Chapter One

Fledgling Wings

The world which rocked with excitement at the invention of the balloon in 1783 would find the nineteenth and twentieth centuries filled with far more sophisticated lighter-than-air (LTA) and heavier-than-air (HTA) craft vehicles, each one successively more capable.

The latter would soon prove to have far more military potential than balloons (of which a concise history can be found in the appendix) or airships, but would face similar problems in development and in gaining acceptance by military leaders. Progress in aeroplanes, as they were known in the early days of heavier-than-air flight, was far more rapid than that of LTA types, thanks to their inherent greater utility. Aircraft, as they became known, revolutionized warfare, although the fact was not fully accepted at first. The first instances in which air power had influence on history were direct and decisive military intervention on the battlefield. The second, less obvious effect was that aviation revolutionized industry with its demand for precision production and with the continual introduction of new and complex systems to make aircraft more effective. This industrial revolution would have profound effects upon the world's economy by increasing productivity even as it increased quality of manufacture.

The aircraft revolution from the beginning carried the seed of a problem that was not recognized for decades, and that was the heavy support the employment of aircraft required, both in the military and in industry. No previous weapon, not even the dreadnoughts that precipitated the naval shipbuilding race before World War I, had required such a large ratio of support to combatant personnel, nor such a huge industry to support it.

Continued Lighter-Than-Air Progress

While the basic systems of the hydrogen balloon had been provided in the very earliest days of ballooning by Professor Jacques Alexandre César Charles, the necessary components to create a balloon that could be flown under power against the wind and steered in a desired course came much later, as did the term to describe such a conveyance, "dirigible." Dirigibles were subject to continuous improvement, a process that goes on to this day.

The first practical airship was conceived of in 1785 by General Jean-Baptiste Marie Meusnier, but was not built because there was no adequate power plant. Several people pursued the basic Meusnier idea, but Henri Giffard was the most successful, flying his airship from the Paris Hippodrome on September 24, 1852. Essentially a 144-foot-long, football-shaped envelope filled with hydrogen, Giffard's dirigible was powered by a three-horsepower steam engine that enabled it to achieve a speed of six miles per hour. Giffard, who at the age of twenty-four had invented the injector had used in all steam engines of the time, piloted his craft from a small open basket suspended beneath the envelope. After a second dirigible of his design crashed, he turned to ballooning again, creating an 883,000-cubic-foot monster that was the largest hydrogen balloon ever built and a great success at the 1878 Paris World's Fair.[1]

The dangerous combination of a coal-burning steam engine and a hydrogen-filled envelope was evident to all, and alternatives were sought. Things were somewhat simplified when coal gas for inflating the envelope became more generally available, and later, when the internal combustion engine came into general use.

These two innovations were first exploited by Paul Haenlein. In 1872, Haenlein's large 1872 airship cleverly ran an early internal combustion engine on gas from the envelope rather than carrying a separate fuel supply. The 164-foot-long envelope held 85,000 cubic feet of coal gas, which had only about one-half the lifting power of hydrogen. Haenlein's dirigible was not completely successful, but it pointed the way to the future.

The next notable attempt was made by a veteran of balloon flights during the siege of Paris, Gaston Tissandier, and his brother, Albert. Their airship was only ninety-two feet long, but was filled with hydrogen, giving it ample lift. Their choice of electric power was a mistake, however, for the Siemens electric motor

they selected had only one-and-one-half horsepower, and could drive the dirigible at only three miles per hour.

It was fitting that the first successful dirigible would come from the old Aérostier's headquarters at Châlais-Meudon near Paris, where, in 1877, the Central Military Installation for Ballooning had been created, the first of the great government-sponsored aeronautical laboratories, like those at Farnborough in England and McCook Field in the United States. Created by the portly Lieutenant Colonel Charles Renard and Captain Arthur Krebs, the dirigible *La France* lifted off from Châlais-Meudon on August 9, 1884. It flew for twenty-three minutes in a great circle, averaging about fourteen miles per hour. It was the first time that an airship had been able to make a controlled flight with a return to its starting point. The 165-foot-long *La France* was inflated with 66,000 cubic feet of hydrogen, and was powered by an eight-horsepower electric motor weighing 220 pounds. These were energized by a special installation of 1,500 pounds of chlorochromic batteries designed by Renard. Krebs had designed the motor, which delivered one horsepower for each 215 pounds of power plant.

The great breakthrough for airships came with the introduction of Gottlieb Daimler's internal combustion engine, which had a much better power-to-weight ratio, producing one horsepower for each eighty-eight pounds of power plant. Unfortunately, imprudent engineering started German airship development off with the same sort of bang with which it ended when the *Hindenburg* exploded in 1937.

No less a personage that Kaiser Wilhelm had taken an interest in the development of airships, and he ordered the Royal Prussian Aerial Navigation Department to assist Dr. Karl Woelfert in testing his Daimler-powered dirigible, the *Deutschland*. Unfortunately, Woelfert had installed the engine too close to the envelope. He and his mechanic, Robert Knabe, had made three flights before taking off from Tempelhof Field in Berlin on June 14, 1897. As the dirigible reached about 2,500 feet, vented hydrogen was ignited by the engine's open-flame ignition system. The *Deutschland* blew up, killing both crew members. This tragedy—and many subsequent ones—did not diminish German interest in the airship, however.

Airships: Popular and Professional

Two aristocrats now emerged upon the scene. One, Alberto Santos-Dumont, was to popularize dirigible flight in a series of per-

sonal vehicles. The other, Count Ferdinand von Zeppelin, was to create gigantic airships which would win the heart of his people, establish the first commercial air service in the world, and create a fleet of combat-capable Zeppelins which would conduct the world's first strategic bombing campaign.

Santos-Dumont was a wealthy Brazilian whose indulgent father sent him at the age of eighteen to Paris to be educated, providing $500,000 to ensure that it was a liberal education. Although small in stature and somewhat reserved in personality, Santos-Dumont became a popular figure in French society. He had a serious side, however, and was dedicated to the idea of flight. No dilettante, he learned the lighter-than-air business in more than a hundred balloon flights.

