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DOUBLE PULITZER PRIZE WINNER

DAVID McCULLOUGH

THE WRIGHT BROTHERS

The Dramatic Story behind the Legend

CHAPTER TWO

The Dream Takes Hold

I wish to avail myself of all that is already known. . . . WILBUR WRIGHT, IN A LETTER TO THE SMITHSONIAN INSTITUTION, 1899 I. As Katharine Wright said of her father, the habit of worry was strong in him. For as long as she and her brothers could remember, he had warned of the dire threat of contaminated water, and articles in the papers confirmed time after time that every case of typhoid fever was an instance of water poisoning. In the late summer of 1896, twenty-five-year-old Orville was struck by the dreaded typhoid. For days he lay in a delirium, close to death, his fever at 105 degrees. The family doctor, Levi Spitler, who had nursed Susan Wright through her final illness, said little could be done. Wilbur and Katharine took turns keeping watch at the bedside. Bishop Wright, then on the road, wrote at once on hearing the news, dreadfully worried about Orville, but also Katharine and Wilbur. "Put him in the best room for air and comfort. Sponge him off gently and quickly. . . . Let no one use the well water at the store henceforth. Boil the water you all drink." It was a month before Orville could sit up in bed, another two weeks before he could get out of bed, and during this time Wilbur had begun reading about the German glider enthusiast Otto Lilienthal who had recently been killed in an accident. Much that he read he read aloud to Orville. A manufacturer of small steam engines and a mining engineer by training, Lilienthal had started gliding as early as 1869, and from the start he had been joined in his aviation experiments by a younger brother, which could only have given Wilbur and Orville a feeling of something in common. He took his lessons from the birds, Lilienthal said, and he saw, as many "prominent investigators" had not, that the secret of "the art of flight" was to be

found in the arched or vaulted wings of birds, by which they could ride the wind. He had no use for gas balloons as a means of flight, as they had nothing in common with the birds. “What we are seeking is the means of free motion in the air, in any direction.” And only by flying oneself could one achieve “proper insight” into all that was involved. To do this, one had to be on “intimate” terms with the wind. Over the years Lilienthal had designed and built more than a dozen different gliders, his normal segel apparat (sailing machines). One he particularly favored had wings shaped like the “fly-fans” to be seen at the tables of restaurants and men’s clubs of the day, and a big vertical rudder shaped like a palm leaf. All but a few of these different models were monoplanes, the wings arched like a bird’s and made of white muslin tightly stretched over a frame of willow. As pilot, he would hang by his arms below the wings. The setting for Lilienthal’s flights, Wilbur learned, was a range of barren hills known as the Rhinow Mountains, a two-hour train ride north of Berlin. A squarely built figure with red hair and a beard who dressed for his flights in knickers with heavily padded knees, Lilienthal would position himself on a steep slope, the wings held above his head. As one American eyewitness described the scene, he “stood like an athlete waiting for the starting pistol.” Then he would run down the slope and into the wind. Hanging on as the wind lifted him from the ground, he would swing his body and legs this way or that—as his means of balancing and steering—glide as far as possible and land on his feet. Lilienthal also had himself repeatedly photographed in action, something no gliding enthusiast had yet done. With advances in the technology of photography, the dry-plate camera had come into use. Reproduction of photographic half-tones had also been achieved, and thus unprecedented photographs of the daring “Flying Man” and his gliders appeared the world over. In the United States, his fame was greater than anywhere. A long article in the

