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Paper Session II-A - Navigating the Air: A History of Flight Before the Wright Brothers

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Navigating the Air:

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When, on June 5 1783, Joseph and Etienne de Montgolfier launched for the first time in public their MACHINE AEROSTATIQUE, an immense enthusiasm took over the whole world. Never, except perhaps with the discovery of America, did any scientific event captured so much the passions of the masses: It seemed that finally MAN had conquered the atmosphere. HE was the master of the air just as much as he was already the master of the Earth and the Sea. Space belonged to him, and for most enthusiasts going to the moon was going to be just a game.

Now a century or more has passed, and the hopes that the invention of Montgolfier had raised have not yet been realized in spite of the very large progresses that have been made. [Are] ... the roads of the atmosphere are closed to us forever? Must we no longer hope to follow one day the eagle in his flight because after 125 years man cannot yet travel at his will within space [the atmosphere]?

... all leads us to expect that the 20th century will bring us the complete solution to the problem. ***Will it be through Dirigible Balloons? Or through the pure heavier than air aircrafts? The future will teach us soon...***

J. LeCornu, Editor
La Navigation Aerienne
Paris, 1903

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A Note About Sources: The primary source for this paper is *La Navigation Aérienne* (Paris: Librairie Nony & Cie, 1903); and see also Tom D. Crouch, *A Dream of Wings: Americans and the Airplane, 1875-1905* (New York: WW.Norton, 1981); _____ Crouch, *The Bishop's Boys: A Life of Wilbur and Orville Wright* (New York: W.W. Norton & Company, 1989); Roger D. Launius, ed. *Innovation and the Development of Flight* (College Station: Texas A&M University Press, 1999); Donald Dale Jackson, *The Aeronauts* (Alexandria, VA: Time-Life Books, 1981).

The First Flight: And the Montgolfier Brothers

On November 21, 1783, Pilatre de Rozier and the Marquess d'Arlandes became the first humans engaged in the free flight of an air craft, using a Montgolfier-type hot air balloon. That moment climaxed almost two-thousand years of thought about flight and endeavors to fly. It marked the beginning of a new epoch in flight, and it climaxed an incredible time of experimentation and excitement in France and most especially in Paris. The piloted flight derived directly from experiments conducted by Etienne and Joseph Montgolfier throughout the year 1783.

Montgolfier family fortunes, and perhaps in some tangential way even the inception of flight began in 1147, when Jean Montgolfier took part in the second crusade and was taken prisoner in Palestine. There he learned the manufacture of paper. He escaped and built the first paper mill in Europe near the village of Ambert in the Dore Valley. The new industry brought "glory and fortune to his descendants."

Six hundred years later, two of the descendants of Jean Montgolfier, Joseph (1740) and Etienne (1745), whose father operated the Vidalon-on-Annonay paper mill, became interested in the possibility of aerial navigation by enclosing in a "light vessel a fluid specifically lighter than atmospheric air."

At the family paper factory in Anonnay, Joseph and Etienne began collaborating on the idea of lighter-than-air flight. Inspired by the ability of large masses of clouds to remain suspended in the air, they attempted to emulate that condition by filling a very light container with steam–which quickly condensed–ending the attempted launch. They next attempted to fill a container with hydrogen, a gas lighter than air, but the paper and the fabrics they used could not contain the gas. Joseph, after watching smoke rise in the air, fashioned a cube of light fabric and burned paper under the opening at the base. The cube filled with hot air and lifted from the surface. The two brothers repeated the experiment, this time using a mixture of wool and wet straw, thinking that the resulting smoke had electrical properties enabling clouds to stay suspended. Their first attempted paper cube launch rose slightly from the surface before catching fire; the second, a fabric cube with a volume of about 20 cubic feet, rose three hundred meters, the height of the Eiffel Tower, and fell 20 minutes later on a nearby hill. But that was the moment of invention. Flight was no longer a fantasy.

The first successful public flight by a lighter-than-air craft, a hot-air balloon devised by the brothers, occurred on June 5, 1783, at Annonay, France. A second balloon flight, using a silk bag coated with rubber and filled with hydrogen was launched with great ceremony in Paris on August 24, 1783, the developers claiming to have preceded the Montgolfier experiment by a full year. The globe rose 3,000 feet in two minutes and disappeared, to the great surprise of the promoters and the almost 300,000 spectators. When the apparatus later fell to the ground, surprised peasants attacked it with guns and pitchforks and put the monster out of its misery. Subsequently, the government published a decree informing the people of France of the new discovery of flight based on gasses lighter than air. It told them that balloons filled with inflammable air could rise to great heights and stay there for long periods of time. It told them of the two experiments in Annonay and in Paris and warned them that other experiments would take place in the future. Those who saw the globes should not be afraid. They could cause no harms and might one day prove useful to society.

