THE MEN WHO LEARNED TO FLY

THE WRIGHT BROTHERS' STORY OF THEIR EXPERIMENTS, THE SENSATIONS OF FLIGHT, AND THEIR ESTIMATE OF THE FUTURE OF THE AËROPLANE

BY

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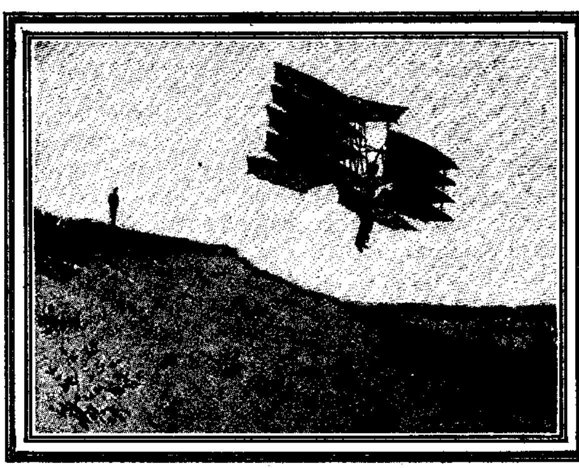
ILLUSTRATIONS FROM PHOTOGRAPHS

IN 1888 scientific authorities could demonstrate mathematically that a mechanical flying-machine was impossible. Formulae — absolutely fundamental formulae proving this — had remained almost undisturbed since they were proposed by Sir Isaac Newton. Any flying-machine must be too heavy to be supported by the air. Yet, it was also well understood that many birds were a thousand times heavier than the air they flew in.

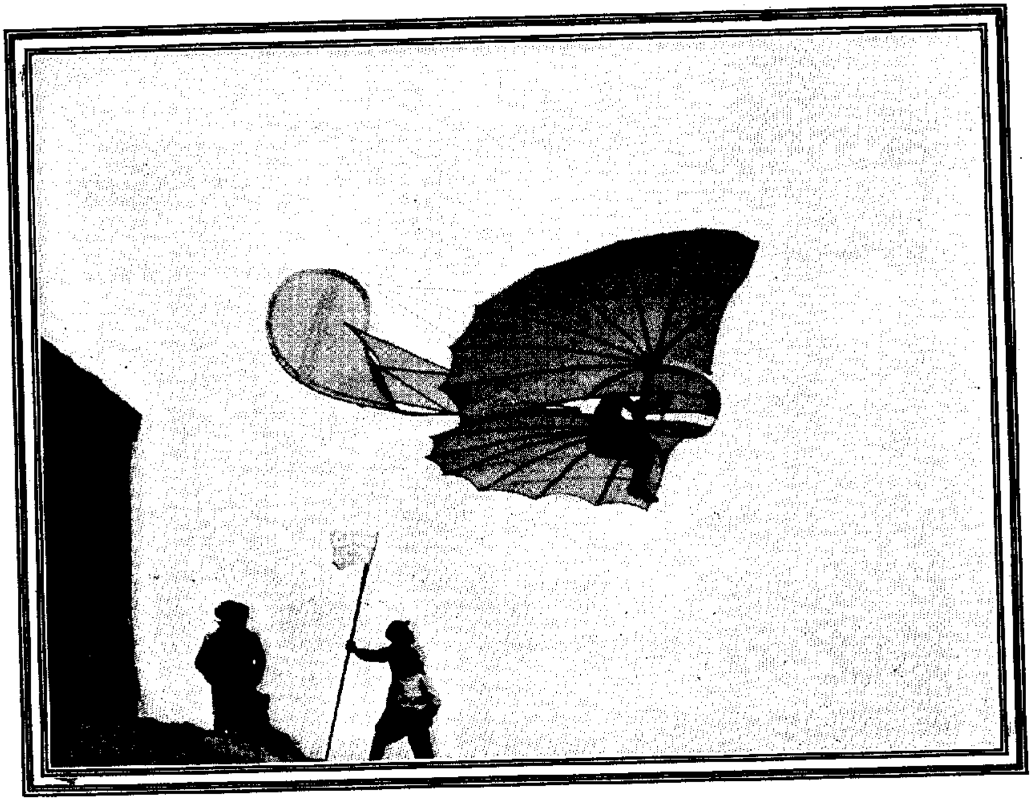
During the eighties a German mechanical engineer, Otto Lilienthal, studied the mechanics of the flight of birds, and decided we knew very little about the laws of flying. The only way for a man to learn to fly, he believed, was to start flying. In 1891 he began to fly. Using wings built like those of soaring birds, such as the hawk and buzzard, he precipitated himself from steep hills, against strong winds, and glided down through the air into the valleys. In more than two thousand flights — varying from a few yards to a fifth of a mile in length — he established entirely new views concerning the support of moving bodies by the air. In August, 1896, Lilienthal's wings gave way in a sudden gust of wind. He fell fifty feet, broke his back, and died the following day.