popular McClure's Magazine, illustrated with seven photographs of Lilienthal in flight, reached the largest audience of all. In 1894 Lilienthal had crashed and lived to tell the tale. On August 9, 1896, flying a favorite "No. 11" glider, he crashed again, falling from an altitude of fifty feet. He died of a broken spine in a Berlin hospital the following day at age forty-eight. "It must not remain our desire only to acquire the art of the bird," Lilienthal had written. "It is our duty not to rest until we have attained a perfect scientific conception of the problem of flight." News of Lilienthal's death, Wilbur later wrote, aroused in him as nothing had an interest that had remained passive from childhood. His reading on the flight of birds became intense. On the shelves of the family library was an English translation of a famous illustrated volume, Animal Mechanism, written by a French physician, Etienne-Jules Marey, more than thirty years before. Birds were also an interest of Bishop Wright, hence the book's presence in the house, and Wilbur had already read it. Now he read it anew. "Aerial locomotion has always excited the strongest curiosity among mankind," the author said by way of introduction. How frequently has the question been raised, whether man must always continue to envy the bird and the insect their wings; whether he, too, may not one day travel through the air, as he now sails across the ocean. Authorities in science have declared at different periods, as the result of lengthy calculations, that this is a chimerical dream, but how many intentions have we seen realized which have been pronounced impossible. Marey's serious, largely technical study led Wilbur to read more of the kind, including such treatises as J. Bell Pettigrew's Animal Locomotion; or Walking, Swimming, and Flying, with a Dissertation on Aeronautics. For most readers the title alone would have been too daunting. For Wilbur the book was exactly what was needed. Those authors who regard artificial flight as impracticable [wrote Pettigrew] sagely remark that the land supports the quadruped

and the water the fish. This is quite true, but it is equally true that the air supports the bird, and that the evolutions of the bird on the wing are quite as safe and infinitely more rapid and beautiful than the movements of either the quadruped on the land or the fish in the water. But, the book stressed, “the way of ‘an eagle in the air’ must of necessity remain a mystery,” until the structure and uses of wings were understood. Of all animal movements, flight is indisputably the finest. . . . The fact that a creature as heavy, bulk for bulk, as many solid substances, can by the unaided movements of its wings urge itself through the air with a speed little short of a cannonball, fills the mind with wonder. Wilbur was to draw upon and quote Pettigrew for years. Like the inspiring lectures of a great professor, the book had opened his eyes and started him thinking in ways he never had. Once fully recovered from his illness, Orville proceeded with the same reading list. They “read up on aeronautics as a physician would read his books,” Bishop Wright would attest proudly. Work at the bicycle shop went on with business better than ever. In 1897 the brothers moved the enterprise to a still larger and final location at 1127 West Third, which, like their previous business locations was only a few blocks from home. The building was a two-story, red-brick duplex, with the adjoining half occupied by Fetters & Shank, Undertakers and Embalmers. After considerable remodeling, the Wright Cycle Company had a front showroom, backed by a small office, and a machine shop to the rear with ample space for a drill press, metal lathe, and band saw, all powered by a gas engine, with room, too, for a workbench. Upstairs there was still more workspace. Less than a year later, in the spring of 1898, Dayton suffered the worst flood in forty years. On the north side of town, two thousand people had to abandon their homes. For days it looked as if the West End, too, would be inundated. “We had a very narrow escape,” Orville reported to his father. “By putting 500 men at

work with teams they succeeded in building the levee high enough to keep the water out." Had the river risen another four inches, both 7 Hawthorn and the new shop would have been under three or four feet of water. Years later, a hardware dealer in the neighborhood, Frank Hamberger, recalled how, at the time of the flood, he had been struggling to get started in his new business. Much of his stock consisted of nails stored in great quantity in the cellar and would have been ruined had the high water struck. When the Wright brothers heard of his troubles, he said, they came immediately, "pulled off their coats," and helped carry the kegs of nails out of the cellar, "without seeking or accepting remuneration." Meantime, the automobile had made its appearance in the streets of Dayton in the form of a noisy homemade machine built by a friend of the Wrights named Cord Ruse, who occasionally helped out at the shop and with whom they enjoyed talking about all manner of mechanical problems and solutions. Orville was particularly interested in Ruse's automobile and thought perhaps he and Wilbur should build one of their own. For Wilbur the idea had no appeal. He could not imagine, he said, how any contrivance that made such a racket and had so many things constantly going wrong with it could ever have a future. His mind was elsewhere. II. On Tuesday, May 30, 1899—Decoration Day, as it was then known—the weather in Dayton was unseasonably cool, the sky overcast, the Wright house uncommonly quiet. Wilbur was home alone. The Bishop and Katharine had gone to Woodland Cemetery to plant flowers at Susan Wright's grave. Orville was off somewhere else apparently. Wilbur seated himself at Katharine's small, slant-top desk in the front parlor to write what would be one of the most important letters of his life. Indeed, given all it set in motion, it was one of the most important letters in history. Addressed to the Smithsonian Institution in Washington, it filled not quite two sheets of the Wright Cycle