The young Brazilian designed and had built a series of airships tailored to his size and taste. His first was eighty-two and one-half feet long, and was capable of lifting only 450 pounds with its 6,345 cubic feet of hydrogen. But that was enough to get the 110-pound Santos-Dumont and his two-cylinder De Dion three-and-one-half-horsepower internal combustion engine airborne, albeit briefly.

Santos-Dumont went on to construct nine more dirigibles, and flew them himself, above, and on one occasion, into, the rooftops of Paris. The crash took place with his No. 5, and left the gallant Santos-Dumont to be rescued from a lightwell of the Trocadero Hotel, to the joy of his adoring Parisian audience. It was his No. 9 that gained him the most fame, however, for it was a personal runabout that he used to cruise the boulevards, dropping in on his favorite spots for a drink or dinner and parking his airship on the sidewalks as casually as modern Parisians do their Citroëns.

Increasingly fascinated with heavier-than-air flight, however, Santos-Dumont would soon lead Europe in that field as well.

There were others who advanced the idea of the dirigible, including: Paul and Pierre Lebaudy, who created the first semi-rigid aircraft; Thomas Baldwin, who followed Santos-Dumont's design lead; and Walter Wellman, whose adventures in the large dirigible *America* were thrilling but never quite successful.

In marked contrast, Count von Zeppelin never contemplated using his dirigibles as a personal vehicle or for adventurous stunts. He intended them from the start to be used commercially for profit and militarily as a weapon.

The first Zeppelin was far grander than any previous dirigible, for it was 416 feet long and carried 399,000 cubic feet of hydrogen. The hydrogen did not fill the envelope of the *Luftschiff Zeppelin* (Airship Zeppelin) LZ-1, as he called it, but instead was retained in seventeen gas bags within the aluminum, fabric-covered framework. Two sixteen-horsepower Daimler internal combustion engines drove four propellers. Horizontal control was provided by rudders, while vertical control was provided by a sliding weight.

First flown on July 2, 1900, the LZ-1 had a top speed of about seventeen miles per hour. Unfortunately, the LZ-1 encountered difficulties on all of its three flights, and no one offered to purchase it. The Zeppelin firm was out of funds, and the LZ-1 was broken up and sold for scrap.

Zeppelin persevered, and by 1905, a second aircraft, the LZ-2, was ready, only to be damaged when it was launched. Repaired, it flew again on January 17, 1906, crashing in a violent storm. With government backing, Zeppelin created the LZ-3, which met with some initial success, and attracted widespread popular backing.

The Count and his company were learning with each new Zeppelin, and by LZ-4 they had created a 446-foot-long airship with 530,000 cubic feet of gas, and capable of lifting more than 10,000 pounds of crew, passengers, fuel, and cargo. This was, at last, a practical airship, and Germany began to become very partial to Zeppelins, so much so that when a storm wrecked LZ-4, there was a spontaneous outpouring of sympathy and six million marks in contributions. More important, the German Army agreed to acquire two airships, for an additional 2.5 million marks. This began a long and ill-fated relationship between the German military and the Zeppelin, one which sustained the Zeppelin factory, but which cost Germany a great deal of resources that it could ill afford.

The Zeppelin firm was well and truly launched, and despite a continuing series of crashes, in the coming years it would operate a highly successful passenger airship line, Deutsche Luftschiffahrts-Aktien-Gesellschaft (German Airship Transport Company). Usually called Delag for short, the company began operations on November 16, 1909, only to encounter difficulty with three more crashes. It was sustained by German Army financing, in return for which the company trained military airship crews. This military/industrial support enabled Zeppelin to persevere. He retained the admiration and

affection of the German public so that by 1911 he could put LZ-10 in service as the *Schwaben*. The following year, three more Zeppelins joined the Delag fleet, including the *Viktoria Luise, Hansa,* and *Sachsen*. The airline flew more than 100,000 miles, carrying 37,500 passengers, and despite several crashes, had no fatalities.

In the meantime, both the Imperial German Army and Navy were acquiring Zeppelins that were presumed to have a formidable military air-power capability, and these would have a definite influence on history.

The Heavier-Than-Air Flying Machine

The internal combustion engine also paved the way for the first flying machine. Unlike the dirigible, the heavier-than-air flying machine proved to be an insoluble problem to everyone but the inimitable Wright brothers of Dayton, Ohio. Orville and Wilbur Wright were self-taught engineers who did not approach flying as scientists seeking basic principles, but as practical men intent on solving the problems of flight. The two men, acting almost as if their personalities were fused, systematically went from an interest in the possibility of flight in 1899 to the successful first flight on December 17, 1903. At that moment in time, they were at least ten years ahead of all possible competitors in the world, including some who had been working on the problem for decades.

There were people who would hotly dispute this fact in 1903, and some people today would still dispute the claim. There are societies that in all honest belief carry the banner for many of these individuals, claiming that this one or that one flew before the Wright brothers did. As a result, the following straightforward paragraphs will perhaps offend those who wish to believe that others had achieved powered, man-carrying flight, or were very close to doing so, prior to the Wrights' success on December 17, 1903.

The hard facts are, however, that no one, not Clement Ader, Alexander Graham Bell, Octave Chanute, Captain Ferdinand Ferber, Lawrence Hargrave, Augustus Herring, Samuel Pierpont Langley, Otto Lilienthal, Hiram Maxim, John Montgomery, Gustave Whitehead, or anyone else had a development line going which approached that of the Wrights, or which could have led in a reasonable time to a controllable, man-carrying aircraft.

