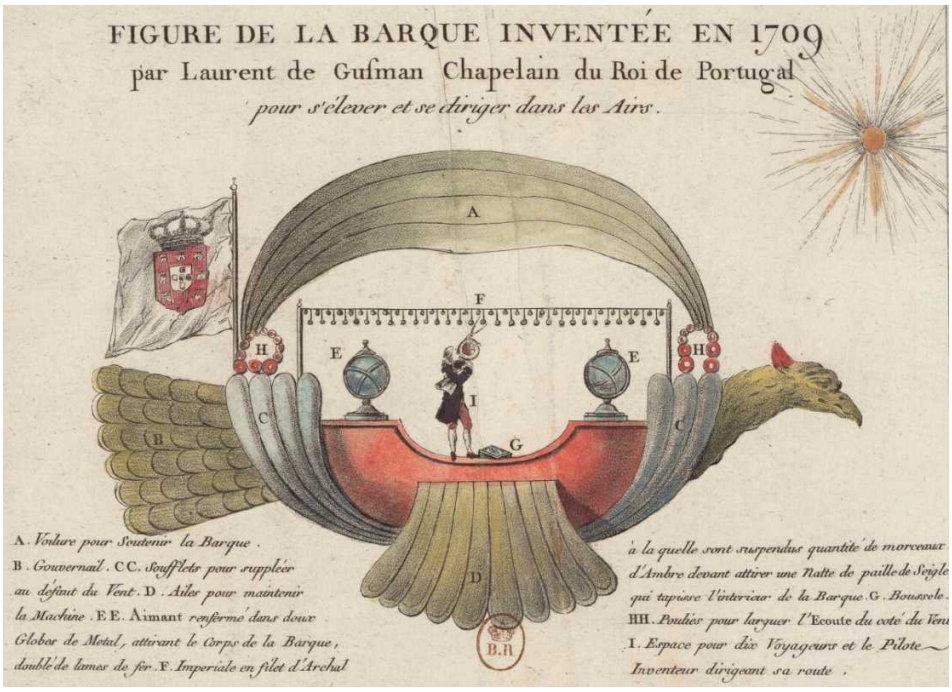
The history of balloons may go back even further to China, but historians have not been able to determine anything conclusively. It seems likely that the first modern balloons used in recent centuries in China would have arrived with the Europeans, which included the British, French, Germans, Russians, and others. It's quite likely that Chinese inventiveness included balloons, because a thousand or more years ago they had already invented paper, gunpowder, and the compass, but it remains unclear.

In 1670, Father Francesco Lana de Terzi, an Italian Jesuit at the University of Ferrara, proposed a real airship. The ship would have sails and oars suspended from copper spheres (Allaz 11). His concept was evacuating the air from four thin copper spheres, each about 24 feet in diameter, which would then be lighter than air, creating lift for a ship. Terzi even speculated that such a craft would be useful in bombing and reconnaissance. In reality, of course, atmospheric pressure would have crushed the thin copper spheres. It is unknown if this Jesuit read Roger

Bacon’s musings, but the copper sphere seems too common an element to be a coincidence.

People had long noticed that in a fire, hot air rose and often took sparks up with it. It’s not known who might first have conceived that hot air might be contained and be able to lift things, but the first known experiments with hot air balloons were done by a Brazilian man named Bartolomeu Lourenço de Gusmão. He traveled from Brazil to Portugal to attend the University of Coimbra, and while there, he conceived of a way to make small hot air balloons.

Gusmão



A model design of his airship

On August 8, 1709, in front of Portugal's King Joao V, Gusmão demonstrated the concept with a small paper balloon that rose from the ground and floated around the room. Before the demonstration, he had written the king a letter emphasizing how balloons could greatly increase the speed of sending messages (Allaz 11). The king was apparently entertained but not interested in anything else about balloons. There is no evidence that anything much resulted from his demonstration, which was essentially a parlor trick. In fact, it may have made him somewhat infamous, because he was briefly imprisoned during the Portuguese Inquisition in 1720 for sorcery.

Joseph-Michel and Jacques-Étienne Montgolfier were members of an affluent French family that ran a paper making factory, which allowed them considerable leisure time. At some point, Joseph-Michel thought about sparks and particles rising from a fire and going up a chimney, and he seems to have had a kind of "Eureka" moment. In 1782, he made a small paper balloon, captured hot air in it, and watched it rise to the ceiling.

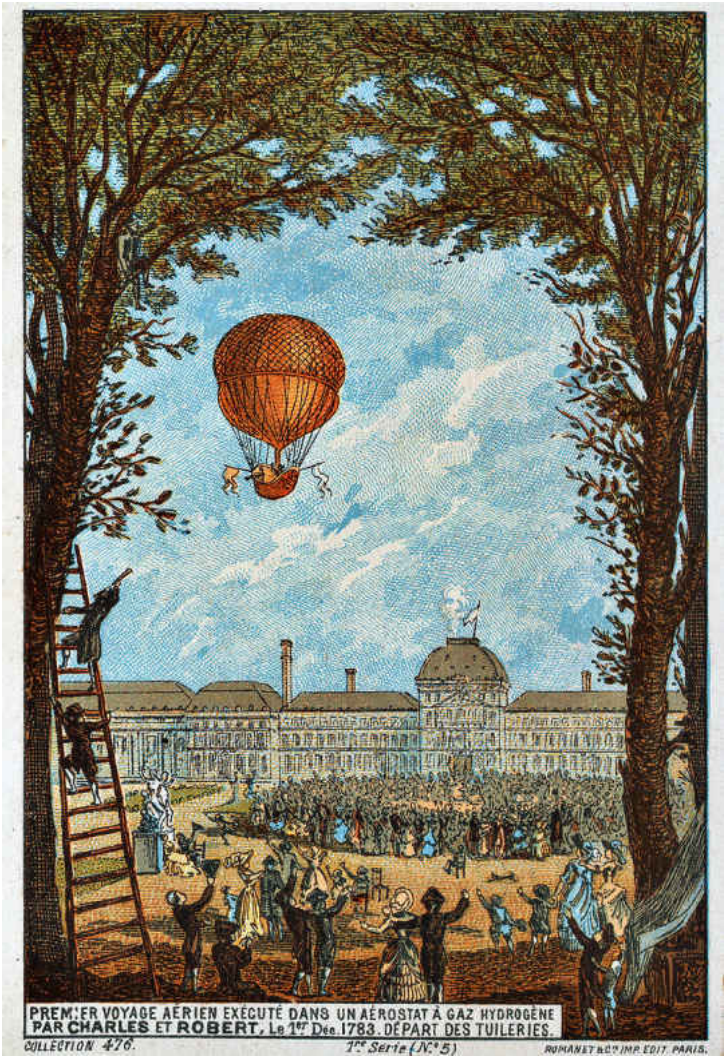
Eventually, this led to the brothers experimenting with balloons on a larger scale. Starting in December 1782, the brothers began experimenting

outdoors. One of their balloons soared up to almost a thousand feet, and from there, the experiments got bolder and the balloons got larger. On June 4, 1783, they gave a public demonstration, with a 35-foot balloon rising to 3,000 feet. This balloon was made of paper with a cloth backing, and the air was heated by straw burned in a brazier below the balloon (Godfrey 228).

A contemporary depiction of the demonstration in June 1783

The Montgolfier brothers were not the only French experimenters with balloons, and hot air was not the only gas to power them. On August 27, 1783, Anne-Jean Robert and Nicolas-Louis Robert launched a 12-foot balloon filled with hydrogen, far more efficient than hot air. They obtained the dangerous hydrogen by pouring sulfuric acid over iron filings. Their balloon, the *Globe*, was released and flew for 45 minutes before landing 15 miles away. The villagers where the balloon landed attacked it with

pitchforks and knives, destroying it out of a mistaken belief that the balloon was the Devil's work.



A depiction of the Robert brothers balloon

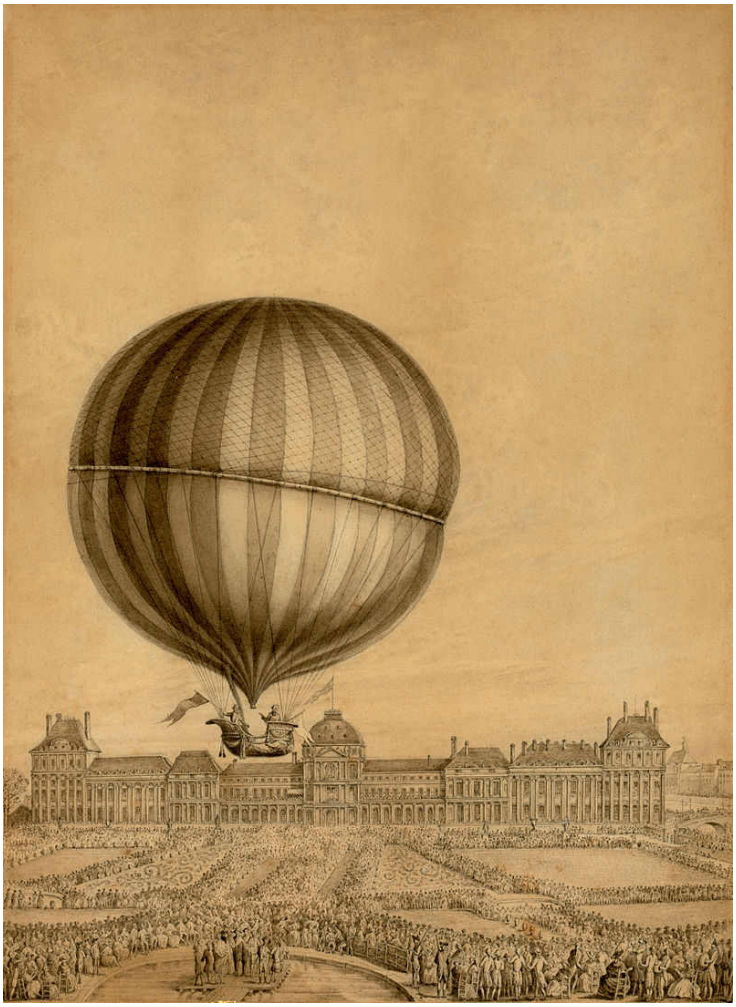
In September 1783, the Montgolfiers worked on a large balloon, but it was destroyed by rain. They quickly built another, the *Martial*, which was launched on September 19 from the grounds at Versailles. The launch attracted an estimated 100,000 spectators as the balloon flew for two miles over the course of eight minutes. The passengers aboard this balloon were a sheep, a duck, and a rooster, suspended in a wicker basket under the balloon. During the flight, the sheep kicked and injured the rooster, and by the king's order, the sheep was added to the menagerie at Versailles. The