CHANUTE'S MULTIPLE-WING MACHINE (1896)

Percy S. Pilcher of England continued similar experiments in soaring flight. In September, 1899, his wings also broke; he dropped thirty feet through the air, and died of his injuries two days later. With the death of the two leading European experimenters, the principal burden of the discovery of mechanical flight was taken up by Americans.

In 1887–89, Professor S. P. Langley, subsequently of the Smithsonian Institution, by means of experiments with impelled metal plates, established new scientific formulae concerning the support given flying-planes by the air, and published them in 1891; in 1896 he made a small steam-aëroplane which flew three quarters of a mile down the Potomac River. In 1896 Octave Chanute of Chicago, assisted by A. M. Herring and others as active operators and designers, made and tested new and better types of glidingm-achines as the result of experiments on the shores of Lake Michigan.



THE FIRST OF THE GLIDING-MACHINES

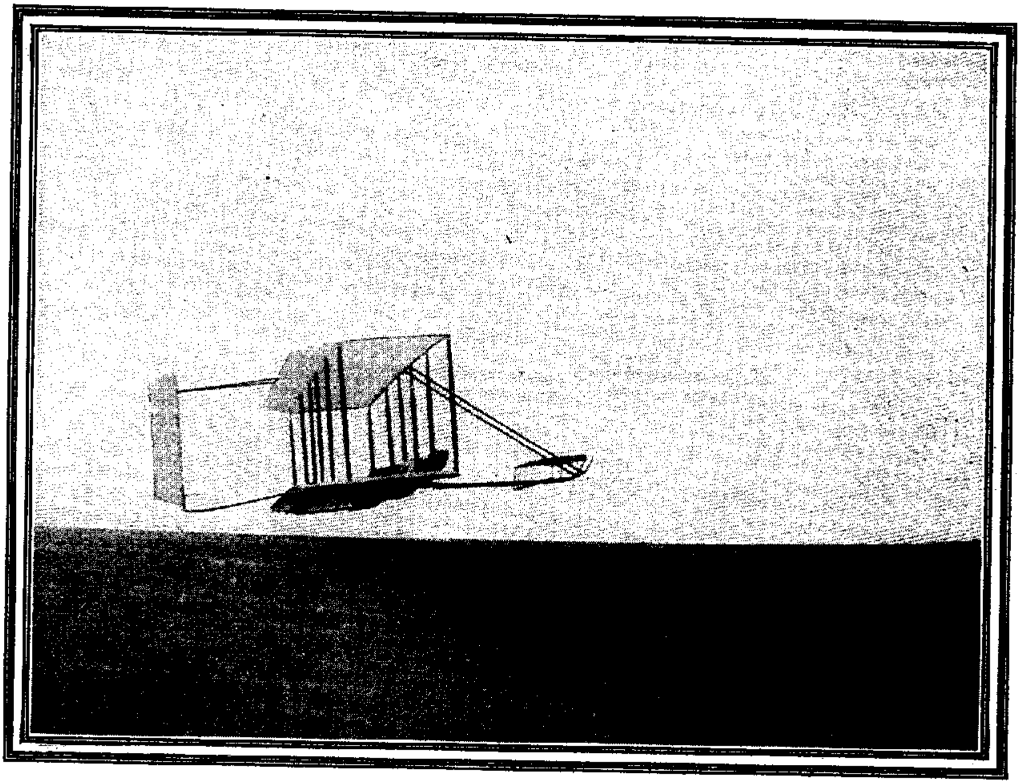
LILIENTHAL OPERATING HIS BIRDLIKE AËROPLANE

In 1900 the Wright brothers, two young bicycle-makers of Dayton, Ohio, started experiments in air-gliding in a machine operated on a new principle. In 1903 they added a gasoline-engine to their aëroplane, and began to navigate the air in mechanical flying-machines. It is a well-established fact that they have been flying on mechanically driven aëroplanes for the past four years. Exactly how they do this is not known; they are keeping their method secret, in the belief that this is the only way in which they can secure a financial return from their invention.

The Wright Brothers and their Story

Before the Wright brothers sailed abroad last summer, for the demonstrations of their machines before foreign war departments, they discussed with me for an entire morning their invention, the theories and sensations of flight, and their personal beliefs and ambitions in connection with their discovery — two lean, quiet men in a dingy, commonplace little brick bicycle-shop; pleasant, unassuming, most approachable, but shy and silent under the oppression of the greatest secret of the time. Orville, of the more social and conversational temperament, did the greater share of the talking — an amiable, kindly-faced man of thirty-five. Wilbur — prematurely bald, about forty, with the watchful eyes, marked facial lines, and dry, brief speech of a naturally reticent man — corroborated or amplified his brother's statements. It would be both unnecessary and impossible to divide the story of their invention between the two men exactly as they told it. Practically their story, like their invention, was the product of one mind — one dual mind. I will tell it as a simple statement of fact, without attempting to reproduce the exact conversation. It is the extraordinary information, and not the method of statement, which is of importance. The story follows:

In 1896 we saw a little press despatch in a newspaper telling of the death of Lilienthal by a fall from his machine. This, and the reading of the "Aëronautical Annual" for 1897, started our first active interest in the problem of aërial navigation. We have been at work at it ever since — first as a mere scientific pastime, but for nearly ten years as the most serious purpose of our



THE WRIGHT BROTHERS' LATEST GLIDER

THE HORIZONTAL POSITION OF THE OPERATOR, THE BALANCING RUDDER IN FRONT, AND THE SLIGHT CURVES OF THE DOUBLE WING SURFACES SHOWN IN THIS PHOTOGRAPH, REPRESENT THREE OF THE WRIGHT BROTHERS' CHIEF CONTRIBUTIONS TO THE ART OF FLYING

life. Up to 1900 we had merely studied and made laboratory experiments; in that year we started actual experiments in flying on our gliding-machine.

At that time (1900) there was really only one problem remaining to be solved to make a workable flying-machine — the problem of equilibrium. Men already knew how to make aëroplanes that would support them when driven through the air at a sufficient speed, and there were engines light enough per horse-power to propel the aëroplane at the necessary speed, and to carry their own weight and the weight of an operator. There were plenty of aëroplanes that would fly in still air. What was needed was an air-ship that would not capsize when the wind was blowing.

The Turbulence of the Air

No one who has not navigated the air can appreciate the real difficulty of mechanical flight. To the ordinary person it seems a miracle that a thin solid plane can be driven up into the air by machinery; but for over ten years that miracle has been accomplished. On the other hand, the great problem — the problem of equilibrium — never occurs to any one who has not actually tried flying. The real question of the flying-machine is how to keep it from turning over.

The chief trouble is the turmoil of the air. The common impression is that the atmosphere runs in comparatively regular currents which we call winds. No one who has not been thrown about on a gliding-aëroplane — rising or falling ten, twenty, or even thirty feet in a few seconds — can understand how utterly wrong this idea is. The air along the surface of the earth, as a matter of fact, is continually churning. It is thrown upward from every irregularity, like sea breakers on a coast-line; every hill and tree and building sends up a wave or slanting current. And it moves; not directly back and forth upon its coast-line, like the sea, but in whirling rotary masses. Some of these rise up hundreds of yards. In a fairly strong wind the air near the earth is more disturbed than the whirlpools of Niagara.

Equilibrium—the Real Problem of Flying

The problem of mechanical flight is how to balance in this moving fluid which supports the flying-machine; or, technically speaking, how to make the center of gravity coincide with the center of air-pressure. Now, the irregular action of the air is naturally reflected in the movement of this center of pressure. If a wind should blow against a plane at right angles to it, the center of pressure would be in the center of the plane. But an aëroplane must be sailed at a very slight angle to the direction in which it is moving. That means that the center of air-pressure is well forward on the surfaces of the machine. Every sudden breeze that blows strikes strongly on the front of the plane and very little on the back of it. The result is that the force of every gust of wind is multiplied by leverage in its tendency to tip the plane over. The wind often veers several times a second, quicker than thought, and the center of pressure changes with it. It is as difficult to follow this center of pressure as to keep your finger on the flickering blot of light from a prism swinging in the sun.

ORVILLE WRIGHT

Lilienthal balanced himself in his gliding-machine by shifting his weight; his body hung down below his wings, resting on his elbows. In Chanute's machines the operator did nearly the same, swinging below the wings, with his arm-pits supported on little parallel bars.* In both machines the rapid motion of the body was difficult and exhausting work, and the size of the machine was definitely limited by the weight which the operator could carry on his back. In our gliding-machine we introduced an entirely new method; we governed the motion of the center of pressure, not by shifting our weight, but by shifting the rudder and surfaces of the machine against the action of the air. Before this can be understood there must be some idea of the wings of our machine.