This statement seems harsh, but detailed examination of each of these would-be first-flighters reveals just how deficient their approach and their apparatus were. Ader's machines, which had received more than 500,000 francs ($100,000) in government financing, were immensely complicated and uncontrollable, and worse, shrouded in fraudulent claims that were later exposed. Bell believed that a flying machine should have the inherent stability to be found in kites, and specialized in intricate tetrahedral multi-cell kites that flew well on a cable, but led nowhere. Chanute acted as information central, gathering information from all over the world, and trying different ideas as they came to him on an almost random basis. He did well in recording and disseminating the actions of others, and created a successful biplane glider. However, he failed to develop a systematic program of his own. Perhaps his greatest failure was his inability to understand what the Wrights were doing, even though he visited them often and observed their activities. Chanute, for all his engineering background and immense knowledge of the aeronautical scene, never grasped that the Wrights had seen and solved the problem of flight in three dimensions. The French enthusiast Ferber was at best an inept copycat, also unable to see the heart of the Wright idea even after studying it, and strangely and sadly incapable of quality craftsmanship. His finished machines looked like a schoolboy's drawing of the Wright glider. The Australian Hargrave might have been the best of the lot, but he was a kite-flyer, tied to antiquated ideas. Herring was bright and ambitious, perhaps the most able of all except for Lilienthal and the Wrights. Unfortunately he was a schemer, claiming ideas that were not his own, more prone to borrow ideas than to create them, and given to achieving his business goals by fraudulent claims to patents he did not own. Langley was the most culpable of all, a man of science who systematically ignored the scientific approach, and was content to scale up what was essentially a model airplane into a design that had no provision for control, was not stressed for either its catapult launch or flight, had a bizarre launch mechanism, and made no provision for landing. Langley topped himself by entrusting this impossible concatenation of anomalies to a Charles Manly who had created a brilliant engine for him. The problem was that Manly had never flown before, not even a single gliding flight. Manly had no means of controlling the Aerodrome, as Langley called it, and

because there was no provision for alighting, was condemned to be submerged immediately upon landing. Fortunately, two crashes yielded no manslaughter charges.

Lilienthal was the most important of this group, and did contribute the concept of a hang glider, controllable by shifting the weight of the pilot. Yet this method placed an inherent limitation on the size and weight of his craft, and ultimately resulted in the crash that killed him. Lilienthal also contributed a great deal of data, not all of it accurate, but a starting point.

It does not get any better. Hiram Maxim, father of the famous machine gun that bore his name and an immensely wealthy industrialist, built a huge machine with a powerful engine and absolutely no means of controlling it if it happened to get airborne. San Jose's favorite son, John Montgomery, made very dubious and unsubstantiated claims about gliding flight, then sent another man and himself to their deaths in gliders that were demonstrably not airworthy. Gustave Whitehead made fanciful claims that could never be corroborated about an aircraft of dubious strength and lift that had one mysterious engine for ground run, and another mysterious engine for flight.

Other than Lilienthal's efforts, with their useful, if flawed data tables, only one lasting contribution to aviation was made by all of these experimenters, the two-surface (biplane) glider of Chanute. Nothing useful to aviation was ever developed from any of the other efforts of these experimenters who, despite all claims, were never in any way meaningful competitors to the Wright brothers. And it must be remembered that these were the most credible of the Wrights' competitors. There were many others who were simply laughable poseurs who wished to sell stock to a gullible public. Still others were sincere eccentrics, totally incapable of creating a flying machine, but still able to garner publicity.

Yet having said this, it should be stated emphatically that all of these men, from Ader to Whitehead and including the poseurs and eccentrics, should be applauded for the attempts they made, for they contributed to the spirit of the age, and made the world conscious of the possibility of flight.

The two brothers from Dayton were smart enough to recognize just how far ahead of the pack they were. They knew how difficult were the problems that they had solved, and how often that

a solution came by a chance insight that might under other circumstances never have occurred, and would probably never occur again. Their experience told them that others, less systematic than they, and perhaps less gifted as well, would take years to cover the same ground.

The Wrights' approach was simple. They believed that previous experimenters had proved that a fixed-wing flying machine could glide, just as birds soar without beating their wings. They also believed that lightweight engines of sufficient power would be available to power the flying machine. They differed from all other experimenters in two basic beliefs, however, and these were crucial to their success. The first of these was that flying was a three-dimensional problem, and that the flying machine should not be inherently stable, but should be controlled about all three of its axes by the movement of control surfaces—not by shifting the center of gravity. They also understood that the pilot of a flying machine would have to learn to fly by moving control surfaces to direct his course and altitude, and that this would take much practice.

Many inventors moved from one configuration to another. Chanute, for example, was equally interested in experimenting with his multiple-wing *Katydid*, his two-surface hang glider, his Lilienthal-type machine or, Edward Huffaker's bizarre cardboard glider. In contrast, the Wrights preferred to solve one problem at a time, building upon past successes. All of their machines had a deep family resemblance. As a result, they moved swiftly from a kite in 1899 to a fairly successful glider in 1900. Their 1901 glider was less successful, and drove them almost to despair, even as it led them to the solutions that would create the highly successful 1902 glider. From there it was but two giant steps—the design and creation of an engine and the propellers—to powered flight in 1903.

The 1903 Wright Flyer is a classic example of designing to a point with economy and finesse. The Wright brothers calculated exactly how much lift would be required to raise the machine and a pilot into the air, and then designed and built wings that would provide that lift—plus a little more as a margin for error. The wings had a span of forty feet four inches and a chord (width) of six feet six inches, providing 510 square feet of wing area. They calculated that they would require an engine of at least eight horsepower to propel the aircraft forward against the wind, and were delighted when the

one they themselves designed and built (with the assistance of Charles Taylor) delivered twelve, giving them another very measured margin of safety. The biggest engineering challenge was the propellers, for there was no existing data from which to work. They had presumed that there would be a great deal of information on the design of marine propellers from which they could extrapolate data. There was not. Then, intuitively seeing the propeller as a rotating wing, they created a marvelously efficient design that delivered, within 1 percent, the thrust they calculated they needed. The finished aircraft weighed 605 pounds, to which had to be added the 140-pound weight of the pilot, both Orville and Wilbur weighing about the same.