king was pleased with the flight and authorized manned flights (Allaz 10). What happened to the rooster and the duck ultimately was lost to history.

By this point, a rivalry had developed between the Montgolfier and the Robert brothers. The Montgolfiers experimented with some tethered flights, and Francois Pilatre de Rozier was the first human known to fly in an aircraft. He was aboard a tethered Montgolfier balloon on October 15, 1783 (van Eaton 3).

On November 21, 1783, Pilatre and the Marquis d'Arlandes flew 25 miles, but once he became concerned about the danger to an aristocrat's life, the king offered two condemned prisoners for use as guinea pigs. One wonders what the prisoners would have done had they flown 25 miles from the authorities in an unpredictable direction.

Meanwhile, the Robert brothers persisted in their hydrogen balloon experiments. On December 1, one of the brothers and a scientist named J.A.C. Charles launched from the Tuileries gardens in Paris, rising to 2,000 feet and drifting some 30 miles. The balloon was well provided for, with cold chicken and a generous supply of champagne (Holmes 17-18). Robert got out when they landed, while Charles, perhaps motivated by scientific curiosity, got back in and was lifted to about 9,000 feet (Murphy 6). A height of almost two miles was by far the highest any human had ever ascended without climbing a mountain.



A depiction of the December 1 ascent

The first British balloon flight came in September of 1784 and was conducted by the transplanted Italian Vincenzo Lunardi, who traveled from London to Hertfordshire and took along his pet cat as fellow passenger (Holmes 23). It perhaps illustrates British sensibilities that he was criticized for putting his cat in danger.

Naturally, people in London and Paris quickly became fascinated by balloons, a fascination intense enough to give rise to the word "balloonomania." At the same time, there was a lot of speculation about what balloons could actually do. Erasmus Darwin, Charles Darwin's grandfather and a scientist in his own right, believed that a balloon could be attached to a wheelbarrow and allow a laborer to carry very heavy loads of fertilizer up a hill. Scientist Joseph Banks thought that if a Montgolfier

balloon was attached to a heavy wagon ordinarily pulled by 10 horses, it might require only a two-horse team.

The fact that such eminent scientists engaged in such mundane speculations shows that it was far from clear what balloons could actually do. For example, Benjamin Franklin, then American ambassador to France, wrote that 5,000 balloons each carrying two soldiers could move 10,000 troops across the English Channel in a single morning (Holmes 19-22).

These early flights were widely covered in correspondence, journals, and newspapers, and an enthusiasm for ballooning that came close to a mania followed. In February 1784, two Italians ascended from Milan. In June of that year, Elisabeth Thible became the first female aeronaut in a balloon launched over Lyons. It is said that Thible sang bits of opera during her flight, which suggests it was designed to get the public's attention. Also in June in the United States. Edward Warren, 13, ascended in a tethered balloon over Baltimore (Murphy 6). Warren's ascent may well have been because, as a boy, he was lighter than a grown man and therefore easier for a balloon to lift.

Balloon launches anywhere sometimes drew very large crowds. The omnipresent potential for disaster must have given it a certain kind of excitement for spectators, something like races today.

Certainly not all ascents in balloons ended happily. There are reports that a balloon with two passengers crash landed in the town of Strasburg. The landing damaged several houses and caused a riot (Nilson and Hartman 291).

A highly significant flight in 1785 was made by Jean Pierre Blanchard and John Jeffries. Jeffries was a Boston-born American, a surgeon in the British Army (Allaz 12), and their flight goal was crossing the English Channel from England to France. When the balloon lost so much altitude it was barely above the water, they had to throw everything overboard, including most of the clothes they were wearing. They even had to urinate over the side in a desperate attempt to lighten the balloon. They barely made it, and the sources are silent on how people reacted to the two nearly naked men climbing out of their gondola as they landed (Pearl).

An earlier attempt at crossing the Channel by pioneering balloonist Pilatre de Rosier and another man had resulted in disaster. Their balloon was a new design, a hybrid of hot air in one compartment and hydrogen in another. The combination was an accident waiting to happen, and it did. The hydrogen caught fire and exploded, killing both men (Balloon Museum).

Balloons were for a considerable length of time popular entertainment, a kind of performance. Launches were widely publicized, often well in advance of the scheduled date, and admission was charged. A few spectators became actual paying passengers, usually in tethered balloons, and the crowds could be rowdy. The ballonomania lasted for several years, even including fashion - some lady's hats were shaped like balloons, and depictions of balloons were featured on such items as clocks, dinnerware, furniture, and even umbrellas and napkins (Pearl). Like the balloons themselves, those balloon hats must have been difficult in a wind.

One related event was the first parachute jump from a balloon. In October of 1797, Andre Jacques Garnerin parachuted from an altitude of 6,000 feet (Smith 146). Parachute jumps had been made before, but to jump out of a balloon in 1797 from over a mile high required being brave or foolhardy.

The First Military Balloons

The military possibilities of balloons were considered early on. Benjamin Franklin, who witnessed some of the balloon ascents, noted that balloons could carry troops across enemy lines and that 1,000 balloons could be built at the cost of one ship of the line (Murphy 7). That could have been a serious consideration, especially since no other nation could afford Britain's scores of ships of the line. Every British rival would have loved to render the Royal Navy useless.

The first military uses of balloons came in 1793, when two French border fortresses were under siege by Austrian forces. In May, General Chancel, commanding the Conde de Escaut fort, wrote a message and sent it by a small balloon. The balloon fell into Austrian hands, and the letter still resides in an Austrian museum. In June, the commander of another fort tried the same method and also had it fall into Austrian hands (Allaz 12-13).

Both incidents illustrate how random and essentially uncontrollable balloon flights were.

Even in the midst of the French Revolution's chaos, the French government was interested in balloons. The Committee on Public Safety authorized a chemist, Jean Marie-Joseph Coutelle, to construct some balloons for observation and scouting. Coutelle developed a dozen balloons using a different method of generating hydrogen than pouring acid over iron filings. The process was called the Lavoisier-Meusnier method, and it involved heating tubes filled with metal filings and extracting the hydrogen from steam (Murphy 7-8).

Coutelle

Coutelle's experiments impressed the French leadership enough that the decision was made to authorize a formal balloon company. On April 2, 1794, the French set up the "1er Compagnie d'Aerostiers." The Company

consisted of 25 officers and men, uniformed in blue (van Eaton 4). This outfit can claim to be the ancestor of all the world's air forces. The Convention also ordered the creation of a second balloon company and set up a school, Ecole Nationale Aerostatique, to train balloonists. This school is the ancestor of all the world's air force academies.

The Company was quickly involved in military action. At the Battle of Fleuries in 1794, Coutelle and a general named Morelot were aloft observing for 9 hours. They dropped weighted messages by the clever method of enclosing messages in small bags weighted with sand and outfitted with rings so they could slide down the tether cable to the ground. The messages from the observation contributed considerably to French success in the battle (Murphy 8).

A depiction of Coutelle in a balloon at the siege of Mainz

The companies eventually fielded four balloons. Their equipment included horse-drawn vehicles for carrying the balloons, portable hydrogen generators devised by Lavoisier, winches, tether ropes, observation equipment and hanger tents to house the balloons (Holmes 28). French field artillery was the best in the world, and the experience with moving the guns, caissons, and other equipment probably transferred seamlessly to balloon service.

Balloons were involved in a number of battles, including Mainz and Mannheim in 1795 and several more in 1796. Many of the battles were

fought during a French invasion of the various German states (Germany did not become a unified nation until 1871), and this was the high-water mark of the first use military campaigns using balloons. The First Company was captured by the Austrians at the 1796 Battle of Wurzburg (Murphy 9).