The Development of Artificial Wings

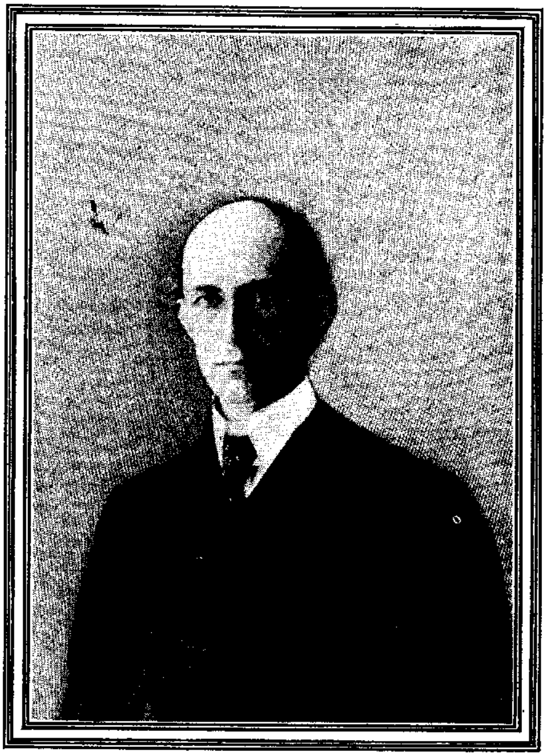
Lilienthal, in his first flights, copied the wings of soaring birds very closely; later he used wings in two planes, that is, one above another. Chanute experimented with wings of as many as five planes, but, like Lilienthal, secured the best results with the "double-deckers." When we took up our gliding experiments, we believed that these wings in two planes had been shown to be the best type for the aëroplane; they were stronger than any other, allowing the principle of the truss-bridge to be used in their bracing, and they were more compact and manageable than the single-surface wings.

By 1900 we had designed our type of gliding-machine. It was made of cloth and spruce and steel wire, very much after the style of the Chanute double-decker—a little larger than his. But in its principle of operation it was entirely different. The operator, instead of swinging below the wings, lay fore and aft across the middle of the lower wing upon his stomach. In front of him—extended out before the machine instead of behind it—was a horizontal rudder. This guided the gliding-machine up and down. But it did much more than that: it counterbalanced the movement of the center of pressure backward and forward on the main surfaces of the machine; that is, it kept the aëroplane from pitching over backward or forward. For steering and balancing sideways we turned the outside edges of the

* Chanute tested three types of his own, in two of which the wings were automatically readjusted by the wind-pressure. The multiple-wing machine was his first type.

wings against the air-pressure by cords controlled by movements of the operator's body. The tail used in previous gliding-machines was given up. Our idea was to secure a machine which, with a little practice, could be balanced and steered semi-automatically, by reflex action, just as a bicycle is. There is no time to be given to conscious thought in balancing an aëroplane; the action of the air is too rapid.

The shape of the wings offered another important problem. Langley and other experimenters had favored wings set at a dihedral angle — that is, each slanting upward from the center where they joined. They hoped to secure a stable equilibrium by this. We believed that this device would work well in still air, but that in the shifting, troubled air of out-of-doors it would add to the danger of turning over. These wings are made after the style of the wings of a soaring buzzard — a bird which avoids high winds. We curved ours down a little at the tips, after the fashion of the soaring gull — a rough-weather bird. Our wings did not approach the exact form of birds' wings so closely as Lilienthal's or Pilcher's. They were made of cloth fixed to two rectangular wooden frames, fastened one above the other by wooden braces and wires. The cloth surfaces were arched by ribs between these frames to secure the curved surfaces of birds' wings, which Lilienthal had shown were essential to the best results in flying.



WILBUR WRIGHT

Those Animated Aëroplanes, the Birds

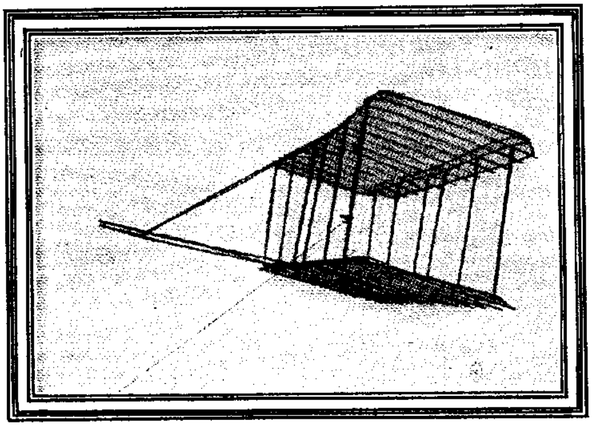
We had also worked out a new method of practice with gliding-machines which we hoped to use. Lilienthal and Chanute had obtained their experience in flying by the operator's launching himself from a hill and gliding down on to lower land. This involved carrying back their apparatus, after a short flight, to the top of the hill again. Because of the difficulties of this awkward method, although Lilienthal had made over two thousand flights, we calculated that in all his five years of experiment he could not have been actually practising flying more than five hours — far too short a time for the ordinary man to learn to ride a bicycle. It was our plan to follow the example of soaring birds, and find a place where we could be supported by strong rising winds.

A bird is really an aëroplane. The portions of its wings near the body are used as planes of support, while the more flexible parts outside, when flapped, act as propellers. Some of the soaring birds are not much more than animated sailing-machines. A buzzard can be safely kept in an open pen thirty feet across and ten feet high. He cannot fly out of it. In fact, we know from observation made by ourselves that he cannot fly for any distance up a grade of one to six. Yet these birds sailing through the air are among the commonest sights through a great section of the country. Every one who has been outdoors has seen a buzzard or a hawk soaring; every one who has been at sea has seen the gulls sailing after a steamship for hundreds of miles with scarcely a movement of the wings. All of these birds are doing the same thing — they are balancing on rising currents of air. The buzzards and hawks find the currents blowing upward off the land; the gulls that follow the steamers from New York to Florida are merely sliding downhill a thousand miles on rising currents in the wake of the steamer in the atmosphere, and on the hot air rising from her smokestacks.