The Wrights were also extremely practical and economic in their approach, having spent only about $1,000 on their experimentation by the time of their successful first flights. Professor Langley had spent about $73,000 on his Great Aerodrome, of which a large percentage, perhaps as much as $20,000, had gone into the houseboat and catapult system he had devised to sling it into the air. The launching system did not work properly, or at least Langley claimed that it did not. The Wrights' launching mechanism consisted of some two-by-four boards laid end-to-end and three bicycle wheel hubs, with a total cost of four dollars. It worked beautifully. The difference in approach really sums up the difference between the Wrights and Langley as aircraft designers, i.e., a successful launch system for four dollars, versus an unsuccessful one for $20,000.

Designing and building a machine to their own remarkably exact specifications was not enough; it was also necessary to be able to fly it. Fortunately, both Orville and Wilbur had made hundreds of glider flights in the essentially similar glider of 1902 and had taught themselves how to fly. It was an unimaginably important asset that, surprisingly, none of their competitors had considered necessary.

The degree of the Wrights' skill was evident in the fact that they did in fact make four successful flights in the face of high winds on December 17, 1903, the first of 120 feet and the last of 852 feet. No one else in the world could have actually flown the skittish Wright Flyer, for no one else had practiced so much nor knew it so well. Ironically, there is considerable question whether a well-trained modern pilot could fly an exact replica of the Flyer, so demanding are its control requirements. (The question may be answered by

the time this book is published, for exacting reproductions of the Kitty Hawk Flyer are being built, and a comprehensive attempt is being made to learn to fly it via the use of gliders and simulators.)

The Wright brothers' conviction that they were ten years ahead of all competitors would prove ultimately to be their undoing, for things change. They would continue to improve their product and extend their lead over everyone through 1905, when they created the first practical airplane in history. Incredibly, the Wrights themselves elected not to fly again from October 1905 to May 1908, concerned that someone might see the flights and steal their secrets from them.

But time, personality, and events would work against them, and as word of their achievements leaked out to a largely disbelieving public, competitors began to gain on them.

The Wrights were extremely, perhaps obsessively, secretive, but Wilbur had published two articles and given two important lectures on their work. The Wrights had discussed their project extensively with Octave Chanute, who also published articles that included material on the Wrights, and had, with colleagues, visited the Wrights at Kitty Hawk. Their 1904 and 1905 aircraft had been seen in flight at Huffman Prairie, the flying field near Dayton that they used after 1903. A sketch of the 1905 Wright Flyer was published in *L'Auto* in Paris on December 24, 1905.[2] The sketch clearly showed the front biplane elevator, the hip cradle in which the pilot lay, the skid undercarriage, the yoke and rail system for launching, the shape and placement of the two pusher propellers, and the double rear rudder.

This body of knowledge allowed European imitators to expand on their own efforts, buoyed by the knowledge that flight was indeed possible, aware of the general configuration of the Wright Flyer, and relieved that pursuing flight could no longer be considered a foolish, impossible endeavor—the Wrights had flown! There were some, of course, who insisted that the Wrights were poseurs who had never really flown at all.

Rivals sprang up both in Europe and in the United States and Canada. France, which had been first with the balloon and the dirigible, had long demanded that it must be first with a flying machine, and the voluble patriots of the Aéro-Club de France as well as the editor of *L'Aérophile* cried for action. In response, Henri Deutsch de

la Meurthe and Ernest Archdeacon established prizes so that the "homeland of Montgolfier" (the father of ballooning, see the appendix) would not be disgraced by having a foreigner be the first to create a flying machine.

Paradoxically, the French copied the ideas implicit in the Wright Flyer with the same zeal with which they condemned the Wrights as "liars not flyers," insisting that the Wrights had never actually flown. But it was not until October 23, 1906, after months of testing, that the redoubtable balloonist, Santos-Dumont, hopped his strange-looking No. 14-bis into the air in Paris to win the Archdeacon Cup for a flight of more than twenty-five meters. The actual distance was about sixty meters, and it was no more than a powered leap into the air. The little Brazilian did better on November 12, 1906, however, making a flight of 772 feet—substantially more than a hop, and an effort that sent shock waves of enthusiasm throughout France.

The greatest threat to the Wright brothers' primacy came from Canada, however, where the great Alexander Graham Bell had gathered four young men of talent into a consortium called the Aerial Experiment Association (AEA), whose stated purpose was "To Get Into The Air." Founded on September 30, 1907, the organization was funded by $20,000 put up by Mrs. Bell. The four men included John Alexander Douglas McCurdy, who would become the first man to fly in Canada; Frederic W. ("Casey") Baldwin, who would always be confused with the balloonist Tom Baldwin; First Lieutenant Thomas Selfridge, a man who knew the ways of the military bureaucracy sufficiently well to get himself posted to the AEA; and Glenn Hammond Curtiss, who, like the Wrights, had owned a bicycle shop, but had moved on to building lightweight engines for motorcycles and then began building his own brand of motorcycle. His capability with powerful lightweight engines and his manufacturing experience more than compensated for the fact that he was the only one of the four without a college degree.

It was a powerful group, handicapped only slightly by Bell's persistence in pursuing the tetrahedral kite as a flying machine. With some chutzpah, members of the AEA wrote to the Wright brothers for information on their flying experience. The Wrights replied with general information on their patents and the papers they had published. The Wrights did not consider the AEA a commercial threat, believing it to be a research agency, as it was under the auspices of

Alexander Graham Bell. Nothing could have been further from the truth.

By early 1908, the AEA had developed its first aircraft, the *Red Wing,* which closely followed Wright practice in that it was a pusher (propeller facing the rear) biplane with a "horizontal rudder" in front and a vertical rudder in the rear. The *Red Wing* had no means of roll control and crashed on its first flight, which covered almost 320 feet. The *White Wing* that followed (the name deriving from the color of the cloth with which the wings were covered) was almost identical to the *Red Wing,* but had two small ailerons mounted on the upper wings, the first attempt made to sidestep the Wright patent for three-axes control. The *White Wing* flew on May 17, and while not up to the Wright standard of design or construction, was flyable, nonetheless, and the AEA was "in the air."