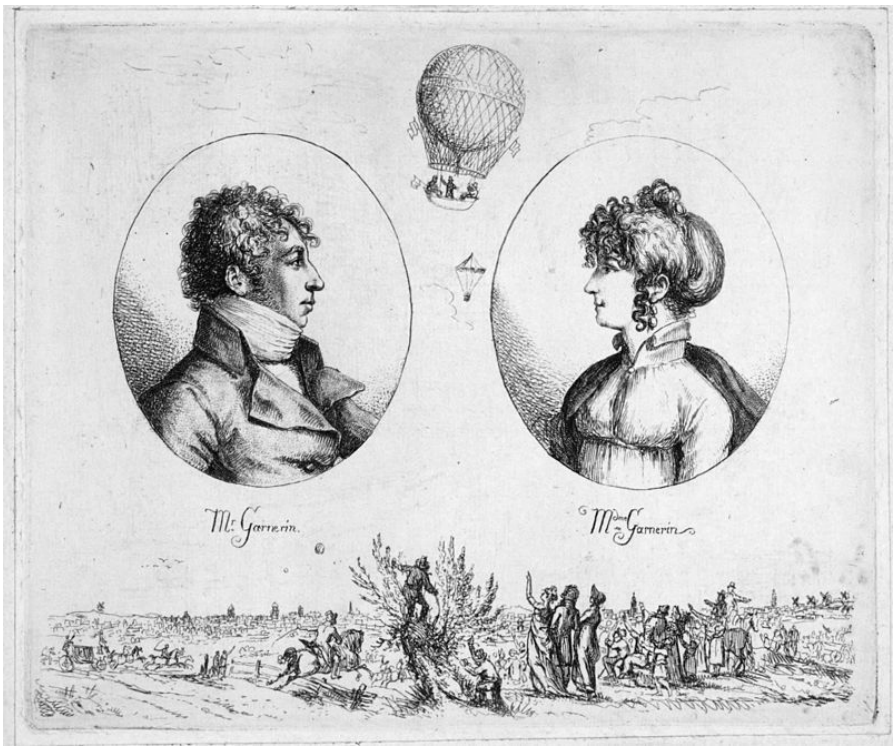
Coutelle and another balloon company joined Napoleon's expedition to Egypt in 1797, but their equipment was never unloaded from the ships and was destroyed when the British attacked the French fleet at the Battle of Aboukir Bay (Murphy 9). The French troops were isolated in Egypt and eventually surrendered to the combined British and Ottoman forces. Napoleon escaped Britain's grasp by taking a fast frigate home to France and future glory.

Napoleon was not particularly interested in balloons, which is surprising given how astute he was when it came to the military potential of just about every other technology. The two balloon companies were disbanded in 1799 and 1802, making clear that Napoleon's generals preferred cavalry for scouting and reconnaissance.

Balloons were used by other nations in the the Napoleonic Wars. The Danes were interested in a device something like a dirigible to use against British ships intervening in the Baltic, but it never was built. They did use balloons to drop leaflets in Sweden advocating a revolt; Denmark was an ally of Napoleon, and Sweden had become an enemy (Murphy 9). This seems to be the first time that leaflets were dropped from the air as part of a propaganda campaign.

The Early 19th Century

Ballooning obviously lent itself to entrepreneurship. Perhaps the most successful of this type of aeronaut was Andre-Jacques Garnerin, who created events centered on balloons that incorporated many kinds of entertainment. The public loved night launches and by fireworks shows provided from balloons aloft. Garnerin provided such spectacles, and his wife, Jeanne-Genevieve, was part of the team. In 1799, she became the first woman to parachute jump. Garnerin took his balloon show on the road, appearing in London in 1802 during one of the periods of peace (Holmes 29-30).



An early 19th century depiction of Garnerin and his wife

Napoleon was not particularly interested in the military value of balloons, but he was quite certain of the value of spectacle as propaganda. In 1804, he commissioned Garnerin to construct a huge balloon that would be colorfully decorated. A huge crown was to be suspended from the balloon to signify the event: Napoleon's coronation as the Emperor of France. The coronation was quite elaborate and carefully choreographed. The story of this very large balloon is one of the most incredible in the history of balloons or aviation. It was launched from near the cathedral of Notre Dame and appears to have functioned well during the coronation. The symbolism is obscure, but perhaps Napoleon meant it to indicate heaven's favor.

During the event, it got loose, flew south over France, and somehow crossed the Alps into Italy, meaning it must have been an especially sturdy craft. Spotted near Rome the next day, the balloon was deflating near the ground, and in a highly improbable sequence, the symbolic crown dangling from the balloon snagged on a tomb, breaking a piece of it off. The tomb was that of the notorious Roman Emperor Nero, and after snagging off a chunk of Nero's tomb, the balloon seems to have vanished into the Pontine

marshes (Holmes 31-32). The Romans probably laughed themselves silly, but they would have done so discreetly given that Rome and much of Italy was under French rule.

Napoleon was not amused by the event, and Garnerin quickly lost favor. Napoleon remained interested as balloons as spectacle, so he replaced Gernerin with Sophie Blanchard, which was also quite unusual. It is unclear how this woman became involved in ballooning. What is clear is that she was determined, intelligent, and a superb balloonist. She met the balloonist Jean-Pierre Blanchard, and she quickly went from being his assistant to becoming his wife. As his health failed, she took on more and more responsibility for what can only be called a balloon business. He died in 1810 of a stroke during a balloon landing, and she did her first solo balloon display in Paris only a few days after his death.

Blanchard

Sophie Blanchard set herself up as a rival to the only other woman in ballooning, Garnerin's niece Lisa. Sophie managed to attract Napoleon's attention, and her balloons became a routine part of various imperial celebrations. The French emperor appointed her as *Aeronaute des Fetes Officielles*, and her signature events consisted of night ascents in a tethered balloon and launching a fireworks display from the balloon.

Sophie's style was deliberately daring. She reduced the size of the gondola to a small silver-colored platform, with sides that only reached her knees. Her balloon was small and made from silk. She adopted a particular style of long white cotton dresses and dressy white hats with feathers (Holmes 33-35). Her approach seemed to be developing a dynamic tension between femininity with the ever-present threat of death.

Despite exploiting the stereotype of women, Blanchard was hardly a helpless woman. She was probably the best balloonist in France, clearly the most popular balloonist, and was a shrewd businesswoman as well. In 1811, she went to Italy and was successful in displays featuring the full course of the symbols of Napoleonic rule. Among other things, she flew from Rome to Naples. On one overnight flight, her balloon rose to 12,000 feet.

After Napoleon's fall, the French brought back a new king from the old dynasty, King Louis XVIII, and Blanchard attracted his attention with a spectacular flight and fireworks show welcoming him to Paris. Louis appointed her Official Aeronaut of the Restoration. This might have been intended as humor, but it assisted her career. For several years her night flights with fireworks became a kind of Paris fixture. Alas, in July 1819, the hydrogen in her balloon caught fire. Her balloon landed on a roof, but she slipped and fell to the street and was killed (Holmes 35-36).

By the 1830s, balloons had become reasonably common, but still unusual enough for the public to find them compelling. People paid to watch balloons launch, particularly in France and Britain. Probably the most famous British aeronaut was Charles Green, who didn't start in the business until he was 40, but still made 526 ascents. Green was a canny businessman, and he had found that coal gas wasn't as good as hydrogen, but still had considerable lift and was much cheaper. A 70,000 cubic foot balloon cost 250 pounds to fill with hydrogen, but only 80 with coal gas.

Green then negotiated a contract for coal gas with the London Gas Light and Coke Company. Green conducted balloon ascents at London's Vauxhall Pleasure Gardens for 20 years. His large balloon *Royal Vauxhall* could carry 9 people, so paying customers could rise to several hundred feet in the tethered balloon (Holmes 44).

Green was involved in a significant night flight by balloon. On November 7, 1836, Green, Monck Mason and Robert Hollond, all British, flew in the *Royal Vauxhall*. Mason was an Irish musician and balloon enthusiast, while Hollond was a wealthy MP and the main backer of the flight. The balloon had more cargo that the three passengers. It included 40 pounds of meats, 45 pounds of cooked game and preserves, various liquors, dozens of bottles of champagne, and a portable coffee brewer. This seems to have been quite a lot for what was an 18-hour voyage.

The balloon crossed the English Channel and eventually landed near the small German duchy of Nassau, covering about 500 miles in all (not straight-line distance). At the time this was a distance record, one which stood for a generation. It was broken in 1859 by the American John Wise and three others in the balloon *Atlantic.*

The record flight seems to have reignited an interest in ballooning, which may have been its intended purpose. Even the generous supply of provisions may have been calculated, because it is the kind of detail reporters would pick up on. The cooked game and the champagne would indicate that English gentlemen were involved.

An American balloon sensation was momentarily created in 1844. On April 13, the *New York Sun* announced that a balloon had crossed the Atlantic in a trip lasting three days, from Europe to the United States. The sensational story was a hoax penned by a then little-known American writer named Edgar Allan Poe (Allaz 13).

Meanwhile, interest in the military potential of balloons continued. A welter of revolts broke out all over Europe in 1848, and some rebel cities stubbornly resisted the re-establishment of imperial control. When the Austrians besieged Milan, the Italians sent up small paper Montgolfiers

carrying anti-Austrian leaflets that aimed to arouse the countryside (Murphy 10).

An obscure Austrian lieutenant, Franz Uchatius, had an interest in using balloons for something other than observing what the enemy was doing. In 1848, he made an 18-foot diameter balloon from varnished linen and paper, which were inexpensive, and he equipped them with bombs. The bombs had a contact detonator, so they would explode on impact. A time fuse, burning through the rope that suspended the bomb below the balloon, would release the bomb.

