'An enjoyable, fast-paced tale' *The Economist*

DOUBLE PULITZER PRIZE WINNER

DAVID McCULLOUGH

THE WRIGHT BROTHERS

The Dramatic Story behind the Legend

CHAPTER FOUR

Unyielding Resolve

We had to go ahead and discover everything ourselves. ORVILLE WRIGHT I. The pall of discouragement disappeared in a matter of days, replaced with a surge of characteristic resolve. They would make a fresh start. Wilbur's gloom on the train was only momentary. As Orville said, "He was at work the following day and it seemed to me was more hopeful and determined than ever." "We knew that it would take considerable time and funds to obtain data of our own," Orville later recounted, "but there was some spirit that carried us through . . ." The "boys" were working every night on their "scientific" investigations, Katharine reported to their father. "We don't hear anything but flying machine . . . from morning till night." Not incidental to the sustaining of spirit were the glass-plate negatives of the photographs taken at Kitty Hawk, which the brothers developed in a darkroom set up in the carriage shed out back. There, Wilbur would write, he and Orville had moments of "as thrilling interest as any in the field, when the image begins to appear on the plate and it is yet an open question whether we have a picture of a flying machine, or merely a patch of open sky." At the end of August came an invitation from Octave Chanute for Wilbur to address the Western Society of Engineers in Chicago on the subject of gliding experiments. It was his first request to speak in public, and he was extremely reluctant to accept, feeling the date set, September 18, left too little time to prepare anything of substance. But Katharine "nagged" him into going. That Wilbur might prove a poor speaker seems never to have entered her thoughts. Only days later, in the first week of September, came the shocking news that President

William McKinley had been shot by an insane anarchist named Leon Czolgosz, while attending the Pan-American Exposition at Buffalo, New York. For days he was at death's door. "McKINLEY IS DYING," read the large headline across the front page of the Dayton Free Press on September 13. The following morning, he was dead, and that same day at Buffalo, young Theodore Roosevelt took the oath of office as the twenty-sixth president of the United States. William McKinley had been "Ohio's own." Born in Ohio, he had served through the Civil War in the 23rd Ohio Volunteer Regiment, married an Ohio girl, served long as an Ohio congressman and for two terms as the governor of Ohio. In Dayton, the day of his death, thousands of people filled the streets downtown. The scene was like nothing in the city's history. Fire bells tolled. The courthouse and other public buildings were quickly and heavily draped in black. The Wright brothers, it appears, kept working as hard as ever at the shop, possibly as a way of coping with the tragedy. For Wilbur there was the added pressure of preparing his lecture. The morning he boarded the train for Chicago, September 18, Dayton was still shrouded in black, as McKinley was not to be buried for another two days. Orville and Katharine having decided that Wilbur's wardrobe was insufficient for so important a public debut, he went off, as Katharine recorded, "arrayed in Orv's shirt, collars, cuffs, cuff-links, and overcoat." Never had he looked "so 'swell.'" How he felt was another matter. Octave Chanute had written to inquire whether he would mind if the meeting of the society was designated "Ladies' Night." Wilbur had replied it was not for him to decide. "I will already be as badly scared as it is possible for a man to be." Asked by Katharine and Orville whether his talk would be scientific or witty, he said, "Pathetic." Arriving in Chicago, he went directly to Chanute's three-story brownstone on Huron Street to dine with Chanute prior to the speech and was relieved to find his host as cordial as ever and the kind