Glenn Hammond Curtiss altered the picture forever on June 21, 1908, at his namesake hometown in Hammondsport, New York, with three successful flights in his *June Bug.* (The name was whimsically selected to acknowledge the myriad "June bugs" that infested Hammondsport and its vineyards that year.) His aircraft still echoed the Wright formula but was powered by an engine of his own design, directly driving the pusher propeller. It also was equipped with a wheeled tricycle undercarriage, and wing-tip ailerons. In it, Curtiss would win the prestigious Scientific American Trophy on July 4, generating tremendous publicity and serving notice to the Wrights that they had a formidable competitor. The AEA, making free use of the knowledge gained from observing the Wright efforts, had caught up, not in ten years but in less than one.

Curtiss traded on his success by offering aircraft for sale commercially. The Wrights responded with the first of many lawsuits, a process of litigation that would drain them of creative effort.

The two brothers from Dayton had always hoped to sell their aircraft to the United States government, naively hoping that as a weapon it would make war impossible because there could no longer be surprises on the battlefield. However, when the U.S. government persisted in refusing to buy, they were forced to attempt to sell it to a foreign government.

Several factors worked against such a sale. The first was the uncompromising standards of the Wrights, who for reasons of secrecy, would not agree to show, much less demonstrate, their aircraft prior

to having a signed contract in hand. They did not demand any money prior to such a demonstration, but they expected potential buyers, including such notoriously difficult clients as the British and French armies, to sign a contract for purchase, sight unseen. In the United States, the War Department was still smarting over the bad publicity it had received for the $50,000 it had advanced Langley. In Europe, no minister wished to go to his government and explain that he was buying an American product sight unseen, when it seemed probable that a native product would be developed soon.

The impasse was not resolved until Congressional pressure and common sense intervened, and the Wrights (and forty others!) accepted an invitation to compete for a Signal Corps requirement for an aircraft that would be "capable of carrying two men and sufficient fuel supplies for a flight of 125 miles, with a speed of at least 40 miles per hour. It must remain aloft for at least one hour and land without damage." The request for proposal also stipulated that the flying machine be designed so that an intelligent man could become proficient in its use in a reasonable length of time, and that it be so constructed as to be able to be transported on a standard Army wagon.

In the event, none of the other competitors actually appeared, and Orville had the parade ground at Fort Myer, Virginia, to himself. The demonstration of the 1908 Wright Military Flyer was a success up to the point that a crash occurred on September 17, injuring Orville severely, and killing First Lieutenant Thomas Selfridge. The first man to die in the crash of a powered aircraft, Selfridge was a member of the team evaluating the aircraft. His presence had irritated Orville, for as a founding member of the AEA, he was a rival to the Wrights. Fortunately, Orville had demonstrated the aircraft so well that there was no doubt that the Army wished to buy it, and the terms of the contract were extended so that the Wrights could rebuild the aircraft and demonstrate it the following year.

Industrial competition and espionage began early in the aviation business, and perhaps could be said to have commenced on September 23, when AEA members Bell, McCurdy, and Baldwin came to serve as Selfridge's pallbearers, and paid a courtesy call on Orville, in the Fort Myer hospital. They were turned away, but then took the time to pay another courtesy call, this one on the balloon hangar where the wrecked Military Flyer was awaiting shipment back

to Dayton. There they persuaded the sergeant on guard to admit them, and Bell was seen to make a measurement of the wings.

While Orville was meeting first success and then disaster at Fort Myer, Wilbur was dazzling Europe with his remarkable, record-setting flights in France. The aviation world was now well aware of the general outline of the Wright design, and could infer from observation how the controls operated. Some, as with Louis Blériot, simply adopted the Wright method of control without a by-your-leave. Others, including Curtiss, sought alternate means of lateral control, such as ailerons, to avoid the Wright patent.

An important by-product of the Wrights' convincing demonstrations that the aircraft had indeed arrived was the establishment of associations that lobbied for air power. In 1908, there sprang up the Air Fleet League in Germany and the National Air League in France, while the Aerial League of the British Empire was formed in 1909.[3] Similar organizations blossomed in Italy and Russia. These organizations corresponded to very popular institutions which promoted the respective interests of their national navies, and which had both political and economic influence. The new organizations were better funded, and far more active, than the typical national "aero clubs." The formation of such groups, linked to the large numbers of young military officers who were intrigued by flying, would help explain why the governments of those nations should spend so much money on the development of air power before the First World War. Further, it became the common practice for members of these organizations to pledge their services and their aircraft to the military, if war came. In return, they were given a stipend for maintaining their aircraft, and were paid a per diem for every day they served in practice maneuvers.

Orville returned to Fort Myer to complete the tests in 1909, resulting in the sale of the first military aircraft in the world, the Wright Military Flyer to the U.S. government. (The Wright Military Flyer still exists, and may be seen in Washington, D.C., at the National Air and Space Museum of the Smithsonian Institution.)

But it was now obvious that the Wright brothers' once unassailable lead had begun to evaporate in 1908 when their brilliant performances served to inspire competitors. By 1909 it was badly eroded, although the Wrights were still sufficiently ahead of all competition to conclude a series of business deals that would make them rich. It

should be noted that the progress in aviation was so rapid, and governments were so nationalistic, that had the Wrights waited another year they probably would not have been able to reach the profitable arrangements they had made in Great Britain, France, and Germany.

Unfortunately for the Wrights, many of their competitors would draw on much of what they had done and significantly improve upon it. The great air shows at Rheims, Los Angeles, and elsewhere provided prizes as additional incentive. The Wright brothers' aerodynamic lead began to fade, and by 1911 their aircraft were not just obsolete compared to some foreign and domestic products, they were coming (correctly) to be regarded as inherently unsafe because of the large number of fatal accidents in which they were involved.