Uchatius got a chance to put his theories into practice in Italy, which revolted against Austrian occupation in 1848. One of the rebel cities was Venice, surrounded by shallow water and marshes in ways that made it difficult to reach with artillery fire (Ziegler 750-751). The siege commander asked the lieutenant to allow his weapons to be used on the city, and the Austrians built and armed almost 200 of these balloons, set to be launched from the steamship *Vulkan* (Austria was then not landlocked, possessing naval bases on the Adriatic coast opposite Italy). The attack was aborted by bad weather.

Such an attack also had a built-in technical problem. Balloons launched in numbers from a single point tend to spread out in a fan-like series of directions, effective for about four miles over a large target such as a major city. Beyond that distance, however, they would be ineffective. Balloon attacks like this one were not attempted for decades because the range of artillery increased to well beyond the range that balloons could effectively deliver bombs (Ziegler 751),

The British rejected the idea of using balloons in the Crimean War in the 1850s. The French did use some balloons in the 1859 Italian War, to little avail. By the time the Civil War broke out in America, balloons had been used for military purposes by Denmark, Sweden, Russia, the French in Algeria, and at the Austrian siege of Venice (van Eaton 4).

That said, balloons and ballooning remained primarily an entertainment, and the entertainment spread far beyond Europe. Fanny Calderon de Barca, the Scottish wife of Spain’s first ambassador to Mexico, described an

attempted balloon launch in Mexico City in 1844. The aeronauts were a Frenchman and his daughter, but the ascent did not happen because of a hole in the balloon (Kuhn 111).

A version of balloonomania had come to Mexico earlier. A traveling French aeronaut named Adolfe Theodore had made a number of ascents in Cuba in 1830-1831, and he was brought to Mexico by General Manuel Barrera. Barrera's intent seems to have been to sponsor a public entertainment and thereby enhance his own prestige. Tickets to the anticipated spectacle were sold, but no flight occurred. The aeronaut was jailed but later allowed to leave the country (Kuhn 14-15).

The first balloon flight in Latin America was in Havana in 1828, made by the British aeronaut Eugene Robertson. Robertson also was invited to Mexico, this time by the Mexican serial caudillo, Antonio Lopez de Santa Anna. Santa Anna knew the value of public relations and had a reputation as a fiery and impulsive man. On February 12, 1835, Robertson successfully launched his balloon, and subsequent flights were encouraged by Santa Anna. Crowds could be sizable and admission was charged (Kuhn 16). The sources are silent on what effect Mexico City's high altitude (over 7,000 feet) might have had on Robertson's balloons.

Balloons in the United States

Ballooning in the United States involved both itinerant European aeronauts and native enthusiasts. In 1854, the highly experienced French aeronaut Eugène Godard brought his suite of five balloons to the U.S., including a large one of 106,000 cubic feet capacity. His company included trapeze artists, parachutists, and female acrobats. This airborne circus visited, among other places, New Orleans, St. Louis, and Cincinnati. Witnessing a launch typically cost 25 cents, and passengers could pay for an ascent in a tethered balloon. Despite the show's public appeal, Godard nearly went bankrupt because of the high cost of replacement equipment (Holmes 74).

Godard

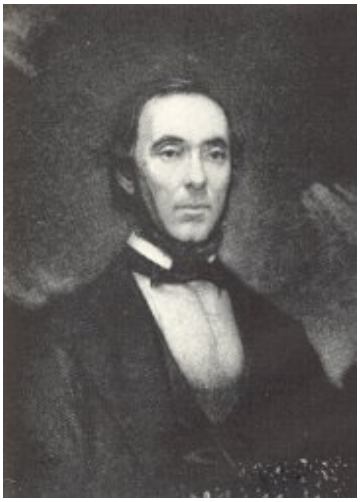
Godard's operation spent a lot of its time in America in Cincinnati. The place at that time was a fast-growing city, and the Midwest was still young and not particularly well-populated. It's not clear why Godard would have settled his balloons there, but the city was on the steamboat route from New Orleans to Pittsburgh, so travel convenience may have been a factor.

The three major American homegrown aeronauts were John Wise, John LaMountain, and professor Thaddeus Lowe. The men knew each other and at times were serious rivals, as Lowe and LaMountain were in the Civil War. Wise made a number of flights in the 1830s in homemade balloons, and even though one of his balloons exploded, he escaped harm. In 1837, he made a deal with the Philadelphia gas works to purchase coal gas for his balloons. His ascents continued through the 1840s into the 1850s (Holmes 77-78).

In 1859, Wise set up a flight that broke Charles Green's 1835 record. The balloon was launched from St. Louis on July 1st with four men aboard: Wise, his assistant and protégé John LaMountain, Oliver Gagen, his main financial backer, and William Hyde, a reporter for a St. Louis newspaper. The newspaper reporter is an important detail, as Wise knew the value of publicity, and it's no coincidence that supplies on board the balloon included a stack of St Louis newspapers. Among the other supplies were various sandwiches, brandy and port, a pail of iced lemonade, and a lifeboat suspended from the gondola (Holmes 79-80).

They flew over Indiana and Ohio, on to Niagara Falls, and then ran into heavy weather over Lake Ontario, barely making it to shore (Allaz 14). The flight really was an epic, officially covering 809 miles, a record distance for balloons that stood until 1910. The launch from St. Louis was deliberate because prevailing winds blowing east made a long voyage more likely.

John Wise had a long and impressive career as an aeronaut. Over several decades, Wise made 462 balloon ascents before he died in an accident in 1879 on his 463rd trip.



Wise

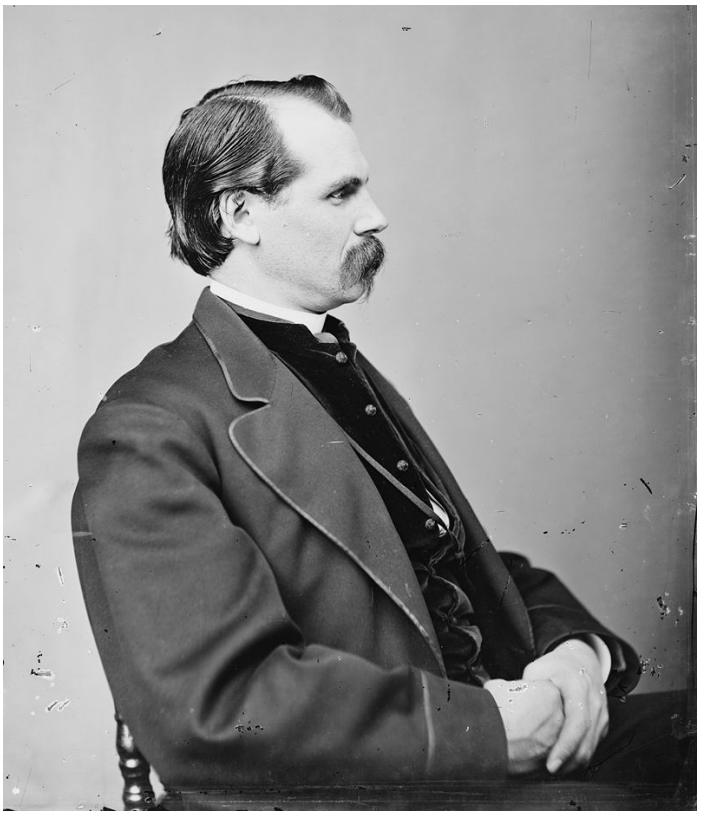
Balloonist and putative professor Lowe designed and built a huge 725,000 cubic foot balloon he named *The City of New York*. Over 200 feet high if it had ever been fully inflated, Lowe exhibited it in New York City, where it attracted large crowds. The craft was so big that it was never fully inflated and never got off the ground (Holmes 89).

The first advocate of American military use of balloons was Colonel John H. Sherbourne, who was in Florida in 1840 fighting against the Seminoles. He thought that by using balloons at night, observers might be able to locate the campfires of the elusive natives, but nothing came of the idea by the time the war ended in 1842.

John Wise advocated using balloons in the Mexican-American War, his idea being to bombard the Mexican port of Vera Cruz (Murphy 10). This gulf port was occupied by the Americans after a sharp engagement and was the starting point for the American army that invaded Mexico and eventually captured Mexico City. Wise continued to advocate the potential of balloons throughout the 1850s.

The principal figure involved in Civil War balloons was Lowe, who had long been involved in balloons and vigorously asserted their value in war. On June 11, 1861, he set up a dramatic demonstration for President Lincoln, during which he ascended in a balloon nearly 1,000 feet over the White House and sent a telegram from the balloon to the president. Lincoln, who frequently admired eccentric technologies, was impressed and let his approval be known. In fact, Lincoln’s insistence overcame the Union army’s skepticism.

Months before that, on April 20, a balloon flight launched from Cincinnati carried Lowe further than intended, and he landed near Unionville, South Carolina. The flight itself in his balloon *The Enterprise* was far and fast, covering 650 miles in just over nine hours. That was an astounding speed for the day, as it even outpaced railroads (Holmes 92). This was just after the attack on Fort Sumter, and at first Lowe was thought to be a Union spy. He convinced the South Carolinians that he was on an innocent flight (Williams 10). Lowe was widely known as a balloon aeronaut, which probably saved him from prison or worse. Had he been executed as a spy, the Union’s use of balloons probably would never have happened.