On August 30, Rozier de Pilatier completed the first of a number of tethered flights in a Montgolfier balloon over Paris to heights of 342 feet, and on the same day he submitted a proposal to the Paris Academy of Science for a free, untethered flight in a Montgolfier "aerostat."

By this time "Balloon fever" began sweeping Paris. On September 11, eight days after the American peace commissioners, Benjamin Franklin, John Jay, and John Adams, and representatives from England, France, and Spain signed the Treaty of Paris ending the American Revolution and establishing American independence, the Baron of Beaumanoir succeeded in launching a small 18-inch windbag balloon filled with hydrogen. *Then everybody wanted to launch one. It became a furor, and every where one could see these small balloons ride in the air.*

Subsequently, the Montgolfiers scheduled a royal (and very public) ascent of their balloon for September 19. This balloon was made of packing canvas reinforced with heavy paper on both sides. It was shaped like a pyramid at the top and the bottom was shaped as an inverted cone (Fig 23), and stood 70 feet high and weighed 1,000 pounds. The displaced air was estimated to weigh 4,500 pounds, and the balloons lift capacity was estimated to be 1,250 pounds.

Unfortunately, because of its size, assembly and filling had to be done well ahead of time and outdoors. On September 11 the assembly was completed and a load of 500 pounds was attached to the balloon. However, sudden rain and wind damaged the balloon so much that it could not rise or be reused. In 5 days Etienne, with the help of friends, assembled a second balloon, and on the morning of the 19th the balloon was transported to Versailles. Standing 57 feet high and 57 feet in diameter, and placed on a large stage surrounded by soldiers to contain the immense crowd, the balloon was beautifully decorated with blue and gold ornaments outlining a tent. Attached to the bottom of the balloon was a willow basket which was to carry a lamb, a rooster, and a duck. Finally, with the king and an enormous crowd in attendance, at four minutes to one, the machine rose "pompously" in the air taking along its equipment and animals, and because of sudden wind gusts ascended (gently) after a flight of 8 to 10 minutes 4 kilometers from the starting point.

The Academy of Science became interested in adapting the Montgolfier design to transport people and encouraged Etienne to construct a much larger 45 foot diameter by 70 foot tall aerostat. The balloon shape had 3 elements: a cylinder in the middle and a cone at each end, one pointing up, the other down. The circular opening at the bottom of the lower cone was 14 feet wide. A cylinder made of canvas was attached to that end. A gallery was mounted on the outside of this cylinder. The gallery, made of willow, was two and a half feet wide and had a 3 foot vertical rail on the outside. A burner fashioned out of iron wires was placed in the center of the gallery circle. It would be used to burn wool or any other combustible. Fully equipped the aerostat weighed between 14 and 15 hundred pounds.

Pilatre de Rozier received approval to make the first flight in a free flying aerostat, and after conducting more tethered tests, he was able to control the upward and downward motion by changing the size of the fire in the burner. He became very skilled, and on a windy day was able to make the craft rise to avoid trees by increasing the fire in the burner. In other demonstrations, Pilatre took on passengers, rose up to 324 feet (half the height of Notre Dame towers), and showed considerable ability in mastering the craft such that he thought it was time to try a manned free flight. Montgolfier, however, opposed the flight and wanted more experiments. King Louis XVI suggested using convicts for the first manned flight. de Rozier strongly objected, and when the Marquis d'Arlandes offered to co-pilot, the Academy and Montgolfier (and presumably the King) agreed to the flight.