Company's pale blue stationery, all set down in Wilbur's notably clear hand. "I have been interested in the problem of mechanical and human flight ever since as a boy I constructed a number of bats of various sizes after the style of Cayley's and Pénaud's machines," he began. (Sir George Cayley, a brilliant English baronet and aeronautical pioneer, had also devised a toy helicopter very like the one by Alphonse Pénaud given to the brothers by Bishop Wright.) "My observations since have only convinced me more firmly that human flight is possible and practicable. . . . I am about to begin a systematic study of the subject in preparation for practical work to which I expect to devote what time I can spare from my regular business. I wish to obtain such papers as the Smithsonian Institution has published on this subject, and if possible a list of other works in print in the English language. Lest there be any doubts about him or the seriousness of his intentions, he added: "I am an enthusiast, but not a crank in the sense that I have some pet theories as to the proper construction of a flying machine." From the list of books provided by the assistant secretary of the Smithsonian, Richard Rathbun, and with a generous supply of Smithsonian pamphlets on aviation forwarded to him, he and Orville both began studying in earnest. Especially helpful were the writings of Octave Chanute, a celebrated French- born American civil engineer, builder of bridges and railroads, who had made gliders a specialty, and Samuel Pierpont Langley, an eminent astronomer and head, or secretary, of the Smithsonian. Formerly the director of the Allegheny Observatory in Pittsburgh and a professor of astronomy and physics at the Western University of Pennsylvania, Langley was one of the most respected scientists in the nation. His efforts in recent years, backed by substantial Smithsonian funding, had resulted in a strange-looking, steam-powered, pilotless "aerodrome," as he called it, with V-shaped wings in front and back that gave it the look of a monstrous dragonfly.

Launched by catapult from the roof of a houseboat on the Potomac River in 1896, the year of Lilienthal's death, it flew more than half a mile before plunging into the water. Along with Lilienthal, Chanute, and Langley, numbers of others among the most prominent engineers, scientists, and original thinkers of the nineteenth century had been working on the problem of controlled flight, including Sir George Cayley, Sir Hiram Maxim, inventor of the machine gun, Alexander Graham Bell, and Thomas Edison. None had succeeded. Hiram Maxim had reportedly spent $100,000 of his own money on a giant, steam-powered, pilotless flying machine only to see it crash in attempting to take off. Meanwhile, the French government had spent a comparable sum on a steampowered flying machine built by a French electrical engineer, Clément Ader, and with such dismal results that the whole project was abandoned, though not before Ader gave the name avion, for airplane, to the French language. Along with the cost of experiments in flight, the risks of humiliating failure, injury, and, of course, death, there was the inevitable prospect of being mocked as a crank, a crackpot, and in many cases with good reason. For more than fifty years, or long before the Wright brothers took up their part, would-be "conquerors of the air" and their strange or childish flying machines, as described in the press, had served as a continuous source of popular comic relief. In the 1850s, one French inventor's ingenious idea had consisted of a chair, a pair of wings attached to his back, and a huge umbrella. (Whether the umbrella was for "ascensional power" or shade was never explained.) In the 1870s, one Charles Dyer of Georgia came up with a flying device in the shape of a duck. In the 1890s, a San Francisco Chronicle roundup report on the subject described "the flying-machine crank" as one who, with advancing age, gets increasingly foolish to the point of "imbecility." Among the more elaborate new ideas flooding the U.S. Patent Office for approval was a gigantic, fishlike