Lowe in the 1860s

The U.S. Balloon Corps was created in September of 1861 by the Secretary of War, and Lowe was named Chief Aeronaut, but it was officially a civilian position (Williams 11). This created an immediate and ultimately unresolvable issue, as it was not clear whether the balloons and aeronauts were part of the military command structure or contracted employees not subject to military orders. The reputation of balloonists was that balloons were spectacles meant for entertainment, not serious use (Scott 24).

Lowe's balloons were of almost immediate use. He ascended at Falls Church in Virginia in time to see Union troops fleeing from the First Battle of Bull Run. Lowe did not see any pursuit by the victorious Confederates, and his report calmed people down (Williams 11).

The high point of the Union balloon program was the Battle of Fair Oaks in 1862. Some of the ascents were made with telegraph equipment, allowing quick communication between observers and people on the ground. Balloon observations at this time helped the Union during the

battle, which was part of George McClellan's Peninsula Campaign, an advance on the Confederate capital of Richmond. General McClellan had moved the Army of the Potomac by boat to the peninsula between the York and James Rivers, but ultimately, the Confederates led by Robert E. Lee compelled the Union army to abandon the campaign. McClellan's reputation was ruined, and the promise of balloon observation suffered because later commanders were much less interested in the technology than McClellan had been. McClellan's enthusiasm for balloons probably tainted their use.

A picture of Lowe ascending at the Battle of Fair Oaks

For their part, the Confederates were seriously concerned about the Union observation balloons. They shot at the balloons to no effect, and no Union balloon was ever shot down, but the Confederates devised methods of deception to mislead balloon observers, such as “Quaker guns,” tree trunk segments painted black and positioned to look like artillery from a distance (Murphy 12). Since the balloons often drew Confederate fire, balloons were quite unpopular among the Union troops nearby.

Lowe’s balloons were robust, made of double layers of silk coated with varnish and provided with “ascension’ ropes. The largest balloons could carry five passengers, and they were better than the usual civilian balloons, but they were still prone to damage to the silk envelope by heavy rain or snow, and wind remained a problem. One balloon lost its tether and flew unmanned from Washington to Delaware. Communication was a problem, as weighted messages dropped from balloons were subject to wind. Signal flags were tried, as were telegraphs (Scott 9).

Lowe created a small fleet of balloons for use along the Potomac. Four were used along that river, and Lowe experimented with aerial artillery spotting. He hired professional draftsmen to sketch landscapes, and visible Confederate forts and encampments. A number of Union officers were passengers in balloons. They included a then-obscure but later famous commander, George Armstrong Custer (Scott 10-13).

Lowe eventually constructed eight balloons, all between 15,000 and 32,000 cubic feet and lofted by hydrogen produced by mobile hydrogen generators devised by Lowe. The observation gondolas must have required brave men, as they were two feet square and two feet deep, not much to grip onto in foul weather. Lowe’s field units each had two balloons, two hydrogen gas generators, carts for the balloons, ropes and other equipment, and a field telegraph unit that was sometimes used to communicate from aloft. Each unit was manned by 50 soldiers (Holmes 98).

In good weather, observers were sent up 1,000-2,000 feet, and in bad weather, it might be 500 feet. All the balloons operated on a tether with winches to reel them in, and one that got away made quite a story. This rogue balloon had Lieutenant General Fitz John Porter as a passenger, and by sheer luck he landed safely. Loose balloons were at the whim of any

breeze or wind, and the Confederates could have just as easily had a Union general air-mailed to them. It is not known if General Porter flew again.

Porter

Early in the war, balloons were lofted using coal gas from nearby city gas works, but Lowe devised a portable hydrogen generator, using thousands of pounds of metal filings and acid. Needless to say, this equipment was heavy, and one solution was developing a balloon barge (Scott 9). The barge would have worked well because of the many rivers in the region. Union barges with balloons are really the ancestor of the modern aircraft carrier.

The Balloon Corps was dissolved in June 1863. Squabbles among balloonists and hostility by some Union commanders were among the causes, but the root cause was probably the fact that balloons were a logistical problem. At Fort Monroe, balloonist John LaMountain (a rival of Lowe) requested 60 gallons of sulfuric acid and three and a half tons of iron filings, which would produce hydrogen for the balloons (Williams 11). Old-fashioned commanders trusted cavalry as the eyes of the army, and horses required easily obtained hay, not difficult materials like sulfuric acid.

The aeronauts who joined the Union were an eccentric bunch. One of them was John Steiner, an immigrant from Bavaria. It is not known how Steiner became a balloonist, but he was a good one who made ascents from Georgia to Canada, making his living from his exhibitions. He was the first man to cross Lake Ontario in a balloon, and another one of his exploits included jumping out of a balloon over New York City and parachuting down from two miles up. Another included winning an 1858 challenge distance race against the French balloonist Godard, thereby winning a $2,000 bet. The balloons launched from Cincinnati, and Steiner won while covering 200 miles (Hopkins 42-43).

Steiner joined the U.S. Balloon Corps in early 1862, and for some reason, he was ordered to Cairo, Illinois, then to a large Union base for campaigns down the Mississippi. In Cairo, Steiner took charge of a balloon called the *Eagle*. The Army was unenthusiastic, but Steiner somehow persuaded Commodore Foote (commander of the river gunboat flotilla) to provide a barge to operate the balloon from, and he made several observation ascents around Island Number 10, a Confederate fortification that blocked Union advance down river. This is the only known use of an observation balloon in the Western theater of the Civil War (Hopkins 44).

Steiner left the service in December 1862, apparently in a huff over issues of pay. One of his ascents carried a most remarkable passenger, a German military observer known as the Graf von Zeppelin, who later lent his name to the airships he developed. Little is known of Steiner’s later life, and he vanished from the pages of history about 1875, but a contemporary newspaper credited him with 315 ascents (Hopkins 44).

An additional problem was that balloonists remained officially civilians under contract with the government. It was not clear if they were subject to military orders, and there was some worry that if captured, they might be treated as spies and possibly executed. It also made for problems in getting paid. Indeed, Lowe eventually resigned over pay issues, as did others (Scott 10).

There were three known Confederate balloons. The first was made with varnished cotton and was a hot-air balloon because the Confederates could not generate hydrogen in the field. The second was the best-known; built in

Savannah, it was claimed that patriotic Southern women donated silk dresses to be used in constructing the envelope. In fact, the reality was that a sizable supply of dress silk was found in a warehouse (Holmes 104). The dress silk made for a colorful balloon and for a more colorful legend. It was a gas balloon, using gas obtained in Richmond.

It is not clear if the Confederate balloon actually had any real military value. It was used during the Seven Days Battles in the Peninsula Campaign, and that summer, the balloon, named the *Gazelle,* was sent aloft almost daily using a railroad car. It does appear to have improved the morale of the Richmond population, and for a time the Confederates could counter the sight of Union balloons with one of their own. At least once, balloons from each side were in sight of each other (Holmes 104). The balloon was captured by the Union when the tugboat carrying the equipment ran aground in the James River (Murphy 12).

The third Confederate balloon was the second made from silk dress cloth. It served in Richmond from late 1862 until the summer of 1863, when it escaped its tether and got loose. It was captured by Union troops.

The impact of balloons on the Civil War may be underestimated because of the dissolution of the Balloon Corps in 1863, but balloons were helpful during the Peninsula Campaign, and also at major battles around Fredericksburg and Chancellorsville (Scott 7). Moreover, the history of balloons in the American Civil War was not written until well into the 20th century. Lowe did write a report for Secretary of War Stanton, and he later wrote a memoir, *My Balloons in Peace and War*. Lowe may have embroidered his own contributions and perhaps did not appropriately report the significance of his rival balloonists' impact (Scott 7).

The first U.S. balloon program since the Civil War was authorized in 1892 as the Balloon Section of the U.S. Signal Corps (van Eaton 6).

New Experiments

The Great Exhibition in 1851 in London was intended as a glorification of British power, and it established the international exhibition as an important phenomenon, a way to display technology, industry and national pride

before the establishment of the World's Fair. One feature was a gallery of balloons, and attendance during the event was very large.

The French artist who called himself Nadar seems to have done some photography from a balloon, although no photos have survived. Nadar was an important pioneer in various aspects of photography, and also like P.T. Barnum in that he was adept at generating publicity about himself and his projects. One such project, in 1863, was constructing a large balloon. Nadar had it designed by Louis and Jules Godard (two more members of a family that produced many balloonists). Called the *Geant*, the craft took 212,000 cubic feet of gas to fill and was 196 feet high. The wicker gondola was as large as a small cottage, and a flight launched from Paris on October 4 carried 15 people. It came down near Meaux after a flight of five hours, though the flight was supposed to have lasted longer.

Nadar tried again on October 18 with only six passengers, and the flight got as far as Hanover in Germany before descending. The end of the flight reads like satire on ballooning, as wind blew the deflated balloon along the ground, ripping the limbs off trees, plowing the ground, tearing apart telegraph lines, and being dragged across railroad tracks only seconds ahead of an express train. The balloon was finally stopped by tangling in a grove of trees. Passengers were banged up, and the huge balloon was destroyed, but miraculously no one was killed (Holmes 117-119).

The most remarkable use of balloons in the second half of the 19th century came during the Franco-Prussian War of 1870-1871. This war is sometimes forgotten, but its political consequences were immense. It toppled the French Emperor Napoleon III, whose regime was eventually replaced by a Republic. The Prussians led the German armed forces, which included the military of Prussia and a number of other German kingdoms and principalities, and in 1871, the German Empire was proclaimed, with the Prussian king becoming the German Kaiser.