On November 21, 1783, Pilatre de Rozier and the Marquess d'Arlandes became the first humans to fly in an air born vehicle, using a Montgolfier-type hot air balloon. According to the Marquess's account:

> *We left the gardens at 1:54 PM. When the machine reached the roof tops the wind gave it a half revolution and Pilatre ended up in front and I behind, and we stayed that way throughout the trip. The crowd was surprisingly quiet, and moved to follow the machine being concerned that the craft would not clear a high wall. This is when Pilatre said to me: "You are doing nothing and we are not climbing." I put a bundle of straw in the fire. When I quickly turned around I had lost the gardens, but I could see the junction of the Seine and Oise rivers, and make out the neighboring towns: Poissy, St Germain, Saint Denis, Sevres. ... As I activated the stove I felt being transported upward. Then I heard a noise from the top of the machine that made me fear that we had burst, and there was a downward bump. We were then between the Military School and the Invalids. We had traveled about 800 meters. I heard another noise, and saw that the south side of the balloon was full of round holes. I took a wet sponge and put out some of the small fires that made the holes. I saw that the sponge also caused pieces of the bottom of the balloon to tear near the ring that supports the gallery. I called my companion to tell him we*

should come down. He said, "We cannot. We are above Paris." I took another look at the balloon and concluded that we could manage onward. In the meantime we had to activate the fires because we were getting close to the roofs. As we rose the air current made us travel south, and I thought I could see the Luxembourg gardens to my left. We crossed the boulevard and I said, " This is it, we are going to land!" We lowered the fire. Pilatre, however, was watchful and feared that we were going to hit the mills which were in front of us. I threw a bundle on the fire, and we passed them. .... We landed on the Quail Mound, between the Marvels Mill and the Old Mill about 100 meters from each.

The official report stated that the balloon had reached an altitude of 3,000 feet, and that its volume was 60,000 cubic feet. The weight was around 1,600-1,700 pounds. One of the witnesses to that ascent was Benjamin Franklin. Franklin was reportedly asked after the event "What use are balloons?" And he answered, "What use is a newborn baby?"

It was the inventors and not the pilots who got the recognition and awards for the first flight. Subsequently, on December 10, the Paris Academy of Science awarded Etienne and Joseph Montgolfier the title of "Correspondent Members," and on the 23rd of December, presented them with the Prize for the Development of Science and the Arts. Louis XVI granted Etienne the Order of Saint Michel. Joseph received a pension of 1,000 Pounds, and their father, then 83, was made a nobleman. Their family motto became *Sic itar ad astra*–which presciently translates to: **On our way to the stars** or **On to the stars.** It was a brave beginning, but flight through the air and certainly into space proved formidable. More than a century passed before aerial navigation became a reality, and almost two centuries before humans ventured into space. [And note, as for the Montgolfier family, the conveyance of nobility on the family some six years before the French Revolution proved to be more a curse than a blessing].

The Prologue to the Age of Flight

Years passed, one-hundred and twenty of them to be exact, and aerial navigation had not yet come to be. The hopes and anticipations raised by the Montgolfier flights in 1783 had not been realized, but they still persisted. J. Cornus edited a massive and beautifully illustrated anecdotal and documentary history of flight published in Paris in 1903 that concluded with this observation: *...all leads us to expect that the 20th century will bring us the complete solution to the problem.* ***Will it be through Dirigible Balloons? Or through the pure heavier than air aircrafts? The future will teach us soon....***

There was, in 1903, an excitement, an expectation, and an anticipation. There was already an understanding that aviation, when it came, held great promise and the prospect of enormous social change. For example, M. Janssen, a member of France's Academy of Science, gave the opening address at the Aeronautic Congress of 1900, with the observation:

> ***I do not hesitate to predict that the XXth Century, which is just born, will see the implementation of Aerial Navigation, and it will also see the earth atmosphere cris-crossed by machines which will finally conquer it...and it will only have taken two centuries to obtain this prodigious result.***

A significant aspect of the 1903 history of aerial navigation by Cornus and his associates is that it was published prior to the December 17 flight of Wilbur and Orville Wright at Kitty Hawk, North Carolina. There is no mention of the Wright brothers. Germany's Otto Lilienthal and his "hang glider" figure prominently, as did Britain's Hiram Maxim, and America's Samuel Langley, among others. The work is significant because it provides the first comprehensive history of human flight to the very moment of the Wright's flight. And it is significant too, that in 1903, when the book was published, and before the flight of the Wright brothers, aerial navigation already had quite a history.

J. Cornus's *La Navigation Aerienne*, thus, commemorates the remarkable achievements (and the failures) of more than two centuries of flight, celebrates the achievements and the centennial of the historic flight of the Wright Flyer as well as the 220th birthday of the first aerial flight by a human, and tangentially, helps mark the approaching golden anniversary of human spaceflight–which began with the 108-minute orbital flight of Yuri A. Gagarin, a Soviet cosmonaut, in April 1961, followed by the sub-orbital flight of Alan Shepherd in May 1961. There is a commonalty in the epochal events and history of human flight.