machine called an “aerostat,” with sheet aluminum body and fan-shaped tail. According to the Washington Post: The body is supported by a pair of wings that run its length, their inclination being controlled by a pilot wheel, so that the aerial vessel is able to rise or descend at will. It is propelled by a series of explosions in the rear, small pellets of nitroglycerine being fed automatically into a cup opening backward and discharged by electricity. “It is a fact,” the Post later categorically declared, “that man can’t fly.” Of all that was reported or said by way of ridicule nothing evoked such widespread delight, or would be so long remembered and quoted, as a comic poem titled “Darius Green and his Flying Machine.” Written by a popular New England author, J. T. Trowbridge, it had been a favorite for public readings and recitals at family gatherings the country over for more than thirty years. Darius was a slow-witted farm boy who pondered: “The birds can fly and why can’t I? Could blue-bird and phoebe, be smarter than we be?” In secret in the loft of a barn, he set to work . . . with thimble and thread And wax and hammer and buckles and screws, And all such things as geniuses use; — Two bats for patterns, curious fellows! A charcoal-pot and a pair of bellows; . . . Some wire, and several old umbrellas; A carriage-cover for tail and wings; A piece of harness; and straps and strings . . . These and a hundred other things. When Darius leaped into the air in his creation from the barn loft, it was only to crash below in a heap of “tangled strings, broken braces and broken wings, shooting stars and various things,” the moral of the story being, “Stick to your sphere.” In no way did any of this discourage or deter Wilbur and Orville Wright, any more than the fact that they had had no college education, no formal technical training, no experience working with anyone other than themselves, no friends in high places, no financial backers, no government subsidies, and little money of their own. Or the entirely real possibility that at some point, like Otto Lilienthal, they

could be killed. In an article in Cosmopolitan magazine several years before Lilienthal's death, Samuel Langley had emphasized that those willing to attempt flight ought to be granted the kind of attention and concern customarily bestowed on those who risk their lives for a useful purpose. It was a risk, however, from which both Langley and Octave Chanute had excused themselves, because of age. All the same, and importantly, the times were alive with invention, technical innovations, new ideas of every kind. George Eastman had introduced the "Kodak" box camera; Isaac Merritt Singer, the first electric sewing machine; the Otis Company had installed the world's first elevator in a New York office building; the first safety razor, the first mousetrap, the first motor cars built in America—all in the dozen years since Orville started his print shop and Wilbur emerged from his spell of self-imposed isolation. Then, too, there was the ever-present atmosphere of a city in which inventing and making things were central to the way of life. At about this time, just prior to the turn of the century, according to the U.S. Patent Office, Dayton ranked first in the country relative to population in the creation of new patents. The large factories and mills of Dayton kept growing larger, producing railroad cars, cash registers, sewing machines, and gun barrels. (The Davis Sewing Machine Company, as one example, was turning out four hundred sewing machines a day in a factory fully a mile in length.) In addition were the hundreds of small shops and workrooms making horse collars, corsets, soap, shirts, brooms, carriage wheels, rakes, saws, cardboard boxes, beer kegs, and overalls, not to say bicycles. In his letter to the Smithsonian, Wilbur had made mention of his interest in birds. To achieve human flight, he had written, was "only a question of knowledge and skill in all acrobatic feats," and birds were "the most perfectly trained gymnasts in the world . . . specially well fitted for their work." Among the material the Smithsonian provided him was an English translation of a book titled

L'Empire de l'Air, published in Paris in 1881. It had been written by a French farmer, poet, and student of flight, Louis Pierre Mouillard. Nothing Wilbur had yet read so affected him. He would long consider it "one of the most remarkable pieces of aeronautical literature" ever published. For Wilbur, flight had become a "cause," and Mouillard, one of the great "missionaries" of the cause, "like a prophet crying in the wilderness, exhorting the world to repent of its unbelief in the possibility of human flight." At the start of his Empire of the Air, Mouillard gave fair warning that one could be entirely overtaken by the thought that the problem of flight could be solved by man. "When once this idea has invaded the brain, it possesses it exclusively." That said, Mouillard moved on to the miracle of flying creatures, writing with unabashed evangelical fervor. Oh, blind humanity! Open thine eyes and thou shalt see millions of birds and myriads of insects cleaving the atmosphere. All these creatures are whirling through the air without the slightest float [support]; many of them are gliding therein, without losing height, hour after hour, on pulseless wings without fatigue; and after beholding this demonstration given by the source of all knowledge, thou wilt acknowledge that aviation is the path to be followed. . . . By merely observing with close attention how the winged tribes perform their feats, by carefully reflecting on what we have seen, and, above all, by striving correctly to understand the modus operandi of what we do see, we are sure not to wander far from the path, which leads to eventual success. It was only necessary to have "good eyes," and know how to keep in sight, with telescope or field glasses, a bird going at full speed, but still more "to know what to look at." Wilbur had taken up bird-watching on a rugged stretch along the banks of the Miami River south of town called the Pinnacles. On Sundays he would ride off on his bicycle to spend considerable time there observing as Mouillard preached. Mouillard had spent much of his life in Egypt and