The first use of balloons was not in Paris, but the large fortress city of Metz, where the Prussians had trapped and surrounded Marshal Bazaine's French Army before inflicting a stunning defeat on a France that was commonly thought to have had the world's best army. An officer conceived the idea of sending messages over the Prussian lines by using a small

balloon, and the idea was approved by the trapped army's Pharmacist in Chief, perhaps because he knew about chemicals and gas. Small balloons were constructed of tracing paper coated with varnish. 14 balloons were sent carrying several thousand letters, and about half got through (Allaz 14).

The success with these small balloons led to the construction of larger balloons. They used town gas and could carry 30,000 letters. Sending messages was opened up to civilians as well as military personnel, and somewhere between 7-10 of the balloons were launched. Several of them fell into the Prussian lines, giving the besiegers very valuable information about morale in the city. Metz surrendered on October 27 (Allaz 14-15).

The Prussian army surrounded and besieged Paris in the Fall of 1870. The huge capital city was cut off from the outside, but the success of balloons at Metz inspired the Parisians. French ingenuity soon came up with ways to create balloons. During the course of the siege, 66 balloons were launched from Paris, and quite amazingly, 58 of them made it safely past the Prussian lines into the French countryside.

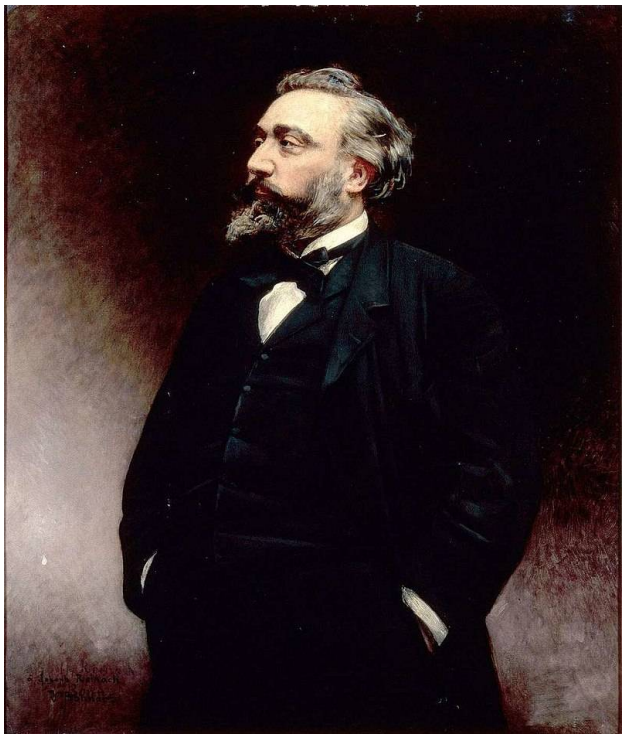
These balloons were manufactured to a standard surprisingly rigorous for a surrounded city. French engineers were then probably the world's best, and the balloon dimensions were set at 15.75 meters in diameter, with a capacity of 3,045 cubic meters of gas. They were to have a payload of 500 kilograms, made of good quality cloth varnished with linseed oil, and provided with a net made of tarred rope. The gondola was tiny, 1.4 by 1.1 by 1.1 meters (Allaz 16).

Remarkably, the regular postal service was merged into the balloon system, and the mail was standardized. Citizens were charged 20 centimes for letters going to France or Algeria, and the letters had to weigh under 4 grams. Postcards were standardized and cost the sender 10 centimes. Even more remarkably, most of this mail got through—over—the siege, and most of it got delivered to the recipient. Receiving a letter from a friend or relative in a besieged city may be a unique historical experience. In effect, this was the world's first air mail (Allaz 16).

From September 23, 1870-January 28, 1871, the balloons carried 10,700 kilograms of mail, 400 carrier pigeons, and 102 passengers, not counting

the 66 aeronauts. Remarkably, more than 90% of the mail got through and was delivered. The carrier pigeons were supposed to carry messages back into Paris, but only 55 made it back. One intriguing aspect of using these carrier pigeons was that the French devised an early version of microfiche so that one bird could carry a large number of messages back to Paris. The spectacular success rate of the balloons was related to the fact that France had by far the largest and most experienced group of balloonists in the world, many of whom were in Paris at the start of the siege (Allaz 16).

The most spectacular single balloon exploit came on October 7. Minister of the Interior Léon Gambetta was a balloon passenger, escaped the city and the Prussians, and, after landing, began to form a resistance government. Gambetta's daring escape enhanced his reputation, and later he became a very important figure in French politics (Murphy 12).

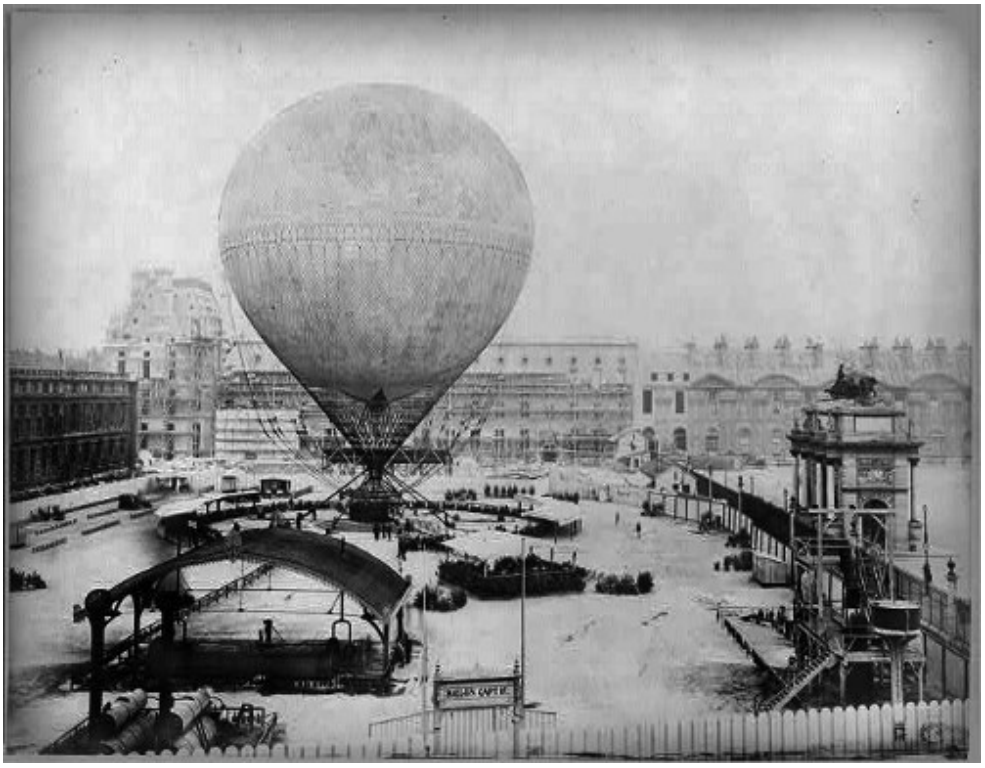


Gambetta

The siege ended with an armistice, and while France avoided total chaos, Paris soon descended into perhaps its worst period before World War II with the rise of the Paris Commune. Whatever unity that had existed in the

face of the Prussians vanished, and a quite gory revolution and repression followed.

Happier days came in a few years. The Paris *Exposition Universelle* of 1878 was designed to show the world the glories of France and French products. The Exposition featured a huge tethered balloon, 220 feet high and with 900,000 cubic feet of gas capacity. This craft is said to have a lift of 27 tons and could lift 50 people at a time. Appropriately named the *Mammoth*, during the Exposition it lofted more than 35,000 sightseers several hundred feet up (Holmes 210). While there are no figures, these 35,000 passengers may well have been equivalent in total to all the aeronauts and all the passengers that came before. It suggested that air transportation might be part of the future.



Pictures of the balloon

In 1874, the French Republic formally added a Balloon Corps to its military. This may seem to be just a detail, but it means there was official recognition of the potential of balloons, and the other major powers quickly followed the French example (Murphy 12).

Balloons were of some interest to the nascent science of meteorology, particularly in exploring the atmosphere. One important scientific balloon flight resulted in tragedy in 1875, when three French scientists rose to an altitude of nearly 28,000 feet. Only one of the three survived, as the other two died of aviation hypoxia. This made it clear that the equipment of the day could not keep aeronauts alive five miles up.

The U.S. used a balloon during the Spanish-American War. In Cuba, a U.S. Signal Corps balloon was able to confirm that the Spanish fleet was in Santiago harbor, important information because the public was spooked by the fact that the location of the Spanish fleet had previously been unknown. However, this balloon, named the *Santiago*, actually became a hazard in combat. During the attack on the Cuban city, American troops became bunched up and the balloon was tethered near the troops. Spanish artillery fired at the area indicated by the balloon's tether, causing casualties. The *Santiago* itself was brought down by Spanish rifle fire (Ullman 125). The U.S. does not seem to have used balloons in the occupation of Puerto Rico, or the conflict in the Philippines.

Balloons were used for military purposes by the British in the Boer War in South Africa, by Japan and Russia in the Russo-Japanese War of 1903-1905, and by the French in various colonial campaigns in Africa, but the basic problem with balloons since their creation was that a flexible envelope made any balloon susceptible to wind, and in high wind, observations might be impossible. An observer in a gyrating gondola would be too busy holding on for dear life to make useful notes on enemy positions.