And the history of flight has an early beginning. Cornus's description of that history is eloquent, and need little embellishment or rephrasing. As he observed:

> *The ability to travel in the air has been one of the aspirations of mankind, and the ancient literature, as well as the antique monuments, are full of legends of flying men, of ascensions (rising in air), and of aerial travel. It seems very probable that some of these fabulous tales hide a historical fact, and maintain, within all the poetic embellishments, a factual base. With this possibility in mind it is interesting to revue the legends of antiquity.*

Daedalus and Icarus are a good examples of experimenters in aerial flight who strongly shook the imagination of their contemporaries in Greco-Roman times, as did Hanouman, in ancient India, who legends say attempted to fly with improvised wings, and, taking off from a hill top managed to land in a lake. Aristophanes' comedies (c. 420 B.C.), especially *The Birds*, often play with the idea and possibilities of human flight. Archytas de Tarente, a friend and contemporary of Plato in the 4th century before Christ devised a mechanical dove made of wood that, according to the Greek writer Favorius, actually did fly [Tarente also invented the screw and the pulley, and experimented with kites].

Christian traditions of the first century AD mention experiments by the famous mechanic Simon, a self-styled magician who used his magic to make himself appear divine. During the 13th year of Nero's reign [66 AD] , he was able to rise (perhaps with the help of demons, but probably with pulleys and ropes), but St. Peter, according to the traditions, through prayers canceled Simon's evil powers and the magician fell and broke his body in the fall and died on the spot. In the 11th Century Oliver de Malmesbury, apparently a priest or monk, attempted to fly from a tower using wings fashioned from a description in Ovide. He glided about 120 feet, all of it down, and broke two legs.

Another, identified by Cornus as a Saracen during the reign of Emperor Emmanuel Commene, claimed that he could fly across a quarry. He donned a very large robe attached to his wrists and ankles with the sides reinforced with willows forming a sort of wing. He was prompted by the crowd, and when he felt that the wind was favorable, he jumped, enjoying perhaps a moment of suspension by the air before falling to the bottom of the quarry. *He broke his bones, and his misfortune was such that no one felt sorry for him. So ended a directed parachute experiment where the unfortunate Saracen was depending on the resistance of the air to be able to come down slowly to earth.* Such were the hazards of flight and of disappointing the crowd.

In the 12th Century Roger Bacon postulated on the possibility of building flying machines shaped like boats in which "rowers" operated cranks that activated wings. But Bacon nor any of his contemporaries tried such a device. A century later, Jean Baptiste Danté, a scientific observer and mathematician, perhaps influenced by the legends of Icarus, built a mechanical bird with wings that operated similarly to the flying machine envisioned by Bacon. Unfortunately his experiments had a tragic end. At a wedding, he leaped from a building, and glided for a moment when one iron rod operating a wing broke and he crashed on the roof of the church and broke his thigh. Mechanical birds, however, continued to dominate thought about flight for the next several hundred years.

It was in this vein that Leonardo de Vinci attacked the problem of flight in the 15th Century. A study of de Vinci's efforts at flight by Hureau de Villeneuve published in *L'aeronaute* in September 1874 explained that de Vinci studied the concept of mechanical birds for many years. But he left behind only incomplete fragments of these studies. He began his work by examining the flight of birds and concluded that birds could fly because they made the air more dense where it flies than were it does not fly–an observation that may have been a precursor to the theory of lift or flight.

De Vinci also concluded that the human body did not have the strength to imitate the flight of the bird, and he thought that possibly human could use the winged configuration of a bat: *After having realized, like many of our contemporaries, that the bird wing is too difficult to emulate, he tried to imitate that of the bat. His drawings also indicate the flow of his thinking.* He tried devices using the arms and fingers, then decided that human legs offered greater power, and he devised a mechanism that would activate wings with action of the legs and feet. The concept is fine for a downward thrust of the wings, but when the wings rise the air forces the flier downward, negating the previous upward thrust. Leonardo then looked for a way to eliminate this inconvenience. He tried double pulley release mechanisms, sets of levers giving more powerful downward thrusts, spring mechanisms, and metallic hinges. He finally decided, as did Roger Bacon, that a flying canoe with a number of men powering levers to activate wings made more sense. Nevertheless, Leonardo was on the theoretical verge of flight, and went on to invent (or devise) a theoretical helicopter and a working parachute. The helicopter was powered by a screw made of linen rotated at a speed sufficient that the air formed its "nut" and the screw, in theory, would rise. The parachute comprised ...*a large starched canvas 12 yards by 12 yards,* [with which a man] ...*will be able to jump from any height without fear of danger."*