A Plan which Failed

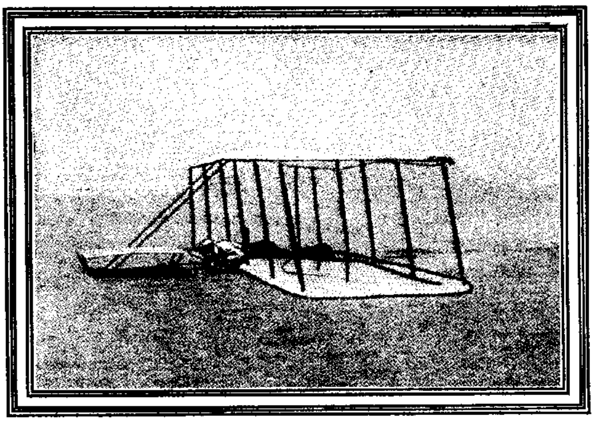
On a clear, warm day the buzzards find the high, rotary, rising currents of air, and go sailing around and around in them. On damp, windy days they hang above the edge of a steep hill on the air which comes rising up its slope. From their position in the air they can glide down at will. Now, we planned to take our gliding-machine, in 1900, to some section where there were strong, constant winds, and try soaring and gliding in the manner of these birds. We calculated, by Lilienthal's tables, that our gliding-machine, which had 165 square feet of surface, should be sustained by a wind of twenty-one miles an hour. We planned to raise the machine — operator and all — like a kite in this wind, men holding ropes at the end of each wing. When the machine had started soaring at the end of the ropes, these would be released and the operator could glide to the earth. In this way we hoped we would avoid the weary dragging back of the machine necessary in the operation of gliding downhill, and could get hours instead of seconds of practice in flying.

Winds of between sixteen and twenty-five miles an hour are not unusual at points on the Atlantic coast, and after a little study and inquiry we located the place we wanted at Kitty Hawk, North Carolina, on the sand-dunes which separate Albemarle Sound from the Atlantic Ocean. There were strong winds there, and steep hills of soft sand for use in gliding from heights, if we found that necessary. In the summer of 1900 we took our first gliding-machine there for experiment.



THE FIRST WRIGHT GLIDER (1900)

We found on this trip that our plan to practise by raising the machine like a kite was impracticable. It required a wind of nearly thirty miles an hour to support our aëroplane at an angle flat or level enough to be of any use in gliding. The surfaces of this first machine were not curved deeply enough, in the first place, but we found also that the tables of the earlier experimenters concerning the lifting power of the wind were not accurate. So we had to give up our plan of soaring, and start gliding from hills, as the others had done. Instead of hours of gliding, as we had hoped, we had only two minutes of actual sailing in the air that year. Nevertheless we came to some very clear and satisfactory conclusions. We found that our new and revolutionary method of steering and balancing by shifting surfaces instead of by weights worked well, and that it promised to work in large as well as in small machines.



THE SECOND WRIGHT GLIDER (1901)

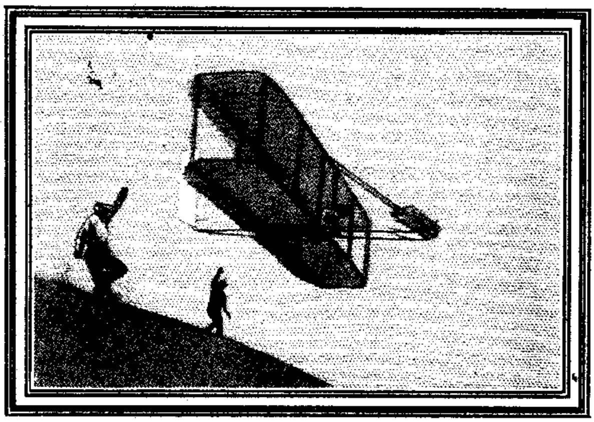
A Revolution in the Art of Flying

In 1901 we started gliding again at Kitty Hawk, on a machine nearly twice as large as had been counted safe before. This machine had a surface of 308 square feet, whereas Lilienthal's had had 151, Pilcher's 165, and Chanute's double-decker 134. Our new glider was 22 feet from tip to tip, and the main surfaces were 7 feet across and 6 feet apart. It weighed 100 pounds, 240 or 250 with its operator. This machine, like the first one, had no tail. Its trials were so successful that the next year

(1902) we made another on advanced lines. The main surfaces of this were 32 feet from tip to tip and only 5 feet across. In addition to the devices in the former gliders, we used a vertical tail on this, as an additional method of keeping the lateral balance. We made between seven hundred and one thousand glides with this — the longest of which was 622 feet. By the actual tests of flying, we established many points definitely, and made many changes in the tables of calculation for aërial flight.