of man whose top-floor, private study was so chock-full of models of flying machines and stuffed birds he could hardly get into it himself. The gathering of some fifty society members and their wives convened at the Monadnock Building at eight o'clock. In his brief introduction Chanute spoke of the advances made in aerial navigation by "two gentlemen from Dayton, Ohio" bold enough to attempt things neither he nor Otto Lilienthal had dared try. The speech Wilbur delivered—modestly titled "Some Aeronautical Experiments"—would be quoted again and again for years to come. Published first in the society's journal, it appeared in full or part in The Engineering Magazine, Scientific American, the magazine Flying, and the Annual Report of the Smithsonian Institution. In the words of a latter-day aeronautics specialist at the Library of Congress, the speech was "the Book of Genesis of the twentiethcentury Bible of Aeronautics." It was authentic Wilbur Wright, straightforward and clear. What was needed above all for success with a flying machine, he said, was the ability to ride with the wind, to balance and steer in the air. To explain how a bird could soar through the air would take much of the evening, he said. Instead he took a sheet of paper, and, holding it parallel to the floor, let it drop. It would not "settle steadily down as a staid, sensible piece of paper ought to do, but it insists on contravening every recognized rule of decorum, turning over and darting hither and thither in the most erratic manner, much after the style of an untrained horse." This was the kind of horse, he said, that men had to learn to manage in order to fly, and there were two ways: One is to get on him and learn by actual practice how each motion and trick may be best met; the other is to sit on a fence and watch the beast a while, and then retire to the house and at leisure figure out the best way of overcoming his jumps and kicks. The latter system is the safest, but the former, on the whole, turns out the larger proportion of good riders. If one were looking for perfect safety,

he said, one would do well to sit on the fence and watch the birds. “But if you really wish to learn, you must mount a machine and become acquainted with its tricks by actual trial.” He praised the work of both Lilienthal and Chanute. “Lilienthal not only thought, but acted. . . . He demonstrated the feasibility of actual practice in the air, without which success is impossible.” Noting that Lilienthal, over a period of five years, had spent no more than five hours in actual gliding, he said the wonder was not that he had done so little, but that he had accomplished so much. What if a bicycle rider tried to ride through a crowded city after only five hours’ practice, spread out in bits of ten seconds over a period of five years? He praised the biplane developed by Chanute as a “very great structural advance” and told how, with a few changes, he and Orville had built and tested their own double-deck glider in Outer Banks winds of up to 27 miles per hour. Much that followed in the published version of the speech was highly technical and included mathematical equations and diagrams of wing curvatures. (“Do not be afraid of making it too technical,” Chanute had urged.) How critical Wilbur had been about the unreliable data compiled by Lilienthal and Chanute when addressing the Chicago gathering is unknown, since no stenographic record was made of the actual speech. But in the published version he pulled back considerably out of respect for Chanute. Of Lilienthal’s tables, he went only so far to say Lilienthal might have been “somewhat in error.” If Chanute took issue with anything Wilbur said, or was in any way offended, he never let on. In a letter written after he finished proofreading the speech before publication, Chanute called it “a devilish good paper which will be extensively quoted.” That Wilbur returned to Dayton from Chicago even more grateful for Chanute’s friendship and counsel can be seen in the increased volume of their correspondence. Over the next three months, until the end of the year, Wilbur would write to Chanute more

than twelve times, or once a week on average. Some of the letters ran as long as seven to nine pages, and Chanute invariably replied without delay. Meanwhile, an article in the September issue of the popular McClure's Magazine written by Simon Newcomb, a distinguished astronomer and professor at Johns Hopkins University, dismissed the dream of flight as no more than a myth. And were such a machine devised, he asked, what useful purpose could it possibly serve? "The first successful flyer will be the handiwork of a watchmaker, and will carry nothing heavier than an insect." With their former trust in the calculations of Lilienthal and Chanute shattered, the brothers set out that autumn of 1901 to crack the code of aeronautics themselves. It was a brave decision and a crucial turning point. Of primary importance was to find a way to achieve accurate measurements of the "lift" and "drag" of a wing's surface, and the ingenuity, as well as patience, they brought to their experiments were like nothing done by anyone until then. For three months, working in one of the upstairs rooms at the bicycle shop, they concentrated nearly all of their time on these "investigations" and with stunning results. They devised and built a small-scale wind tunnel—a wooden box 6 feet long and 16 inches square, with one end open and a fan mounted at the other end, and this powered, since the shop had no electricity, by an extremely noisy gasoline engine. The box stood on four legs about waist high. Although a wind tunnel had been used by an English experimenter, Francis Herbert Wenham, as early as the 1870s, and by several others since, including Hiram Maxim, their tests were nothing like those of the brothers, who proceeded entirely on their own and in their own way. For testing apparatus inside the box, they used old hacksaw blades cut to different sizes with tin shears and hammered into a variety of shapes and thicknesses—some flat, some concave and convex, or square or oblong, and each about six inches square and one-thirty-second of an