First Military Uses of the Airplane

In almost every country there were adventuresome military personnel who wanted to demonstrate the utility of the aircraft in warfare. As soon as aircraft performance would permit carrying a few more pounds than just those of the pilot and his observer, attempts were made to install and use weapons. On January 19, 1910, the famous Louis Paulhan flew an airplane over a field in Los Angles, and U.S. Army Lieutenant Paul Beck dropped dummy bombs. On June 9, the French lieutenant (later general) Philippe Féquant made the first photo-reconnaissance flight. On August 20, Lieutenant Jacob E. Fickel, U.S. Army, fired a rifle from his Curtiss biplane at a target in Sheepshead Bay, New York. On November 14, Eugene Ely launched naval aviation with a flight in his Curtiss pusher from the U.S.S. *Birmingham.* He would make the first landing on January 18, 1911, on the U.S.S. *Pennsylvania.* On March 3, the famed Wright exhibition pilot, Phil O. Parmelee, and his passenger, the future Chief of the United States Army Air Corps, Lieutenant Benjamin ("Bennie") Foulois, used both radio and carrier pigeons to communicate with the ground from their Curtiss biplane. On June 2, 1912, Lieutenant Thomas DeWitt Milling flew a Wright Model B biplane, with Captain Charles de Forest Chandler firing a machine gun from the air. Both men became famous U.S. Air Service aviators. Similar indications of progress, not so well reported, took place in the military services of other countries.

Yet long before Chandler and Milling had fired a shot, the aircraft had gone to war, and in a significant way. On September 28, 1911, Lieutenant Colonel Vittorio Cordero di Montezemolo ordered the Aviation Unit of the Italian Specialist Battalion Headquarters to send an "air fleet" to Libya (then a part of the Ottoman Empire) as a part of a Special Army Corps "to protect Italian commercial interests." It was, in fact, essentially an invasion of Turkish territory. Five pilots, under the command of Captain Carlo Piazza of the Eighth Field Artillery were assigned to the task. They brought with them nine aircraft, including two Blériots, three Nieuports, two Farmans, and two of the dove-like Etrichs. All of these aircraft were equipped with fifty-horsepower Gnome rotary engines, and each one was provided its own hangar. More aircraft were dispatched later, along with a lighter-than-air unit consisting of four observation balloons and two airships.

The Italian invasion of Libya began on October 2, 1911, and had gone off relatively smoothly, but the transportation of the air fleet could not be undertaken until after the fall of Tripoli. Thus it was not until October 21 that Captain Piazza could report that his aircraft was ready for action.

The world's first combat flight took place on October 23, when the Commander of the Air Fleet, Captain Piazza, took off at 6:19 A.M. to reconnoiter Turkish positions. In a sixty-one minute flight, he discovered several enemy encampments. While he was airborne, Captain Riccardo Moizo also took off to observe enemy dispositions. By this time, military observations from balloons had been conducted for many years, but this was the first military observation from an aircraft. The difference was enormous, for while the balloon was tethered (normally), the aircraft was free to fly wherever the pilot wished, allowing him to observe many more hundreds of square miles than the balloon observer could do.

There followed a yearlong series of sorties under extremely dangerous conditions. The French Military Air Force had signaled the Italian headquarters that it had found daytime flights over the desert to be particularly hazardous because of the air currents and the possibility of sandstorms. Nonetheless, the Italian air fleet carried on with surprising effectiveness for an initial effort at full-scale warfare.

On October 26, Captain Moizo's Nieuport became the first aircraft ever to sustain combat damage. He had discovered a large

encampment of some six thousand men, and came under rifle fire, suffering three hits in the wing, but no major damage.

It fell to Second Lieutenant Giulio Gavotti to make the world's first combat bombing sortie, flying an Etrich Taube. He carried four of the grenade-like "Cipelli" bombs, each weighing about four pounds and roughly the size of a grapefruit. He dropped one on a Turkish position at Ain Zara, and three on the Oasis of Jagiura. Gavotti's raid was widely reported, and had great effect upon the thinking of airmen in other armies. Another raid, this time by Captain Moizo, resulted in the Turkish government issuing what would be come a familiar protest. They stated that bombs had been dropped on a hospital, a claim the Italians investigated and denied.

The tempo of the air campaign was accelerated, with heavier bombs being brought into play. Reconnaissance flights took place every day until weather conditions during December and January made regular sorties difficult.

During the long campaign, there were many other notable firsts, including the first dropping of propaganda leaflets, spotting for artillery, night-bombing and reconnaissance missions, and radio communications that involved no less a person than Guglielmo Marconi himself. The first pilot to be wounded in combat was Captain Carlo Montu, who was struck by a rifle bullet on January 31, 1912, over Tobruk. Sadly, the first pilot to die in combat was Second Lieutenant Piero Manzini, who crashed on August 25, 1912, shortly after takeoff for a photographic reconnaissance mission. The valiant Captain Moizo was forced to land behind enemy lines on September 10, when his Nieuport developed engine trouble. He was the first airplane pilot ever to be taken prisoner, and was not liberated until after the armistice was signed in November 1913.

The successful Italian air campaign received worldwide notice. On August 12, 1912, the *London Times* stated that "no one can have observed the work accomplished by the Italian airplanes at Tripoli without being deeply impressed by the courage and the ability of the Italian pilots and without being convinced of the valuable use of aviation in wartime."[4]

On September 10, 1912, the *Berliner Tageblatt* took a slightly different view, reporting "for now at least, airplanes and airships are not practical used as offensive weapons: they have, however been shown to be very useful for reconnaissance. The Italian Command is always,

thanks to aircraft, informed of every displacement of Turkish troops, and knows the exact positions of them. Moreover, following the photographs and relief maps made by the airships and airplanes, it has been possible to compile a map with which to conduct the war."[5]

The Italian air campaign had great effect upon the Italian people, who rejoiced when the principals were showered with decorations, and responded with a flood of poetry, songs, and even a board game celebrating it.

Perhaps the most influential aspect of the Italian campaign was philosophical rather than military, for it fell to Major (General Staff) Giulio Douhet, provisionary battalion commander, to make the full report on the campaign. Douhet had for years been an advocate of air power, writing articles in the service journal *La Preparazione,* but the campaign in Tripoli gave him his first chance to report facts rather than theories, and he made the most of it. His extensive report analyzed the technical and professional considerations that had affected the use of aircraft, and he drew interesting inferences on the preparation of flying personnel, their recruitment and training, as well as the types of aircraft to be procured. He concluded with an organizational proposal that became the structural framework for Italian aviation and industry during the 1914-18 war in Europe.