Perhaps one of the most remarkable characters in the 17th Century to contemplate human flight was Cyrano de Bergerac, a playwright, a master of comedy, a musician, and a physicist. Among his works were the plays entitled *Travel to the Moon*, and the *Comical Story of the States and Empires of the Sun.* Cyrano was preoccupied if not obsessed with the idea of travel through the air and space. In one of his scripts a character ascends to the Moon using vials filled with dew that are heated by the sun's rays to form clouds that raise the character into the air–and beyond to the Moon. In another episode a spring-driven winged vessel is captured by soldiers who then surround the vessel with fireworks. The hero saves the vessel by firing a bank of six rockets, and then another, and yet another stage. The point is, Cyrano is envisioning rocket or reaction engine propulsion in the 17th Century. Another flight in one of Cyrano's plays is made by a character who attaches two large jars filled with smoke under his armpits. Since smoke rises, so does the lead character; in fact, he rises all the way to the Moon and then parachutes or glides back to Earth. In his *Comical History of States and Empires*, de Bergerac describes an aerostatic machine which he seems to have considered as feasible. The machine, using concave mirrors and the sun's rays created a constant vacuum, and because "nature abhors emptiness" *the device constantly inhaled air propelling the machine and its attached pilot at a furious speed.*

Mechanical wings, compressed air jets, cloud chambers, and parachute devices tended to dominate aeronautical thought well into the 18th Century when the Montgolfiers and others introduced balloons. There were reports of a circus performer in the court of the King of Siam who used a device similar to two beach umbrellas to safely ascend from high places, but reports of a balloon ascent having occurred in China as early as 1306 were discounted in the west. Vague stories from Europe could find acceptance, but vague stories from the Far East were deemed too uncertain to have historical value.

Navigating the Air: 1783-1903

Numerous balloon flights were staged in 1783 and 1784, most of those in France. Among the highlights was the introduction by the Montgolfiers of a hydrogen-filled balloon using a prototype dirigible design. On January 1, Pilatre de Rosier attempted to fly across the English channel from Boulogne but failed because of adverse winds, while on January 7, 1784, Jean Pierre Blanchard and Dr. John Jeffries from America succeeded in flying from Dover to Calais because the same winds that were so unfavorable to de Rosier pushed them across the Channel in a matter of two hours. De Rosier attempted a Channel crossing using a hydrogen-filled balloon in 1785, ending in a fire and crash that took his life. In the 1790s, the French government constructed the first military aerostat or balloon called the *L'Entrepenant,* designed primarily for observation, which did see use during the Napoleonic wars. To operate the device the army created a company of "Arostiers" including three officers, five no-commissioned officers and twenty-four soldiers, that could possibly be considered the first air corps.

During the most of the first half of the 19th Century war and political chaos essentially suspended experimentations with flight, especially in France. But the onset of the age of steam and locomotives in the first half of the 19th Century affected ideas about flight. In England, in 1843, William S. Henson designed a steam-powered aircraft of an advanced design, but which failed to fly. Attempts were made to combine the apparatus of powered flight with balloons. Probably the most significant advance in aviation occurred in the 1850s by virtue of the enhanced design of a propeller mounted on a stick and used as a toy–called by the French a spiralafere. But the age of "automotion" as some referred to it, triggered a reaction against balloons and much more intense investigation and interest in aviation. An "Aerial Automotion Manifesto" released in Paris by Felix Tournachon Nadar, a writer, artist and "man of imagination," and his constituents which proclaimed "that which has killed balloon navigation is the balloon itself." In order to fly against the air, an air craft must be heavier than the air! But almost as to disprove this proposition, Nadar and a partnership designed and constructed what Nadar considered the grand finale in ballooning–the GIANT which flew over Paris and then went to the exhibitions between 1864 and 1867.