inch thick—these strung on bicycle spoke wires. Though such apparatus did not look like much, it was to prove of immense value. For nearly two months the brothers tested some thirty-eight wing surfaces, setting the “balances” or “airfoils”—the different-shaped hacksaw blades—at angles from 0 to 45 degrees in winds up to 27 miles per hour. It was a slow, tedious process, but as Orville wrote, “those metal models told us how to build.” Octave Chanute was astonished by what Wilbur had to report. “It is perfectly marvelous to me how quickly you get results with your testing machine,” he wrote. “You are evidently better equipped to test the endless variety of curved surfaces than anybody has ever been.” When Wilbur apologized for writing to him at such length, Chanute assured him his letters were always too brief. The work was unlike anything the brothers had ever undertaken and the most demanding of their time and powers of concentration. They were often at it past midnight. As said later in the Aeronautical Journal of the Aeronautical Society of Great Britain, “Never in the history of the world had men studied the problem with such scientific skill nor with such undaunted courage.” In December came another voice of scientific authority denouncing, as Simon Newcomb had, the dream of flight as a total sham, the article appearing in the greatly respected North American Review, and written by no less than the chief engineer of the United States Navy, Rear Admiral George Melville. “A calm survey of certain natural phenomena leads the engineer to pronounce all confident prophecies for future success as wholly unwarranted, if not absurd. Where, even to this hour, are we to look for the germ of the successful flying machine? Where is the preparation today?” By late December, their experiments finished and feeling the pressure of economic necessity, the brothers turned to the production of the next season’s bicycles. As Charlie Taylor liked to stress, they had to keep the business going to pay for the experiments. Octave Chanute wrote to

say how greatly he regretted their decision. For some time Chanute had been offering to provide financial help to the brothers, which they greatly appreciated but were unwilling to accept. “Practically all the expense of our aeronautical experiments lies in the time consumed and we do not wish to increase the temptation to neglect our regular business for it,” Wilbur wrote to him. What if some rich man were to provide $10,000 a year, Chanute asked, adding that he happened to know Andrew Carnegie. “Would you like for me to write to him?” Again Wilbur tactfully declined. Besides, he added, it seemed likely Carnegie was “too hardheaded a Scotchman to become interested in such a visionary pursuit as flying.” As he and Orville had no need to say, they knew full well the importance of what they had achieved with their “laboratory work.” They had done it together on their own, paying their own way, as they did everything, and they intended to keep going on their own. Not for another several months, until the spring of 1902, were they able to begin building a new glider based on all they had learned from the wind tunnel tests, for even with the help of Charlie Taylor, production and sales of their bicycles still demanded a great part of their time and attention. Word of what they were up to seems also to have been getting around in some circles and apparently with their approval if not at their own instigation. For on January 25, 1902, a short, unsigned notice appeared in the Dayton Daily News stating for the first time in any publication that two local “aeronautical experts” had demonstrated “to an absolute certainty that many of the theories heretofore advanced in flying machine circles may be cast to the four winds. These gentlemen are Wilbur and Orville Wright, cycle dealers and makers, who have experimented with marked success in [North] Carolina and who at present bid fair to revolutionize the work of experts in making tests of aerial navigation. . . . It would be fitting that Dayton should afford experiments which may lead to a complete