The problem was partly solved in 1898 when German engineers devised a sausage-shaped balloon equipped with fins or vanes at one end. This resulted in greater balloon stability in wind and bad weather, and it obviously improved the quality of any observations made. Called the *Drachen*, the German design was quickly adopted by the other powers (Murphy 13).

A *Drachen*

Balloons were a technology easily adaptable to fiction. As early as the 1780s, *The Adventures of Baron Munchausen* featured a tall tale about the baron using a balloon at night to mischievously relocate a castle while the inhabitants were asleep. Perhaps the first novel prominently featuring balloons was a pioneering and inventive work of science fiction, written by 20-year-old Jane Loudon in 1827. *The Mummy: A Tale of the Twenty First Century* had a balloon that folded into a size that fits into a desk drawer, but when unfolded, it would conveniently transport three passengers to Egypt. Jules Verne wrote *Five Weeks in a Balloon* in 1863 about a fictional flight from Zanzibar to Senegal. Mark Twain's 1894 *Tom Sawyer Abroad* had Tom, Huckleberry Finn, and Jim flying across Africa to Mt. Sinai, a sort of satire of Verne's novel.

Other than exploiting their military and scientific potential, ballooning remained largely entertainment, so it attracted adventurers and what might be described as hobbyists. The career of Mexico's first native balloonist illustrates this.

Benito Leon Acosta made his first ascent in April 1842, and his balloons generated a great deal of public interest. One of his benefactors was Santa Anna, Mexico's on-and-off dictator for two decades. Santa Anna awarded

Acosta a three-year monopoly on balloon launches anywhere in Mexico. As with many dictators, Santa Anna liked to present public spectacles, with himself as benefactor to the people. His program of grandiosity seems to have worked because, despite repeated disasters and losing wars, Santa Anna kept returning to power. After some serious accidents, Acosta retired in 1855. He lived to a ripe old age, and he would sometimes make small hot air balloons to entertain children (Kuhn 115-16).

Mexico's most famous balloonist was Joaquin de la Cantolla y Rico. Aside from hundreds of ascents, he tested a dirigible prototype, but it didn't work. In his age, he became a bit of an eccentric, walking about town in a top hat, telling stories about his quite real adventures, and fascinating children with his glass eye, the consequence of a crash landing (Kuhn 117-18).

Other forms of entertainment merged with balloons, and the public interest remained intense enough for aeronautical spectacles to be mildly profitable. The continued underlying feature was the presence of danger. For example, one famous Mexican daredevil entertainer was Tranquileno Aleman, who performed on a trapeze suspended from a balloon. He did hundreds of performances, but his luck ran out in 1889 in Cuernavaca when he fell from the trapeze (Kuhn 117).

The Development of Airships

As noted earlier, the Jesuit Lana de Terzi proposed an airship in 1670. His concept was suspending a real fighting ship from four copper spheres from which the air had been removed (Murphy 3). He and Leonardo seem to have been the first to have thought in terms of an actual ship in the air. Terzi's airship had masts and sails, anchors and cannons, a bowsprit and keel. The term "airship" is significant because of the historical baggage of the word "ship." An airship took nautical terminology into the air, sailing in the atmosphere in a real version of Roger Bacon's long-ago vision.

Airships are defined as lighter than aircraft with a semi-rigid or rigid structure and some means of self-propulsion. The crucial difference between airships and balloons is the ability of an airship to be steered and to overcome the balloon's vulnerability to wind and weather. In a way, it's the

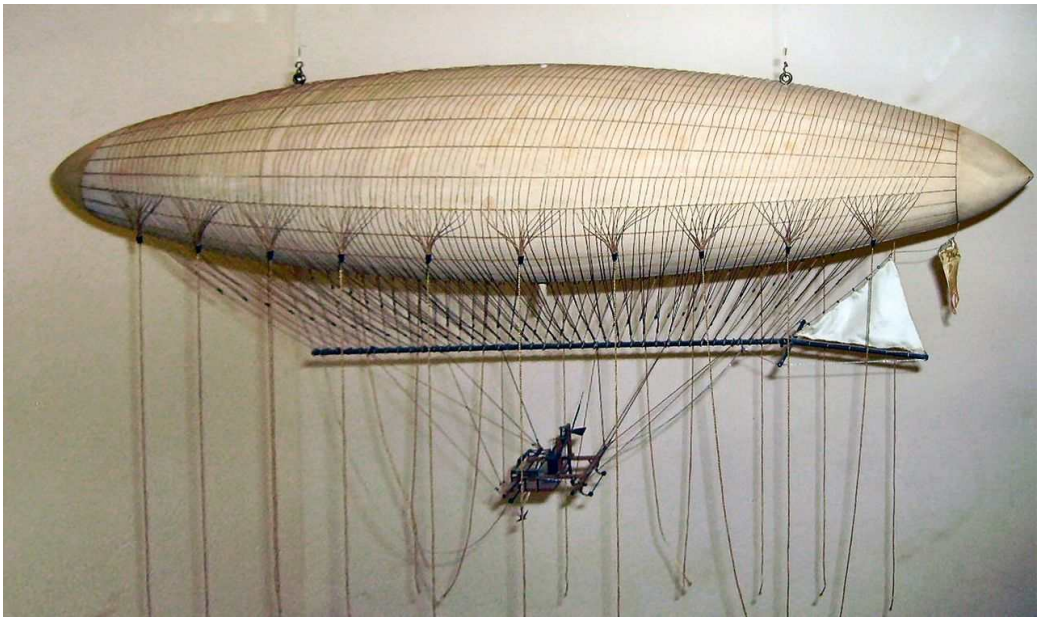
difference between a raft and a boat with oars. Balloons can be small or large, but steering and navigation possibilities have always been limited. Airships can be small or enormous, and power and steering allowed vastly more potential.

A major engineering problem in developing airships was devising an engine that could power the ship but that was light enough not to offset a lot of the craft's lifting capacity. The first such airship carrying an engine was devised by a French engineer named Henri Giffard, who became interested in powered flight, and how to overcome the air resistance that made balloons difficult to control and very difficult to navigate along any sort of regular flight path. As an engineer, he was able to envision solutions that took the form of a non-rigid but shaped airship 140 feet long with a maximum diameter of 40 feet, and pointed at each end so the envelope's construction gave it a navigable shape. The balloon held 88,000 cubic feet of hydrogen, and a gondola was suspended under it.

Giffard

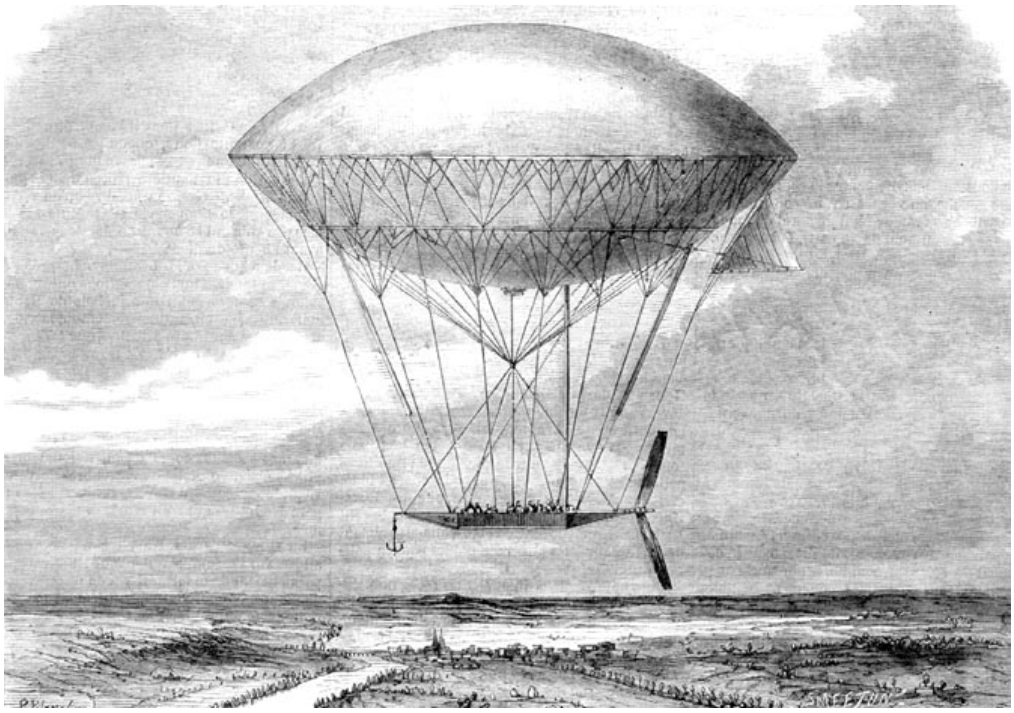
Giffard built a three-horsepower steam engine, based on a boiler that burned coke, with precautions against sparks, which were a serious danger with the highly combustible hydrogen. The engine powered a three-bladed propeller. The airship reached 3,000 feet and achieved a speed of about six miles per hour. It worked, but it only worked in calm conditions with no winds (Murphy 14).

This aptly named “aerial steamer” flew for about 15 miles on September 24, 1852 (van Eaton 4). Giffard’s experiment was in its way to becoming highly successful, but nothing came of the pioneering flight. That the airship could only be used during conditions of absolute calm may have been one reason. Another factor probably was the realization that Giffard’s type of engine was highly dangerous in conjunction with hydrogen gas.