Eighteen Miles an Hour — the Rate when Flight Begins

We found that a rate of eighteen miles an hour through the air would sustain our aëroplane and its operator in flight. A rate of sixteen miles would sustain it, but at too great an angle to allow progress through the air. A wind of eighteen miles an hour is a good strong breeze, but it is not extraordinary. Half our glides in 1902 were made in winds of twenty miles an hour, and at one time we were gliding in a wind which measured thirty-seven miles an hour. You understand, of course, that these gliding experiments do not mean the mere sliding down an inclined plane in the air. In heavy winds the aviator is sometimes lifted above the point he starts from and often held soaring in one place. If he had the balancing skill of a soaring bird, he could remain there as long as there was enough wind to support him. Indeed, in our experiments we have remained motionless in one position for over half a minute.



THE THIRD WRIGHT GLIDER (1902-3)

December 17, 1903, the First Flying-machine Sails

In these three years of gliding we established enough practical knowledge, we thought, to go on to the next experiment of placing a gas-engine upon our aëroplane and starting work on the real object of our research — mechanical flight. In the next year we experimented in our workshop with models and machinery for this. On December 17, 1903, our first mechanical flier, in a trial at Kitty Hawk, made four flights, in the longest of which it sustained itself in the air fifty-nine seconds, and moved 852 feet against a twenty-mile wind; that is, it actually moved half a mile through the air. After this first experiment we felt assured that mechanical flight was feasible.

This first flying-machine, with its operator, weighed about 745 pounds. It was run by a gas-engine which weighed 240 pounds complete with fuel and water, and developed 12 or 13 horse-power. The next year another flier was made, weighing, with ballast, 925 pounds, with an engine giving 16 horse-power, but weighing the same as that of the first flier — 240 pounds. With this machine we made the successful experiments in flying of 1904 and 1905, over 150 in number, averaging a mile apiece.

The Trouble Turning Corners

The problem of the real power-driven flying-machine was exactly what we knew it must be — the question of equilibrium. It was no longer necessary for us to have the peculiar conditions furnished by the wind and hills at Kitty Hawk to make our experiments with the mechanical machine. We secured the use of a swampy meadow eight miles east of Dayton, Ohio. On our tests there it became clear that the flying-machine would operate well in a straight line; the difficulty came immediately upon turning corners, as it was necessary to do in the small field. Just what the trouble was we could not tell. Several turns might be made safely; then, all at once, the machine would begin to lose its balance, and must be stopped and brought down to the ground. We kept experimenting to discover the cause of the trouble and the way of dealing with it, and in the latter part of the year 1904 we made some progress. We accomplished a complete circle on September 20, and two flights of three miles each around the course in November and December.

A Practical Working Air-ship

In 1905 we kept making changes in the machine, but made few flights until fall. Finally, about the middle of September, we discovered the way to control the flier in turning corners. The machine was now under practical control. Six flights from September 26 to October 5 averaged over fifteen miles each; on October 5 we obtained a flight of twenty-four miles in thirty-eight minutes, that is, at the rate of thirty-eight miles an hour. As this was on a curved course, the speed would have been over forty miles an hour straight away.

Up to this time we had been able to work and to escape much notice. The local papers were good enough not to print descriptions of our work. There was, in fact, very little understanding locally of what we were trying to do. There was general knowledge that dirigible balloons — like those of Santos-Dumont — were being operated in France, and the local people did not seem to grasp the difference between his experiments and ours. After we had made these long flights we began to attract attention, and we were compelled to give up experimenting in order to keep secret our method of management. We took our machine to pieces and started to plan the 1907 flier. We knew that we had at last secured a practical working aëroplane. Our experiments had been witnessed by a considerable number of reliable men, who constituted a sufficient guaranty that we had made the long flights we claimed, though they did not have technical knowledge enough of mechanics to understand how we made them.

For Sale — An Aërial War-ship

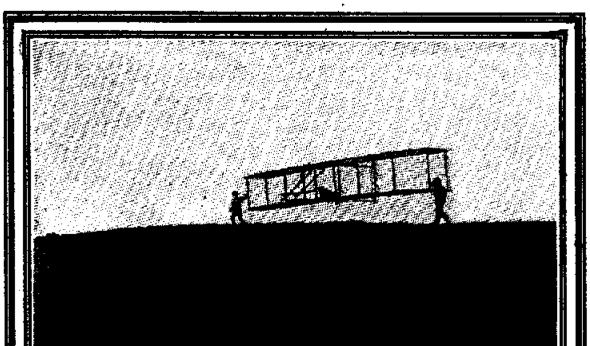
We feel that it is absolutely essential for us to keep our method of control a secret. We could patent many points in the machine, and it is possible that we could make a success of the invention commercially. We have been approached by many promoters on the matter. But we believe that our best market is to sell the machine to some government for use in war. To do this, it is necessary for us to keep its construction an absolute secret. We do not believe that this secret can be kept indefinitely by a government, but we believe that the government which has the secret can hold the lead in the use of the invention for years. It will be able constantly to keep ahead of other nations by developing the special knowledge in its possession.