French defenders employed balloons both for observation, and (interestingly) to deliver the mail during the Siege of Paris in 1870. Albert Tessandier introduced an elongated balloon with an electrically operated propeller at the Electricity Exposition in Paris in 1881, and during the next two decades balloons entered the realm of sports as "aeronauts" competed for altitude, a competition that probably continued into the 1960s. In the first balloon race near Paris on June 12, 1899, six balloons competed for the distance in a given amount of time. By now the United States had joined in the spirit of ballooning, including an ascent by Sarah Bernhardt in the 1890s, and the first wedding staged in a balloon at Lowell, Massachusetts in the same year. After the nuptials the balloon was untethered and the bride and groom ascended to their honey moon. The United States also employed a balloon for observation in 1898 during the Spanish-American War at Santiago with disastrous results. The balloon floated over the heads of the 71st New York Volunteers who were showered with bombardments aimed at the balloon–almost throwing the entire invasion into total disarray. Finally, the close of the decade, Count Ferdinand von Zeppelin had introduced the dirigible design that would close the epoch of ballooning as a people transport.

Most of the accomplishments related to flying in the 1890s had to do with powered flight and reflected the introduction of the internal combustion engine, and the first real advanced scientific studies of flight conducted since the time of de Vinci. To be sure, there had been a small stream of research relating to aerodynamics in the modern era. Benjamin Robins (1701-1751) and Sir George Cayley (1773-1857) developed data on wind resistance and aerodynamic lift. Britain's Frank H. Wenham (1824-1908) designed and constructed the first wind tunnel in 1872–a device 12 feet long and 18 inches square with a fan at one end, but there was little evidence that the knowledge gained found any productive application.

Among the most significant pioneers in theoretical and analytical studies of aerodynamics at the dawn of powered flight were Albert Francis Zahm (1862-1954), and his mentor, Octave Chanute, born in Paris, and a Chief Engineer of the Erie Railroad, who, after the Erie collapse, became an independent consulting engineer and a devotee of heavier-than-air flight. Zahm was the catalyst in organizing the International Conference on Aerial Navigation at the Columbian Exposition in Chicago in 1893, an event which was a milestone in the inception of the discipline of aeronautical engineering. His thesis completed at Johns Hopkins University in May 1898 proposed "a method of measuring exactly the resistance of the air to spheres, spheroids, and other surfaces of convenient form moving 50 to 500 miles an hour." He followed the flight experiments of Samuel P. Langley very closely, and, in 1901, at Catholic University, began operating America's first aeronautical laboratory and wind tunnel. He continued making significant contributions to aeronautical engineering and design studies until the eve of World War II.

Experiments with wings and gliding during the 1890s contributed to the inception of powered flight, but the key to such flight had largely to do with a suitable power plant. Otto Lilienthal, for example, devised a machine with flapping wings which worked best simply as a hang glider, an airplane without motors. He flew some 2,000 flights near Berlin before dying in a crash in 1894. His device, and

the flying models of Alphonse Pénaud, who successfully tested fixed-wing "twisted-rubber" propeller-driven models, influenced the work of Octave Chanute, Herring, Zahm, and Samuel P. Langley in the United States. Lawrence Hargrave, Hiram Maxim, Horatio Phillips, Clement Ader and others had designed aircraft that could fly given suitable propulsion and guidance and control systems. By the close of the 1890s the key to successful flight had more to do with propulsion, rather than with lift. Steam, compressed gas engines, and electric motors could not provide the power within the limitations of weight.

Samuel P. Langley came very close. He built his first airplane model in 1893, and in May 1896 privately flew an aircraft using a small, very light steam engine, and on November 28, 1896, his unmanned aircraft flew a distance of 1,600 meters in 1 minute 45 seconds. and the distance traveled was 1,600 meters with a speed of 13.33 meters per second. On December 17, 1903, the Wright Flyer built by Orville and Wilbur Wright incorporated the light structural designs of previous experimenters and added refinements that improved stability and control, plus an engine producing twelve horsepower especially designed and built for the aircraft. During a series of four flights Orville flew 120 feet in 12 seconds, Wilbur flew 175 feet, then Orville, encountering gusts, flew only a few feet, and finally, with Wilbur at the controls, the Flyer went 852 feet and was airborne for fifty-nine seconds. Controlled flight, the ability to navigate the air, became a reality almost two-thousand years after its anticipation and more than a century after the first flight of de Rozier and d'Arlandes.