A model of Giffard’s dirigible

During the Franco-Prussian War, the French naval engineer Henri Dupuy de Lôme devised a highly unusual airship design. The war ended before any prototype was constructed, but in 1872 he built a craft 49 feet long, with a 46 foot maximum diameter, a 123,000 cubic foot capacity and a four-bladed propeller 29 feet long. The most unusual feature of this design was that the propeller was powered by a crew of eight using a hand crank. One historian dryly observed that the crew was powered by rum (Murphy 14). The airship did manage short flights, which is surprising, and the method of power was much like the hand-crank-powered Confederate submarine CSS *Hunley*.



A depiction of the airship

The next powered flight of an airship a semi-rigid craft over Vienna in 1872, using an internal combustion engine designed by Paul Haenlein. The engine was powered by coal gas (Smith 147).

In October 1883, Albert and Gaston Tissandier flew another French airship design, this time powered by a 1.5 horsepower electric engine (Smith 147). Electric engines were potentially much less dangerous in common with hydrogen than other kinds of engines.

The year 1884 brought another French airship design. Army Captains Charles Renard and Arthur Krebs, both engineers, built *La France*. At 165 feet long, this rather large airship was driven by an 8.5 horsepower electric engine based on a battery system. The ship was essentially an early dirigible and the design was promising, but lack of funding killed the effort (Murphy 15). Batteries in this period were heavy and expensive, but the technology was quickly improving.

One technological development in 1885 profoundly affected airship development. Germany's Gottlieb Daimler designed an effective internal combustion engine. Yet another technology was a new process for

producing aluminum, which soon allowed a lightweight means of giving airships some framework structure.

As internal combustion engines were improved, the power versus weight ratio became more and more favorable for airships (and also for heavier than air machines, then in an early but intense stage of development). The first use of an internal combustion engine in an airship came in 1885, when Friedrich Wölfert used one to power an airship of his own design. Wölfert was a German clergyman, illustrating that non-professional enthusiasts still had important contributions to make. Professional engineers and designers did not yet dominate aviation.

Perhaps the most colorful of the pioneer airship designers was the Brazilian Alberto Santos-Dumont. He came from a family wealthy enough to support his interest in airships and aircraft, and after moving to Paris, he designed and built several small airships in 1898. He moored one of his airships, Number Nine, outside his Paris apartment and also outside his favorite restaurant (Murphy 16).

In one of his early flights, with dirigible Number 1, he rose to 1,300 feet before the airship lost gas and drifted down. Santos-Dumont yelled at some boys playing in a field to grab the guide rope and run into the wind. They did, and he landed safely. He collected all the parts, put them in the wicker basket gondola and then caught a cab back to Paris (Hiam 18).

It made for a great story, but it’s easy to wonder how all the ropes, the envelope, the rudder, propeller and the other gear fit into a basket or a taxi cab. The cheerful story seems somewhat improbable, and perhaps many of the stories about him are. His colorful personal life cloaked an aeronautical genius with a taste for danger. He also was a master writer, and reading his tales provides a zesty sense of adventure a century later.

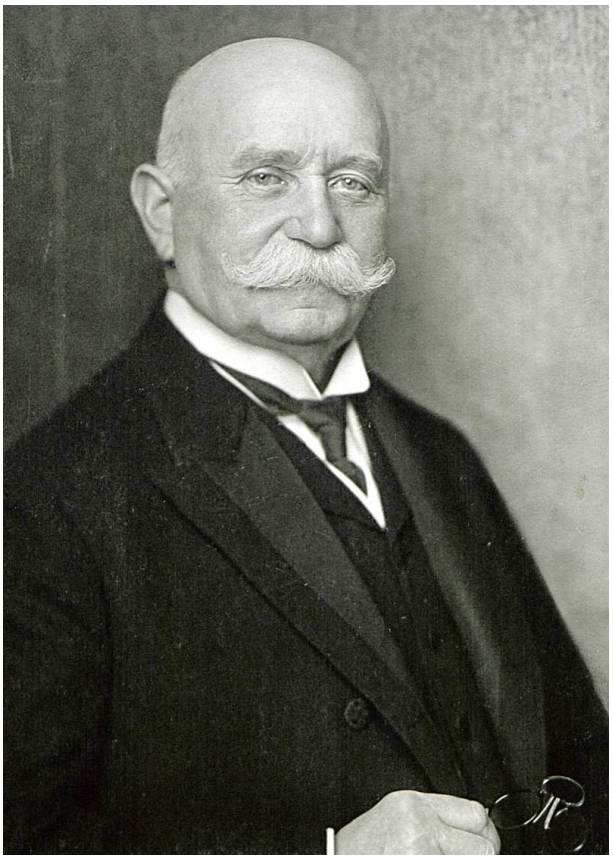
To be fair, Santos-Dumont continued his eccentric experiments with increasing seriousness and increasing significance in the next several years. His Number 6 was used in his most famous exploit. There was a cash prize called the Deutsch Prize of 100,000 Francs for an airship to fly from the suburb of St. Cloud to and around the Eiffel Tower and back in under a half hour.

On October 19, 1901, Santos-Dumont took off for Paris in an attempt to win this prize. He made it, circled the Eiffel Tower, and started back, but his engine sputtered and stopped nd then started again. He made it back to the starting point with some 30 seconds to spare. His reputation was enhanced when he gave part of the prize to the poor in Paris and the rest to the employees who had built his airships (Hiam 19-20).

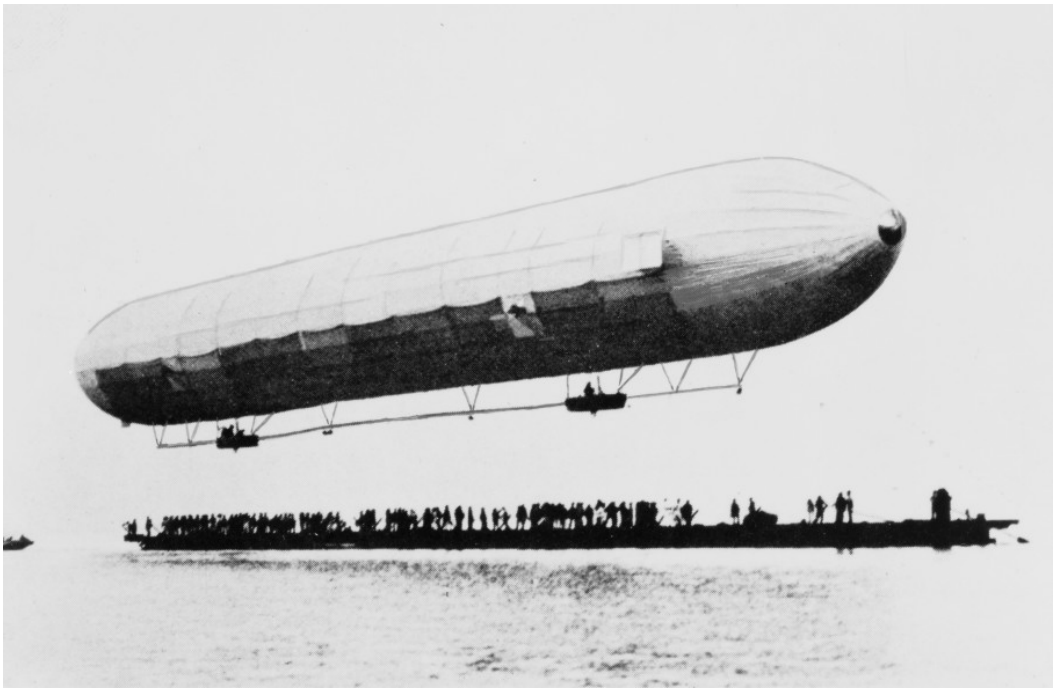
Around the same time, Ferdinand Graf von Zeppelin was experimenting with airships. Zeppelin had been a military observer for the Duchy of Wurttenburg, one of a number of independent German states, during the American Civil War. He had ascended with Union observation balloons and was apparently impressed with their utility, and he was the only person among these airship pioneers who actually had experience in the use of balloons under battlefield conditions.

Ballooning continued to attract attention, and as the 19th century ended, something of an extreme era of ballooning commenced. It was characterized by the search for records to break, deliberately risky exploits to entertain onlookers, and sheer recklessness (Holmes 212-213). A typical exploit was a flight by the Count de la Vaux. Lifting off during yet another Paris exposition, this flight lasted 35 hours and the balloon landed near Kiev in Russia. The flight covered 1,195 miles, breaking a distance record set in 1859 (Fischer 5).

As the great era of ballooning was coming to its end, airship developers were busy. In 1900, an experimental Zeppelin flew over Lake Constance. Significantly, the craft had an aluminum frame and was powered by a Daimler engine (Holmes 210).



Zeppelin



One of the first Zeppelins

By 1899, it was clear that airborne attacks were going to become practical military options in the near future. In fact, the American delegate to the 1899 Hague Convention pushed for a ban on balloons dropping bombs, on the grounds that bombs dropped from a drifting balloon were impossible to aim accurately and might accidentally hit civilians. The ban was adopted, but in a somewhat surprising twist, the ban was only for five years, because it was assumed that within five years, airships like the Zeppelins being developed would be so accurate in dropping bombs that the ban would no longer be needed (Ziegler 751-752).

Needless to say, the next generation of aerial technology and wars would prove that thinking remarkably shortsighted.

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