solution to aerial navigation. This notice, carefully clipped from the paper by the brothers, or perhaps Katharine, would figure prominently at the beginning of a first scrapbook documenting their efforts. II. At the same time the family was facing a highly unpleasant situation involving Bishop Wright that put severe strain on them all, and Wilbur in particular. It was a burden he accepted without complaint, even as it required giving up days, eventually weeks of his time. The trouble had first taken root some fifteen years before, in the 1880s, when two contentious factions within the United Brethren Church struggled for control. The issue was mainly the church's traditional anti-Masonic stance, one side holding firm to that position, the other arguing for acceptance of Freemasonry and its secret ways as one of the realities of the times and, not incidentally, as a clear means to increase church membership and revenues. Those in favor of welcoming Masons to church membership were the socalled Liberals. Those opposed, the Radicals, were led by Milton Wright, never one afraid to speak out for what he believed, who, even then, had called on Wilbur to help write articles and editorials in response to attacks by the opposition. But the Liberals prevailed. The Bishop lost his fight. His role in the church was reduced to virtually nothing. Undaunted, he continued with his travels as an itinerant preacher and in 1889, the year of Susan Wright's death, he set about establishing a new church to be known as the Old Constitution Church. Time passed. Then, in 1901, an investigation initiated by Bishop Wright found the official in charge of publications for the Old Constitution Brethren, the Reverend Millard Keiter, had been making use of church money for his personal expenses, to the amount of nearly $7,000. In February 1902, the Bishop asked Wilbur to examine the church account books, and from his review Wilbur concluded the Reverend Keiter had indeed helped himself to church funds to pay for his own insurance premiums, personal clothing, and

part of the construction cost of his home. But when the church's board of trustees met to review the charges against Keiter, it was decided, despite the evidence, that any discrepancies had resulted from carelessness, not fraud. "My chief regret," Wilbur wrote to his father, "is that the strain and worry which you have borne for fifteen years past shows no sign of being removed. . . . It would seem however that the fight only increases in intensity." Wilbur also had no doubt that the fight must go on. The question of whether officials shall rob the church and trustees deceive the church for fear of injuring collections, must be settled now for all time. In the long run nothing can be gained financially by deceit. To cheat the people by lying reports is more dishonest than Keiter's stealing, and so far as church interests are concerned, the penalty will be greater. In mid-March, Wilbur took the train to Huntington, Indiana, for further examination of the publishing house records and returned home two days later to assure his father that Keiter's books and papers were "very crooked." With strong encouragement from Wilbur, the Bishop decided to do something on his own. He and Wilbur spent a full day preparing "an exposé of Keiter's defalcations," as the Bishop wrote in his diary, and the day after, Orville finished typewriting the final tract. Without waiting for approval from his church, the Bishop accused Keiter of criminal conduct. Keiter was brought to trial, but not convicted. Sentiment within the church began to turn against the Bishop for having overplayed his hand. Old friends, he told Katharine, spoke of him behind his back as an "egotist." Then in May, Millard Keiter filed formal charges against the Bishop, accusing him of libel. Wilbur described the situation as "absolutely inconceivable, incomprehensible, and incredible." He had not stopped examining Keiter's books and was, as he wrote, "finding new instances of his stealing every few days." Worn down and filled with worry, his father had trouble sleeping. The charges and countercharges continued