Algeria, where he came to love especially the great soaring vultures of Africa. He had observed them by the thousands, yet however often he saw one fly high overhead, he could not help following it with a feeling of wonderment. He knows how to rise, how to float . . . to sail upon the wind without effort . . . he sails and spends no force . . . he uses the wind, instead of his muscles. This, Mouillard said, was the way of flight that would "lead men to navigate the immensity of space." III. For Wilbur and Orville the dream had taken hold. The works of Lilienthal and Mouillard, the brothers would attest, had "infected us with their own unquenchable enthusiasm and transformed idle curiosity into the active zeal of workers." They would design and build their own experimental glider-kite, drawing on much they had read, much they had observed about birds in flight, and, importantly, from considerable time thinking. They had made themselves familiar with the language of aeronautics, the terms used in explaining the numerous factors involved in attaining "equilibrium" or balance in flight, where balance was quite as crucial as in riding a bicycle. Lift came from air moving faster over the arched top of a wing, thereby making the pressure there less than that under the wing. Pitch was the lateral tilt of the flying machine, front and back, nose down, nose up. Roll applied to the rotation of the wing, up or down on one side or the other, like a boat rocking. Yaw applied to the direction of the flight, the turning of the plane pointing the nose left or right. Equilibrium was the all-important factor, the brothers understood. The difficulty was not to get into the air but to stay there, and they concluded that Lilienthal's fatal problem had been an insufficient means of control—"his inability to properly balance his machine in the air," as Orville wrote. Swinging one's legs or shifting the weight of one's body about in midair were hardly enough. Wilbur's observations of birds in flight had convinced him that birds used more "positive and energetic methods of regaining equilibrium"

than that of a pilot trying to shift the center of gravity with his own body. It had occurred to him that a bird adjusted the tips of its wings so as to present the tip of one wing at a raised angle, the other at a lowered angle. Thus its balance was controlled by “utilizing dynamic reactions of the air instead of shifting weight.” The chief need was skill rather than machinery. It was impossible to fly without both knowledge and skill—of this Wilbur was already certain—and skill came only from experience—experience in the air. He calculated that in the five years Lilienthal had devoted to gliders and gliding, he spent a total of only five hours in actual flight. It was hardly enough and not how he and Orville would proceed. On an evening at home, using a small cardboard box from which he had removed the ends, Wilbur put on a demonstration before Orville, Katharine, and a visiting Oberlin classmate, Harriet Silliman. He showed them how, by pressing the opposite corners of the box, top and bottom, the double wings of a biplane glider could be twisted or “warped,” to present the wing surfaces to the air at different angles or elevations, the same as the birds did. Were one wing to meet the wind at a greater angle than the other, it would give greater lift on that side and so the glider would bank and turn. With “wing warping,” or “wing twisting,” as it was sometimes referred to, Wilbur had already made an immensely important and altogether original advance toward their goal. IV. In the summer of 1899, in a room above the bicycle shop on West Third Street, the brothers began building their first aircraft, a flying kite made of split bamboo and paper with a wingspan of five feet. It was a biplane, with double wings, one over the other, the design Octave Chanute used for his gliders and that was believed to provide greater stability. The wings were joined in the fashion of a bridge truss, with vertical struts of pine and crisscrossing wires. Also included was an original system of cords whereby the operator on the ground, using