So far as we can learn, we are able now to give a government a five years' lead in the development of the flying-machine. The recent trials of Santos-Dumont's aëroplane in France confirm us in this belief. Take one point only. He is trying to sustain a 500-pound machine in the air for short flights with a 50-horse-power engine — that is, sustaining ten pounds to the horse-power. We are flying and carrying, at a rate of 30 miles an hour, 925 pounds with 16 horse-power — that is, practically sixty pounds to the horse-power. The comparison speaks for itself concerning the relative efficiency of the two machines.

Like the Bicycle, but Easier

It is impossible, under these circumstances, for us to discuss the exact secrets of control and management which are our only asset in our machine. We have not even drawn working-plans of our machine, for fear they might fall into other hands. But there are general principles of operating our aëroplane of which we make no secret.

It has been a common aim of experimenters with the aëroplane to solve the problem of equilibrium by some automatic system of balancing. We believe that the control should be left in the possession of the operator. The sense of equilibrium is very delicate and certain. If you lie upon a bed three quarters of an inch out of true, you know it at once. And this sense of equilibrium is just as reliable a mile above the earth as it is on it. The management of our aëroplane, like that of the bicycle, is based upon the sense of equilibrium of the operator. The apparatus for preserving the balance of the machine consists of levers operated by simple uniform movements which readjust the flying surfaces of the machine to the air. The movement of these levers very soon becomes automatic with the aviator, as does the balancing of a bicycle-rider. In fact, the

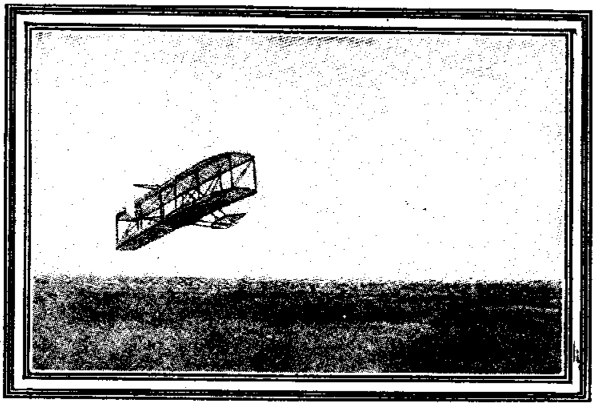


STARTING A FLIGHT

aëroplane is easier to learn and simpler to operate than the bicycle. In all our experiments with gliding- and flying-machines, we have not even sprained a limb; we have scarcely scratched our flesh.

No Danger from Stopping Engines

The only danger in our aëroplane is of turning over. We have purposely made our machine many times heavier than necessary, so that it cannot break. There is absolutely no danger — as might appear at first thought — from the stopping of the engine. The aëroplane is supported by its motion through the air, it is true; but, however high it is flying, gravity furnishes it all the potential energy it needs to get safely to the ground. When the power is shut off, it merely scales through the air to its landing. Theoretically, it is safer at a mile above the earth than at two hundred feet, because it has a wider choice of places in which to land; you can choose your landing from 256 square miles from a mile above the surface if descending one in sixteen. As a matter of fact, we always shut off the power when we start to alight, and come down by the force of gravity. We reach the ground at so slight an angle and so lightly that it is impossible for the operator to tell by his own sensation within several yards of where the ground was first actually touched.



THE GLIDER TURNING IN THE AIR

The Uses of the Aëroplane

We know that we have made the aëroplane a practical machine, but we are not over-sanguine about its revolutionizing the transportation of the future. It will scarcely displace the railroad or the steamboat; necessarily, its expenditure of fuel will be too great. In a steamship, it is calculated that the heat from the burning of a sheet of letter-paper will carry a ton a mile; you could scarcely expect such results in an air-ship. The air-ship, so far as we can see at present, will have its chief value for warfare, and for reaching inaccessible places — for such uses as expeditions into the Klondike, or to Pekin during its siege a few years ago. The value of an air-ship moving faster than a railroad train for reconnoitering or dropping explosives upon an enemy in time of war is now obvious to the entire civilized world. The aëroplane may also be of great value in the near future for service like the carrying of mail. When properly developed, it will be quicker than any means of locomotion now in use for direct journeys between two places — unless against hurricanes. There will be no switches, no stops whatever; and the journey can be made in an air-line.