on into summer. On August 15, Wilbur issued a tract in defense of his father. When my father and myself came to examine the charges [against the Bishop] carefully, we at once saw that the whole thing was a mere sham. The charges were so trivial as to be laughable. . . . Although Mr. Keiter and his followers are on general principles opposed to investigations and trials, nevertheless they saw some advantages in instituting a pretended prosecution against Bishop Wright. . . . The institution of even a bogus case would afford opportunity for the wide circulation of reports that Bishop Wright's own character was under a cloud. That day in a letter to his father, who was back on the road again, Wilbur wrote to assure him "things are moving nicely" and not to worry. Katharine followed with another letter to tell him Wilbur and Orville were so convinced things would turn out right that they were talking of leaving for Kitty Hawk the following week and that she thought it past time they got away for a while. "Will is thin and nervous and so is Orv. They will be all right when they get down to the sand where the salt breezes blow. . . . They think that life at Kitty Hawk cures all ills." By late August, the brothers had reached the final stage in building their new glider—stitching yards of white Bride-of-the-West muslin for the wing covering —which they carried on in the backyard at 7 Hawthorn Street, and so inspiring much talk and speculation in the neighborhood. "Some say the boys just go camping and they make their own tents," said one neighbor. "Others say they are trying to fly. I don't believe they're that foolish." "Will spins the sewing machine around by the hour," wrote Katharine, "while Orv squats around marking the places to sew." On August 26 with everything needed for Machine No. 3 packed and crated for shipment, the brothers departed on their third expedition to Kitty Hawk, leaving it to Katharine and Charlie Taylor to carry on with the bicycle store. She was particularly pleased to see Wilbur off—it was the best thing in the world for him to go away,

Katharine told her father. “He was completely unnerved. When he gets a thing on his mind, he thinks of it continually.” She also wanted her father to know she was in the fight with him every bit as much as the brothers. “We’ll never stop fighting now, Pop, until we’ve shown those rascals up.” Soon she had more to contend with. Charlie Taylor, as she informed the brothers, was making her “too weary for words.” The man claimed to know everything about everything. “I despise to be at the mercy of the hired man.” Thankfully the school year had begun, her classes had resumed, and she was now making an unprecedented $25 a week. Things would indeed turn out right for the Bishop in the end. Two years later, at a church conference in Grand Rapids, Michigan, in 1904, he would be completely exonerated by a two-thirds majority. Writing to a niece a few years later, the Bishop said of Millard Keiter, “His former friends have become convinced of his unworthy character, and he has gone to Tennessee as a timberland speculator.” In all, the continuing worry and frustrations involved in defending the Bishop’s honor, the countless hours consumed, had brought the family closer together than ever, resolved to be ever wary of those of “unworthy character.” III. She would just have to get used to some of Charlie Taylor’s peculiarities, Orville told Katharine in his first letter to her since reaching Kitty Hawk, then went on to say the weather there was fine, that he and Wilbur had been assembling the machine and were nearly ready to start testing. He imagined, he said, that by the time she received the letter she would be back at school teaching again, and he asked her to send a list of her “victims.” “I like to see someone else catch it besides us.” By the second week of September word from Kitty Hawk grew more extensive, as both brothers took time to fill her in with news of the kind she most liked to hear, no more trouble from the mosquitoes and that they were sprucing up their quarters at Kill Devil Hills with such “royal luxuries” as white oilcloth on the dining table and

burlap upholstery on the dining chairs. Orville's letters, which delighted Katharine especially, refute any idea that he had no gift for writing and express how much he did not want "little sister" to feel left out. Most enjoyable to her was a rendition from Orville of an all-out pursuit of an uncommonly resourceful mouse that kept prowling about the kitchen and thereby provided the only excitement of the moment. "He met with a rather warm reception the other night when he undertook to promenade on Will's bed," Orville began, "[and] got tossed a good deal . . . in a blanket, until finally he escaped. We found him snugly wrapped up in our carpet this afternoon. We had a merry chase all about the building, inside and out. The large cracks in the floor making it easy for him to get in or out in a hurry when necessary. But as there were two of us, one with a stick and one with a gun, one above and one below the floor, his chances of escape were beginning to look rather shaky. Finally, he nestled up in a corner below the floor to take time to get a breath, when I blazed away at him with the gun. The mark of the bullet is in the corner right back of where he stood, nevertheless the little beastie turned around and calmly walked away and I in my astonishment just stood there and watched him go. The standard of living at Kitty Hawk had been greatly enhanced. Damage done to the camp by storms in their absence had required immediate attention, but they also saw to considerably more. The kitchen was "immensely improved," and they slept now in new, more comfortable beds rigged up in the rafters. They hammered up battens to seal off the cracks between the boards the whole length and width of the building. They had sunk a deeper well that produced better water. Best of all, they had devised a bicycle that ran far better over sand than they could have hoped for, so a round-trip to Kitty Hawk now took only one hour, instead of three on foot. Little if any of what the brothers did went unnoticed by the local residents, who by now, as John T. Daniels said,