sticks held in both hands, could control the wing warping. In early August, Wilbur tested the model in an open field outside of town. Orville, for some reason, had been unable to attend. A few small boys were the only witnesses. According to Wilbur's account of the tests [Orville later wrote], the model . . . responded promptly to the warping of the surfaces . . . when he shifted the upper surface backward by the manipulation of the sticks attached to flying cords, the nose of the machine turned downward as was intended; but in diving downward it created a slack in the flying cords, so that he was not able to control further. The model made such a rapid dive to the ground that the small boys present fell on their faces to avoid being hit. Nonetheless, the brothers felt the test had plainly demonstrated the efficiency of their system of control and that the time had come to begin work on a man-carrying glider. In April of 1900 Wilbur turned thirty-three. Four months later, in August, Orville and Katharine turned twenty-nine and twenty-six. For her birthday, as Katharine was pleased to tell their father, "the boys" had given her a bust of Sir Walter Scott. With the three of them working now, Katharine had decided to hire someone to come in by the day to help around the house. Carrie Kayler was fourteen years old and so small still that to reach the gaslight in the kitchen she had to stand on a chair. Orville loved to tease her about it until she was near tears and Wilbur would say, "I guess that's about enough, Orv." "Mr. Orville would stop instantly," she would remember. "Mr. Orville always listened to Mr. Will, but never to anyone else." Carrie Kayler was to remain part of the family for nearly half a century. On May 13, 1900, Wilbur wrote a letter to Octave Chanute—his first letter to the eminent engineer—asking for advice on a location where he might conduct flying experiments, somewhere without rain or inclement weather and, Wilbur said, where sufficient winds could be counted on, winds, say, of 15 miles per hour. The only such sites he knew of, Chanute replied,

were in California and Florida, but both were “deficient in sand hills” for soft landings. Wilbur might do better along the coasts of South Carolina or Georgia. Wind was the essential, the brothers had already come to appreciate. And clearly, if ever they were to succeed with what they had set their minds to, they must learn—and learn from experience—the ways of the wind. In answer to an inquiry Wilbur sent to the United States Weather Bureau in Washington about prevailing winds around the country, they were provided extensive records of monthly wind velocities at more than a hundred Weather Bureau stations, enough for them to take particular interest in a remote spot on the Outer Banks of North Carolina called Kitty Hawk, some seven hundred miles from Dayton. Until then, the farthest the brothers had been from home was a trip to Chicago for the Columbian Exposition of 1893. And though they had “roughed it” some on a few camping trips, it had been nothing like what could be expected on the North Carolina coast. To be certain Kitty Hawk was the right choice, Wilbur wrote to the head of the Weather Bureau station there, who answered reassuringly about steady winds and sand beaches. As could be plainly seen by looking at a map, Kitty Hawk also offered all the isolation one might wish for to carry on experimental work in privacy. Still further encouragement came when, on August 18, 1900, the former postmaster at Kitty Hawk, William J. Tate, sent a letter saying: Mr. J. J. Dosher of the Weather Bureau here has asked me to answer your letter to him, relative to the fitness of Kitty Hawk as a place to practice or experiment with a flying machine, etc. In answering I would say that you would find here nearly any type of ground you could wish; you could, for instance, get a stretch of sandy land one mile by five with a bare hill in center 80 feet high, not a tree or bush anywhere to break the evenness of the wind current. This in my opinion would be a fine place; our winds are always steady, generally from 10 to 20 miles velocity per hour. You can reach

here from Elizabeth City, N.C. (35 miles from here) by boat . . . from Manteo 12 miles from here by mail boat every Mon., Wed., & Friday. We have telegraph communication & daily mails. Climate healthy, you could find good place to pitch tent & get board in private family provided there were not too many in your party; would advise you to come anytime from September 15 to October 15. Don't wait until November. The autumn generally gets a little rough by November. If you decide to try your machine here and come, I will take pleasure in doing all I can for your convenience and success and pleasure, and I assure you you will find a hospitable people when you come among us. That decided the matter. Kitty Hawk it would be. In the final weeks of August the brothers built a full-sized glider with two wings that they intended to reassemble and fly at Kitty Hawk, first as a kite, then, if all went well, fly themselves. Its wingspan was 18 feet. The total cost of all the necessary pieces and parts—ribs of ash, wires, cloth to cover the wings—was not more than $15. The only thing missing were long spruce spars for the glider, which had proven impossible to find in Dayton. But Wilbur felt confident they could be picked up on the East Coast. All was packed up in crates for shipment east, along with the necessary tools and a tent. Wilbur was to go first and get things in order. For more gear and his clothing, he borrowed Katharine's trunk and suitcase. Not forgetting the example set by Otto Lilienthal, he also brought a box camera and tripod. Katharine could hardly believe he was going where he said. "I never did hear of such an out-of-the-way place."