CLASSICS OF SCIENCE: The First Flight

Aviation

This is the inventor's account of the first successful flight of a power-driven plane.

HOW WE MADE THE FIRST FLIGHT, by Orville Wright, published in "Flying," December, 1913.

The Motor

The flights of the 1902 glider had demonstrated the efficiency of our system of maintaining equilibrium, and also the accuracy of the laboratory work upon which the design of the glider was based. We then felt that we were prepared to calculate in advance the performance of machines with a degree of accuracy that had never been possible with the data and tables possessed by our predecessors. Before leaving camp in 1902 we were already at work on the general design of a new machine which we proposed to propel with a motor. . . .

Finally we decided to undertake the building of the motor ourselves. We estimated that we could make one of four cylinders with 4-inch bore and 4-inch stroke, weighing not over two hundred pounds, including all accessories. . . . In just six weeks from the time the design was started, we had the motor on the block testing its power.

. . . In these short tests the motor developed about nine horsepower. We were then satisfied that, with proper lubrication, and better adjustments, a little more power could be expected. The completion of the motor according to drawing was, therefore, proceeded with at once.

Weight and Thrust

While Mr. Taylor was engaged with this work, Wilbur and I were busy in completing the design of the machine itself. The preliminary tests of the motor having convinced us that more than 8 horsepower would be secured, we felt free to add enough weight to build a more substantial machine than we had originally contemplated.

Our tables of air pressures and our experience in flying with the 1902 glider, enabled us, we thought, to calculate exactly the thrust necessary to sustain the machine in flight. But to design a propeller that would give this thrust with the power we had at our command, was a matter we had not as yet seriously considered. No data on air propellers were available, but we had always understood that it was not a difficult matter to secure an efficiency of 50 per cent with marine propellers. All that would be necessary would be to learn the theory of the operation of marine propellers from books on marine engineering, and then substitute air pressures for water pressures. Accordingly we secured several such books from the Dayton Public Library. Much to our surprise, all the formulae on propellers contained in these books were of an empirical nature. There was no way of adapting them to calculations of aerial propellers. As we could afford neither the time nor expense of a long series of experiments to find by trial a propeller suitable for our machine, we decided to rely more on theory than was the practice with marine engineers.

It was apparent that a propeller was simply an aeroplane travelling in a spiral course. As we could calculate the effect of an aeroplane travelling in a straight course, why should we not be able to calculate the effect of one travelling in a spiral course? At first glance this does not appear difficult, but on further consideration it is hard to find even a point from which to make a start; for nothing about a propeller, or the medium in which it acts, stands still for a moment. The thrust depends upon the speed and the angle at which the blade strikes the air; the angle at which the blade strikes the air depends upon the speed at which the propeller is turning, the speed the machine is travelling forward, and the speed at which the air is slipping backward; the slip of the air backwards depends upon the thrust exerted by the propeller, and the amount of air acted upon. When any one of these changes, it changes all the rest, as they are all interdependent upon one another. But these are only a few of the many factors that must be considered and determined in calculating and designing propellers. Our minds became so obsessed with it that we could do little other work. We engaged in innumerable discussions, and often after an hour of so of heated argument, we would discover that we were as far from agreement as when we started, but that both had changed to the other's original position in the discussion. After a couple of months of this study and discussion, we were able to follow the various reactions in their intricate relations long enough to begin to understand them. We realized that the thrust generated by a propeller when standing stationary was no indication of the thrust when in motion. The only way to really test the efficiency of a propeller would be to actually try it on the machine. . . .

The Power Plant

When the motor was completed and tested, we found that it would develop 16 horsepower for a few seconds, but that the power rapidly dropped till, at the end of a minute, it was only 12 horsepower. Ignorant of what a motor of this size ought to develop, we were greatly pleased with its performance. More experience showed us that we did not get one-half of the power we should have had.

With 12 horsepower at our command, we considered that we could permit the weight of the machine with operator to rise to 750 or 800 pounds, and still have as much surplus power as we had originally allowed for in the first estimate of 550 pounds. . . .

We left Dayton September 23 and arrived at our camp at Kill Devil Hill on Friday, the 25th. We found there provisions and tools which had been shipped by freight, several weeks in advance. The building, erected in 1901 and enlarged in 1902, was found to have been blown by a storm from its foundation posts a few months previously. While we were awaiting the arrival of the shipment of machinery and parts from Dayton, we were busy putting the old building in repair, and erecting a new building to serve as a workshop for assembling and housing the new machine.

Just as the building was being completed, the parts and material for the machines arrived simultaneously with one of the worst storms that had visited Kitty Hawk for years. . . .

The next three weeks were spent in setting the motor-machine together. On days with more favorable winds we gained additional experience in handling a flyer by gliding with the 1902 machine, which we had found in pretty fair condition in the old building, where we had left it the year before.

