

Flying Machines: Construction and Operation

Flying Machines: Construction and Operation by the Wright brothers is a detailed guide that combines technical insights with practical advice on building and operating early aircraft, reflecting their pioneering contributions to aviation.

AVIATION DEVELOPMENT

In this chapter, the evolution and achievements within the realm of aviation for the year 1911 are meticulously documented, featuring both European and American records that underscore the rapid advancements in the science of aviation. Highlighting the exceptional feats, the records are segmented into categories that include greatest speed, distance, duration, and altitude achieved by aviators, with distinctions made between flights conducted solo, with one passenger, and with two passengers.

European records spotlight the accomplishments of aviators like Garros in St. Malo, France, who achieved the highest solo flight in a Bleriot Machine, reaching an altitude of 13,362 feet. Similarly, American records showcase the prowess of pilots such as A. Leblanc and St. Croix Johnstone. Leblanc, flying solo in a Bleriot Machine at Belmont Park, N.Y., accomplished a remarkable speed of 67.87 miles per hour. Meanwhile, Johnstone, piloting a Moisant (Bleriot Type) Machine in Mineola, N.Y., achieved the longest distance flown alone, covering 176.23 miles.

Significant mentions include Howard W. Gill from Kinloch, Mo., who, flying a Wright Machine, maintained the longest duration aloft solo, with a flight lasting 4 hours, 16 minutes, and 35 seconds. In the domain of altitude, L. Beachy from Chicago, Ill., ascended to 11,642 feet in a Curtiss Machine, marking the greatest height reached solo in America.

Furthermore, the chapter delineates the advancements in weight carrying, with P. O. Parmelee's feat of transporting 458 lbs. in a Wright Machine from Chicago, Ill., underscoring the potential for practical application of aviation technology.

The chapter concludes by emphatically stating the unprecedented progress made in aviation throughout 1911, emphasizing that this advancement was not limited to any one country or continent. It presents a picture of global participation in the pursuit of aviation excellence, marking 1911 as a notable year in the annals of aviation history for its remarkable achievements and the broadened horizons of flight capabilities and technology.

CHAPTER I -Flying Machines Construction And Operation

Octave Chanute's opening chapter in "Flying Machines: Construction and Operation" outlines the evolution of the two-surface flying machine, a pivotal innovation in the history of aviation. Chanute begins by acknowledging F. H. Wenham, who, in 1866, patented the initial concept in England, involving multiple aeroplanes arranged above each other to support a framework or car containing the motive power, using materials like silk or canvas stretched on a frame.

Wenham's presentation to the Aeronautical Society of Great Britain in 1866 marked a significant contribution, discussing bird flight observations and his experiments with models large enough to carry a man. His design, involving superposed surfaces to increase supporting surface area without significantly

adding weight, laid foundational principles still recognized in aviation.

Subsequent experiments by others, such as Stringfellow's superposed surfaces model and Linfield's unsuccessful venture, further explored the concept, albeit with mixed results. The chapter also mentions Commandant Renard's "dirigible parachute" and Horatio Phillips' work on wing sections and stability issues, highlighting the trial-and-error nature of early aviation development.

Lawrence Hargrave's invention of the cellular kite introduced a stable design, utilizing superposed surfaces connected by a rod or frame, portraying another step towards reliable flight. Chanute then shares his and contemporaries' glider experiments, emphasizing adjustments and refinements leading to more functional designs. Particularly, Chanute recounts his own work with Herring and Avery on multiple-winged machines and the eventual development of a three-decked machine that demonstrated improved safety and manageability.

The chapter concludes by crediting Wenham's initial proposal of superposed surfaces as a pivotal contribution to aviation, despite Chanute's own novel modifications leading to successful gliders. This foundational work underscores the collaborative and iterative nature of aviation innovation, highlighting the importance of building upon previous efforts to advance flight technology.

CHAPTER II -Flying Machines Construction And Operation

Chapter II of "Flying Machines: Construction and Operation" dives into the theory, development, and usage of early aviation technology, particularly distinguishing between balloons (lighter-than-air machines) and flying machines (heavier-than-air machines) propelled by engines rather than lifted by gas. The chapter underscores the critical inspiration drawn from birds, with the successful designs of flying machines mimicking bird flight on a mechanical scale.

Central to the history of aeroplane development is Octave Chanute of Chicago, heralded as a pioneer for his work in moving beyond previous experimenters like Langley and Lilienthal. Chanute's significant contributions were in the realm of gliding machines that laid the groundwork for future powered flight, despite not having engines themselves. His experimentation with biplanes in 1896, described through firsthand insights from the author's experience, made evident the potential of fixed-wing aircraft.