His experience and his report prepared him to write one of the most influential documents in the development of air power, *Command of the Air.*

Other Conflicts

The First Balkan War of 1912-13 saw Turkey in conflict once again, this time with the Balkan League consisting of Bulgaria, Greece, and Serbia. This was the first international war during which all combatants deployed operational aircraft. While the air war was not integrated as tightly into the ground war as it had been in the Italian campaign in Libya, it was nonetheless influential, coming as it did on the heels of the Italian successes. One of the major contributions, to become so significant in later years, was the export of military aircraft, a business that would come to have significant importance, not only in the balance of payments but also in the political alignment of nations.

Greece had sent six officers to France in 1911, and there purchased aircraft to equip its newly formed air units in the Greek Army

and Navy. The Army Aviation Unit was ready for action on October 12, 1912, conducting reconnaissance operations.

Serbia had purchased two German observation balloons in 1909, and in 1912 had sent six people to France for pilot training and to purchase eleven aircraft. Major (later General) Joseph Barès sent two additional French aircraft to Serbia as a goodwill gesture. The Serbia Aviation Command was formed on December 24, 1912, and began conducting operations in March 1913.

The third member of the Balkan League, Bulgaria, had not made formal efforts to obtain training, but instead used French aircraft and French and Russian pilots as mercenaries to do reconnaissance and bombing.

Turkey had established a balloon unit by 1911, and also sent officers to France in 1911 for training. With greater resources than the other three combatant nations, Turkey purchased more than a score of aircraft from France, Great Britain, and Germany, using them, as the others did, primarily for reconnaissance, but also for bombing. The reconnaissance mission was by far the most fruitful, for there were as yet no bomb sights, and few targets that were bombed were hit. Those that were suffered only minor damage because the bombs were so small.

Although the air efforts in the first Balkan War were relatively small, they accurately forecast what might develop on a larger scale in a conflict between major countries, and had a strong effect on the thinking of military leaders in the great European powers and in Russia. This influence was reflected in military budgets and in the surprising growth in the aviation industry in the years prior to 1914.

The Western Hemisphere also saw the application of air power. In 1911, a Native-American pilot, Hector Worden, a Cherokee Indian, was commissioned a captain in the Mexican Army to fly reconnaissance and bombing missions in Blériot XIs against revolutionaries. The following year, the world's first dogfight took place in Mexican skies when two mercenary airmen, Dean Ivan Lamb, flying a Curtiss pusher, engaged Phil Rader in a Christofferson biplane. The men exchanged pistol shots, without doing serious damage, but setting a pattern that would become all too familiar during World War I.

The General Situation in Europe

Each of the major European powers found itself in similar situa-

tions, in respect to air power. On the one hand, national governments and the top military leaders did not wish to expend large sums on a new and as yet unproven weapon. The existing competitive demand for battleships, artillery, horses, and so on by their respective arms—and their civil and industrial backers—already strained defense budgets. On the other hand, the growing evidence of the usefulness of aviation, and the growing influence of aviation proponents, including the slowly emerging aviation industry, called for appropriations at some level.

The division in opinion was easier to handle within the military than within the government. The relatively few pro-aviation officers were often regarded as eccentrics who had no idea about career progression. To many professional military officers it was self-evident that only someone who had given up all hope of promotion, or who had a death wish, would sacrifice a comfortable assignment in a crack cavalry or artillery unit for the unknown and extremely hazardous world of aviation. It was more difficult at the political level, for even in the early days, the promise of a large aviation industry was attractive for the very reason that it is today—profits, jobs, and the assignment of contracts to specific areas of the country.

Yet the eccentrics who wanted to be in aviation had a driving passion that could not be denied, and the industry that aviation was giving birth to was attractive to many businessmen and politicians. And there was the matter of national pride. No government wanted to admit to its people that another nation was making faster progress in a new branch of service than it was. When Germany perceived that France had seized the advantage in heavier-than-air craft, and that there was little chance of matching it in the near future, the Germans decided to move forward in the lighter-than-air field as rapidly as possible. Despite many wise protests, the Germans seized upon dirigibles as a primary weapon, one in which Germany already had clear superiority. This lead in lighter-than-air craft was then used for propaganda purposes to counter the French claims, and to satisfy the *amour propre* of the military leaders.

The general popular appreciation of the use of air power in Libya and the Balkans exerted influence on both democratic and totalitarian governments in Europe, and always in the same way. When people with influence and an interest in aviation understood that the general public was aware of the effects of air power, they reached

out with programs that enlisted the public's interest and gave it a voice with which to express its opinion to the government.

This created the previously mentioned phenomenon peculiar to Europe—and totally foreign to the United States—the formation of civil associations designed to promote interest in, and more important, raise money for, the air services. The model was the German Flottenverein (Navy League) that was founded in 1898 and grew to have 1.1 million members by 1914. The Navy League's push for German naval equality with Great Britain was an extremely important factor in the great naval rearmament race prior to the First World War, and may be said to have been an important causal issue for that war. Besides raising money to buy dreadnoughts, its jingoistic-anglophobic publications conditioned the German public, not just to the inevitability of war with Great Britain but the desirability of it.[6]

The German Navy League was far larger than any of its aviation counterparts. The corresponding German Air Fleet League had 3,000 members by 1909 and 12,500 by 1912. But aviation was new, and the Air Fleet League often recruited important industrial and political figures and attracted some extremely important people, including Hermann von der Lieth-Thomsen, the architect of Germany's Army Air Service, and his superior, the redoubtable General Erich Ludendorff. The latter, with Field Marshal Paul von Hindenburg, would virtually rule Germany from 1916 on, all the while giving tremendous support to the German Air Force.