Mr. Chanute and Dr. Spratt, who had been guests in our camp in 1901 and 1902, spent some time with us, but neither one (*Turn to next page*)

The First Flight—*Continued*

was able to remain to see the test of the motor-machine, on account of the delays caused by trouble which developed in the propeller shafts. . . .

Just as the machine was ready for test, bad weather set in. It had been disagreeably cold for several weeks, so cold that we could scarcely work on the machine some days. But now we began to have rain and snow, and a wind of 25 to 30 miles blew for several days from the north. While we were being delayed by the weather we arranged a mechanism to measure automatically the duration of a flight from the time the machine started to move forward to the time it stopped, the distance travelled through the air in that time, and the number of revolutions made by the motor and propeller. A stop watch took the time; an anemometer measured the air travelled through; and a counter anemometer and revolution counter were all automatically started and stopped simultaneously. From data thus obtained we expected to prove or disprove the accuracy of our propeller calculations.

Propeller Shaft Trouble

On November 28, while giving the motor a run indoors, we thought we again saw something wrong with one of the propeller shafts. On stopping the motor we discovered that one of the tubular shafts had **cracked!**

Immediate preparation was made for returning to Dayton to build another set of shafts. We decided to abandon the use of tubes, as they did not afford enough spring to take up the shocks of premature or missed explosions of the motor. Solid tool-steel shafts of smaller diameter than the tubes previously used were decided upon. These would allow a certain amount of spring. The tubular shafts were many times stronger than would have been necessary to transmit the power of our motor if **the strains upon them had been uni**form. But the large hollow shafts had no spring in them to absorb the unequal strains.

Wilbur remained in camp while I went to get the new shafts. I did not get back to camp again till Friday, the 11th of December. Saturday afternoon the machine was again ready for trial, but the wind was so light, a start could not have been made from level ground with the run of only sixty feet permitted by our mono-rail track Nor was there enough time before day to take the machine to one of the hills, where, by placing the track on a steep incline, sufficient speed could be secured for starting in calm air.

Monday, December 14th, was a beautiful day, but there was not enough wind to enable a start to be made from the level ground about camp. We therefore decided to attempt a flght from the side of the big Kill Devil Hill. . . . We laid the track 150 feet up the side of the hill on a 9-degree slope. With the slope of the track, the thrust of the propellers and the machine starting directly into the wind, we did not anticipate any trouble in getting up flying speed on the 60-foot mono-rail track. But we did not feel certain the operator could keep the machine balanced on the track.

The First Attempt

When the machine had been fastened with a wire to the track, so that it could not start until released by the operator, and the motor had been run to make sure that it was in condition, we tossed up a coin to decide who should have the first trial. Wilbut won. I took a position at one of the wings, intending to help balance the machine as it ran down the track. But when the restraining wire was slipped, the machine started off so quickly I could stay with it only a few feet. After a 35- to 40-foot run, it lifted from the rail. But it was allowed to turn up too much. It climbed a few feet, stalled, and then settled to the ground near the foot of the hill, 105 feet below. My stop watch showed that it had been in the air just 3½ seconds. In landing the left wing touched first. The machine swung around, dug the skids into the sand and broke one of them. Several other parts were also broken, but the damage to the machine was not serious. While the test had shown nothing as to whether the power of the motor was sufficient to keep the machine up, since the landing was made many feet below the starting point, the experiment had demonstrated that the method adopted for launching the machine was a safe and practical one. On the whole, we were much pleased. . . .

During the night of December 16th, 1903, a strong cold wind blew from the north. When we arose on the morning of the 17th, the puddles of water, which had been standing about the camp since the recent rains, were covered with ice. The wind had a velocity of 10 to 12 metres per second (22 to 27 miles an hour). We thought it would die down before long, and so remained indoors the early part of the morning. But when ten o'clock arrived, and the wind was as brisk as ever, we decided that we had better get the machine out and attempt a flight. We hung out the signal for the men of the Life Saving Station. We thought that by facing the flyer into a strong wind, there ought to be no trouble in launching it from the level ground about camp. We realized the difficulties of flying in so high a wind, but estimated that the added dangers in flight would be partly compensated for by the slower speed in landing. . . .

The frame supporting the front rudder was badly broken, but the main part of the machine was not injured at all. We estimated that the machine could be put in condition for flight again in a day or two.

While we were standing about discussing this last flight, a sudden strong gust of wind struck the machine and began to turn it over. Everybody made a rush for it. Wilbur, who was at one end, seized it in front, Mr. Daniels and I, who were behind, tried to stop it by holding to the rear uprights. All our efforts were in vain. The machine rolled over and over. Daniels, who had retained his grip, was carried along with it, and was thrown about head over heels inside of the machine. Fortunately he was not seriously injured, though badly bruised in falling about against the motor, chain guides, etc. The ribs in the surface of the machine were broken, the motor injured and the chain guides badly bent, so that all possibility of further flights with it for that year were at an end.

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