had “learned to love ’em,” and in no small part because they “could do anything they put their hands to. They built their own camp; they took an old carbide can and made a stove of it; they took a bicycle and geared the thing up so that they could ride it on the sand. They did their own cooking and washing and they were good cooks too. “There are other improvements too numerous to mention, and no Huffaker and no mosquitoes,” Wilbur reported to George Spratt, who was to join them again. This time, too, Orville was keeping far better day-to-day diary records of just how hard they were working. Monday, September 8. Finally began work on machine. . . . Completed frame of upper surface [wing] ready for ribs. Tuesday, September 9. Worked 8 hours on machine. Fastened ribs to frame and put on cloth. Wednesday, September 10. Worked about 5 1 /2 hours each, tacking and sewing on cloth. . . . Surface complete except part of covering to rear spar. Thursday, September 11. Completed covering of rear spar. Erected poles for testing angles at various velocities of wind. . . . Began work on lower surface in afternoon. Spliced spars, and fastened on end bows, ready for attaching ribs. Friday, September 12. Worked eight hours each on machine. Put on ribs and cloth. Took upper surface on Big [Kill Devil] Hill a little before noon. Find that much better results are found by walking the machine. Saturday, September 13. Finished lower surface. . . . Monday, September 15. Worked 10 hours each. . . . With each wing, or “surface,” measuring 32 by 5 feet this time, and a total wingspan therefore of 320 square feet, it was by far the largest glider yet built and, as Wilbur also told George Spratt, “an immense improvement over last year’s machine.” On September 19, they took it to a small hill and began flying it first as a kite and with “very satisfactory” results. After moving to Kill Devil Hills they made nearly fifty glides in three days—including manned flights—but cautiously. Even the longest flights were not much over 200 feet. Orville, too, was

now gliding for the first time, and proudly so. Then only days later, he suddenly lost control and crashed. Luckily, he got out "without a bruise or a scratch," but it was a clear reminder of just how dangerous it all was, and how suddenly things could go wrong. My brother [wrote Wilbur to Octave Chanute], after too brief practice with the use of the front rudder, tried to add the use of the wing-twisting [wingwarping] arrangement also, with the result that, while he was correcting a slight rise in one wing, he completely forgot to attend to the front rudder, and the machine reared up and rose some twenty-five feet and sidled off and struck the ground. . . . We hope to have repairs made in a few days. Close to the end of September brother Lorin Wright walked into camp for an unexpected visit, and George Spratt appeared soon after. At the same time came a rare lull in the wind lasting several days. With all tests postponed, Lorin and Spratt went fishing, while Wilbur and Orville kept busy as usual, Wilbur also taking time to write an exuberant letter to his father to report how extremely well things were going. "We are in splendid health and having a fine time." And yes, they were being "very careful." Beyond that, he was proud to report, their new machine was a "very great improvement over anything anyone has built. . . . Everything is so much more satisfactory that we now believe that the flying problem is really nearing its solution." The letter was dated October 2. That night, as Orville later told the story, discussion in camp on aeronautical theory went on at such length that he indulged himself in more coffee than usual. Unable to sleep, he lay awake thinking about ways to achieve an even better system of control when suddenly he had an idea: the rear rudder, instead of being in a fixed position, should be hinged—movable. In the morning at breakfast, he proposed the change, but not before giving Lorin a wink, a signal to watch Wilbur for one of his customary critical responses. Wilbur, as George Spratt once told Octave Chanute, was "always ready to oppose an idea expressed