Speed Sixty to One Hundred Miles an Hour

The eventual speed of the aëroplane will be easily sixty miles an hour. It will probably be forced up to a hundred miles. Our last machine showed forty miles, and the one we are building now will go considerably faster. At speeds above sixty miles an hour the resistance of the air to the machine will make travel much more expensive of power. Our experiments have shown that a flier designed to carry an aggregate of 745 pounds at 20 miles an hour would require only 8 horse-power, and at 30 miles an hour 12 horse-power. At 60 miles 24 would be needed, and at 120 miles 60 or 75 horse-power. It is clear that there is a certain point of speed beyond which the air resistance makes it impossible to go. Just what that is experiment will determine. Every year gas-engines are being made lighter — a fact which will increase the surplus carrying power of the machine available for fuel and operator and heavier construction; but at present sixty miles an hour can be counted on for the flying-machine. This, of course, means speed through the air.

Fuel for a Thousand Miles

The aëroplane running sixty miles an hour will have surplus lifting power enough to carry fuel for long journeys. Our 1907 machine will carry gasoline enough to fly 500 miles at a rate of some 50 miles an hour. We can, and possibly soon will, make a one-man machine carrying gasoline enough to go 1,000 miles at 40 miles an hour. Moreover, any machine made to move at speeds up to 60 miles an hour can be operated economically, at a cost of not much more than one cent a mile for gasoline.

The aëroplane, while developed originally from the study of the flight of birds, will have a considerably different mechanism for flying. Probably the chief departure comes from the use of the screw-propeller to secure motion. The bird moves forward by sculling with the outer portion of its wings. In some ways this is a more effective mechanism than the screw-propeller, because at each motion the bird secures a grip on new air, while the propeller keeps operating on the stream of air it sets in motion behind it. At the same time, the propeller can go so much faster than any other method of propulsion that it is undoubtedly the device which must be used to propel air-ships.

Better Wings than a Bird's

There is no question but that a man can make a lighter and more efficient wing than a bird's. A cloth surface, for instance, can be produced, offering less surface friction than feathers. The reason for this fact is that a bird's wing is really a compromise. It is not made for flying only — it must be folded up and gotten out of the way when the bird is on its feet; and efficiency in flying must be sacrificed to permit this. The wings of aëroplanes will vary in size according to speed. A slow machine will require a large wing; but the faster the speed, the less will be the supporting surface necessary, and wings for high speeds will naturally be very small. Not only will less support be needed, but the size must be reduced to reduce the friction of the air.

One difficulty with these fast machines will be in launching them at a high enough speed for their wings to support them. There may also be some difficulty in landing. We have launched our machines from an arrangement of wheels, and have landed upon stout skids fastened to the bottom of the machine. The aëroplane will make its journeys, we believe, 200 or 300 feet above the earth — just high enough to escape the effects of the disturbance of the air along the ground — just out of the surf, so to speak. Our experiments have been at a considerably lower level — at some 80 feet or less.

Our idea in our experiments has been to produce a strong, practical motor flying-machine. We have made no great effort to secure extraordinary machinery to furnish power. We found the gas-motor already developed to a point where it was practically available for our purposes. We have applied ourselves to the invention of an aëroplane which would balance safely, could be easily steered, and would move with a moderate expenditure of power. In doing this we have devoted our chief attention to the scientific construction of wings and screws and steering apparatus.

Scientists, not Mechanics

Our hope is, first, to get some adequate financial return from our invention. We are not rich men, and we have devoted our time and what money we could command to the problem for nearly ten years. We do not expect a tremendous fortune from our discovery, but we do feel we should have something that would be an ample competence for men with our comparatively simple tastes. If we do secure this, we are anxious — whenever it becomes possible — to give the world the benefit of the scientific knowledge obtained by our experiments.

We object to the manner in which we have so far been put before the public. Nearly every writer upon our work in current publications has characterized us as mechanics, and taken it for granted — because of the fact that we are in the bicycle business, no doubt — that our invention has come from mechanical skill. We object to this as neither true nor fair. We are not mechanics; we are scientists.

We have approached the subject of aërial navigation in a purely scientific spirit. We are not highly educated men, it is true, but the subject of aërial navigation is not so much a problem of higher mathematics as of general principles; it can be approached by any one possessing a high-school education — which we have had. We have taken up the principles involved in flying, one after another — not only by practical flights, but in constant laboratory experiments in our workshops. We have worked out new tables of the sustaining power of the air.

Discovered Principles of Screw-propeller

Besides inventing a practical flying-machine, we claim to have discovered for the first time the method of calculating in advance the exact efficiency of screw-propellers, which will save the great waste involved in the present practice, by which screws must be made and tested before their efficiency can be accurately learned. This method of ours has been tested in the manufacture of our aëroplanes; our screws were made with only a slight margin of power over what was demanded by our flier, and they have invariably proved successful.

We say frankly that we hope to obtain an ample financial return from our invention; but we care especially for some recognition as scientists, and, whenever it becomes possible, we propose to bring out the results of our investigations in a scientific work upon the principles of aërial navigation.