In many countries, activist political organizations, such as the German Air Fleet League, were supplemented by more popular movements, e.g., the German National Aviation Fund. Other countries had similar sets of organizations, and these spurred both popular and governmental interest in aviation, doing it with the hard cash of the time. These groundswells of enthusiasm for aviation were led by powerful personalities who focused popular opinion on practical results such as the purchase of aircraft or the training of pilots. Thus in Germany, Prince Heinrich of Prussia was the well-liked figure who led a drive in 1912 that netted the National Aviation Fund 7.2 million marks. These were used to purchase 62 aircraft and trained no less than 162 pilots. In Russia, the Grand Duke Aleksandr Mikhailovich became the royal patron of aviation. (The grand duke, after failing in his attempts to establish a reasonable government in Russia, would in 1916 predict the revolution.[7]) With the

Imperial All-Russian Aero Club he worked both inside the government and with the public to raise funds, buy aircraft, establish flying fields, and train pilots.[8] Similar, if smaller, organizations would be found in Austro-Hungary, Great Britain, and Italy, doing much the same work in much the same way.

Another factor in common among the great nations that would soon be tearing at each other's vitals was the basic similarity of the equipment available to them. While aviation progress had been rapid since 1903, and especially since 1909, it was still quite early in the history of aeronautics, and all nations were more than content just to have their air forces equipped with two-place aircraft for use in reconnaissance. They were stable, slow, and while often unreliable, nonetheless provided that crucial look at "the other side of the hill." There were, in all countries, air-power advocates and prophets who saw the future and knew that it consisted also of bombing aircraft and fighters whose task it was to prevent the enemy from observing and bombing. But, correct in their ideas as they may have been, they were in the minority, for aviation technology had not yet reached a point where their claims could be justified. Indeed, some of the more extravagant claims could not be justified for another thirty years, but the reasonable claims were within only a few years of being proven.

The soon-to-be combatant nations were similar in another way. While all wished to see a strong civilian aircraft industry in their homeland, their military services were determined to control that industry, but beset by conflicting ideas. In each country the military services were concerned that the industry would not build aircraft to meet its requirements, that a few large companies might be in a monopoly position, able to dictate price and schedules, and that many smaller companies would not have the skill or productive capacity to meet demand. Each country established centralized controls, which tended to distort, rather than regularize, industry. It was not until the pressures of war forced wholesale changes that a rationalized industry came into being in France, Germany, and Great Britain. In Russia, not even the pressures of war could overcome the intricate bureaucracy, and despite having excellent designers and builders, including Igor Sikorsky, the Russians were unable to establish an aviation industry comparable to the Western European powers.

One factor was very different among the countries in question, and that was in the capability to produce large numbers of high-quality aircraft engines. It was not yet fully realized that engines were a more difficult engineering challenge than airframes, and developing an engine from concept to production took many years and much investment.

France led the way. Its Gnome, Renault, Clerget, Salmson, and Anzani engines gave it a range of types (rotary, in-line, and radial) and horsepower that no other nation could match. Indeed, France supplied engines, particularly the Gnome, to many nations, including those with which it would soon be at war. Germany was a poor second, with a capability to produce a limited number of good, if heavy, Daimler in-line, water-cooled engines. England, Italy, and Russia relied on France for engines, although all three countries were trying hard to establish an indigenous engine industry.

The aviation engine industry is in fact a metaphor for the early effects of air power on history, for the demands of that industry are many. The entire culture and economy of a country has to bend to accommodate the creation of an engine industry, for it requires a new kind of engineer, new kinds of plants, new standards of machine tools, and new manufacturing, inspection, and testing methods. It also calls forth new materials, new instruments, new standards of quality, new education programs in schools, new subcontractors—the list goes on and on. If this metaphor is expanded to include aircraft, airfields, flying training, the training of mechanics, and such sciences as meteorology, it quickly becomes obvious how great an effect establishing an aviation industry will have on culture and economy. Deeper analysis will reveal that the effects go further, intruding on agriculture, mining, forestry, transportation, manpower requirements, raw material use, priorities—in short upon almost every aspect of national life.

Nonetheless, in the years prior to 1914, the old order held sway, with aviation receiving a very small percentage of each nation's defense budget. That portion allocated to aviation did grow over the years 1910 to 1913, probably at as great a pace as the infant industry could absorb.

In several countries, there were two important manifestations of the increased regard for military aviation indicated by the growth in spending. The first of these was the formal establishment of an air

arm, while the second was the establishment of formal trials to obtain aircraft designed for military use.

Naturally, given its great interest in aviation, France was a leader, establishing on October 22, 1910, a Permanent Inspector of Military Aeronautics to oversee all aspects of aeronautics. A long battle for control of military aeronautics ensued between the artillery and the engineering branches, the former advocating the close control of aircraft by ground units, the latter wishing to establish a more autonomous air arm. The issue was resolved in favor of the artillery, and there was no formal French Air Force established until 1934. The French held a Military Aeroplane Competition in October and November 1911, which attracted thirty-one contenders, of which only nine passed the trial elimination tests.[9]

In Great Britain, the first step was the creation of the Air Battalion of the Royal Engineers on February 28, 1911. This was followed by the establishment of the Royal Flying Corps on April 13, 1912. It had a Naval Wing, a Military Wing and a Central Flying School (ultimately, perhaps the most important constituent.) A Military Airplane Competition was held in August 1912, attracting a wide variety of "aeroplanes" to be evaluated.[10]

Germany's preoccupation with large airships and a bureaucratic standoff had dampened aircraft development. Most of the available funds went for Zeppelins, and when German aircraft manufacturers sought funds for development of aircraft, they were told that the government was interested only in buying already developed aircraft, which hampered formal military trials. In November 1910, the Chief of the Central Staff, Helmuth von Moltke, established an Inspectorate for Aviation and Motor Vehicles to procure aircraft. A Fliegertruppe (Flying Force) was established in October 1912, and its units were completely subservient to the German Army, actually coming under the Railways and Transport Communications Department.[11] Exactly one year later to the day, an Inspectorate of the Flying Force and an Inspectorate of the Airship Service were formed.

When the First World War began on August 3, 1914, the great powers had not yet embraced aviation as an essential part of their armed forces, but nonetheless each had surprising aerial strength.