by anybody," ready to "jump into an argument with both sleeves rolled up." And as Wilbur himself would explain to Spratt, he believed in "a good scrap." It brought out "new ways of looking at things," helped "round off the corners." It was characteristic of all his family, Wilbur said, to be able to see the weak points of anything. This was not always a "desirable quality," he added, "as it makes us too conservative for successful business men, and limits our friendships to a very limited circle." This time, however, after a moment when no one spoke, Wilbur declared he liked the idea, then surprised Orville even more: Why not simplify the pilot's job by connecting control of the rudder with those of the wing warping? Work began on the change that same day. Rather than a fixed rudder of 2-foot vertical fins, as it had been until now, the glider hereafter would have a single movable rudder 5 feet high, and the operator, stretched on his stomach, would operate both the rudder and the warping of the wings by means of a new wooden "hip cradle." Thus no hands were needed, only movement of the hips, not coincidentally like the use of the hips in maneuvering a bicycle. Two days later, the camp grew more crowded still. Octave Chanute and another of his associates, Augustus Herring, arrived, making six now at meals and even closer-packed sleeping accommodations aloft in the rafters. Further, they had brought a triplane hang glider of their own design they wished to test, which consumed far more time and attention than the brothers wished and proved a total failure. After Herring failed several times to get the cumbersome three-wing machine off the ground, Wilbur and Orville each gave it a try and did no better. Chanute and Herring stayed a week. But Chanute, for all his disappointment in his own glider, understood the importance of what the brothers had achieved, and on his way back to Chicago, during a stopover in Washington, made a point of calling on Samuel Langley to report what he had seen at Kitty Hawk. As head of the Smithsonian,

Langley occupied a spacious office in the institution's turreted "Castle" on the Mall. He and Chanute were close in age, Langley, sixty-eight, Chanute, seventy-two, more than thirty years older than the Wrights. They were two personages of high reputation and accomplishment, and with their white beards looked every bit the savants they were. But where Chanute espoused an open exchange of knowledge and ideas among those involved in the quest for flight, Langley maintained extreme secrecy about his efforts. Every aspect of his heavily financed Smithsonian experiments remained confidential. In sharp contrast to the affable Chanute, Langley, a thorough Boston Brahmin, had what his friends kindly termed a "shell of hauteur." Since the launching of his pilotless, steam-powered aerodrome in 1896, Langley and his Smithsonian "team" had been at work on a far larger, and again well-financed, version of the same machine, except that this would be powered by a gasoline engine and carry a single operator. Almost no one, other than those directly involved, knew anything about it, just as Langley wished. Until now Langley had paid little or no attention to the Wrights and their efforts, but hearing all Chanute had to report, he was suddenly quite interested and wrote at once to the brothers to say he would like to come to Kitty Hawk to see for himself. Wilbur and Orville politely declined, but for what reason is unknown. Lorin, too, soon made his exit, and on October 17, with the help of Spratt, the brothers moved the remodeled glider to Kill Devil Hills to resume testing. The weather by now had turned cold enough that a fire had to be kept burning all night. Rations were down to little more than canned beans. None of this seemed to matter. When Spratt's turn came to depart, the brothers were on their own again, and as so often before, with help only from the faithful Bill Tate. In ten days of practice they made more glides than in all the preceding weeks, and increased their record for distance to more than 600 feet. Altogether in two months on the Outer

Banks they had made nearly a thousand glides and resolved the last major control problem. They were elated and would gladly have stayed another several weeks had Bill Tate not long since committed himself to taking charge of a boat and crew at the opening of the fishing season. They broke camp at first light on October 28 in a cold, driving rain and walked the four miles to Kitty Hawk to start the journey home and in a frame of mind far different from what it had been at their departure the year before. All the time and effort given to the wind tunnel tests, the work designing and building their third machine, and the latest modifications made at Kill Devil Hills had proven entirely successful. They knew exactly the importance of what they had accomplished. They knew they had solved the problem of flight and more. They had acquired the knowledge and the skill to fly. They could soar, they could float, they could dive and rise, circle and glide and land, all with assurance. Now they had only to build a motor