Chanute, along with collaborators Herring and Avery, intensively studied bird flight to refine their aeroplane designs. Their insights led to the establishment of the biplane design, which later aviators, notably the Wright brothers, further developed. The Wright brothers, transitioning from bicycle makers to aviation innovators, adapted Chanute's concepts, introducing innovations such as a front-mounted rudder and a more aerodynamic positioning of the pilot to reduce wind resistance. Their advancements culminated in success after years of trials with gliders, eventually incorporating a motor to achieve powered flight.

Despite these remarkable achievements, the chapter closes on a cautionary note regarding the practical limitations of early flying machines. Experts of the era expressed skepticism about the commercial viability of these machines for passenger or freight transport due to inherent constraints on their carrying capacity. The narrative suggests a future where flying machines, despite their groundbreaking nature, would remain curtailed by technological and practical boundaries that limit their widespread application in transport sectors. This exploration into the roots of aviation reveals the blend of innovation and inspiration that propelled humanity's quest to conquer the skies, framed by a sober recognition of its initial limitations.

CHAPTER III - Flying Machines Construction And Operation

To grasp the fundamentals of modern flying machines, one must delve into the dynamics of bird and wind action. A straightforward experiment involving a circular cardboard piece illustrates this concept vividly. When dropped, the cardboard falls due to gravity; however, if thrown edgewise against the wind, it sails, mimicking flying machine behavior. This experiment underscores how motion—whether generated by the force of an arm or a motor—keeps the object afloat. The motor's continuous and powerful propulsion differentiates it from the temporary thrust provided by human effort.

Furthering the understanding of flight mechanics, another experiment uses a piece of cardboard with a paper attached to one edge. By bending the paper into a curve and blowing across its convex surface, the paper lifts instead of collapsing. This is contrary to naive expectations, as air flow over the curved surface raises the paper. Conversely, when the paper is curved with the concave side up and blown across, it moves downward, emphasizing that the direction of curvature significantly impacts the air's effect on the object.

These principles are central to all flying machines. The construction of monoplanes and biplanes relies on curved surfaces for sustentation. Initially, straight planes were tested but proved inefficient in sustaining flight. By adopting curved planes with the concave side facing downward, air is trapped and creates buoyancy. The optimal curvature degree remains debated among engineers, with variations from one to three inches per foot showcasing different designs' attempts to harness air effectively.

This insight parallels the initial actions of a bird commencing flight. Like a bird flaps its wings to gain altitude, a flying machine's motor propels it into the sky. However, unlike birds, flying machines require constant propulsion from the motor to remain airborne, highlighting the mechanical principle: a flying machine, to sustain flight, must continuously move forward.

The term "plane" traditionally suggests a flat surface, yet in aviation, it incorrectly describes the curved supporting surfaces of flying machines, leading to the common but technically imprecise usage of "aeroplane." Despite the terminological inaccuracy, its widespread acceptance ensures its continued use in discussions related to flight mechanics.

CHAPTER IV - Flying Machines Construction And Operation

The realm of flying machines is divided into three fundamentally different categories: aeroplanes, helicopters, and ornithopters. Among these, aeroplanes claim the spotlight, becoming the primary choice for aviators due to their proven efficacy, whereas helicopters and ornithopters, despite their unique advantages, struggle with critical limitations that hinder their widespread adoption.

Helicopters: Defined by their distinct vertical propellers or helices, helicopters boast the ability to ascend directly upward from the ground. This characteristic eliminates the need for a runway, allowing operation within confined spaces—an advantage in certain scenarios. However, this benefit is overshadowed by significant drawbacks. Helicopters suffer from a lack of sustaining capacity and demand an excessive amount of motive power, making them less efficient than their counterparts.

Ornithopters: Mimicking the flapping wings of birds, ornithopters represent an attempt to harness the natural mechanics of avian flight. Early aviation enthusiasts were drawn to this design, believing it to closely follow the ideal flight principle. Despite its intuitive appeal, the ornithopter falls short in practicality. The reality that birds essentially act as aeroplanes, with their wings providing both lift and propulsion, underscores the ornithopter's inefficiency. Primarily serving as a novel toy, efforts to scale ornithopters for human flight have yielded disappointing results, confirming their impracticality in real-world applications.

Aeroplanes: As the dominant form of flying machine, aeroplanes have successfully addressed the challenges that limit helicopters and ornithopters. Their design and operational principles allow for superior lift, sustainability, and power efficiency, reasons for their predominant use in aviation. While helicopters and

ornithopters contribute interesting concepts to the field, it is the aeroplane that stands out as the most viable and efficient means of achieving manned flight.

CHAPTER V - Flying Machines Construction And Operation

Constructing a gliding machine requires careful consideration of its design, specifically the choice between a monoplane, biplane, or triplane. For beginners, a biplane is recommended due to its compactness and ease of handling. This design is predicated on the principle that 152 square feet of surface can support the weight of an average-sized man (170 pounds), and arranging this surface across two planes results in a more manageable structure.

To embark on building a flying machine, one starts with constructing a glider, which becomes a flying machine upon the addition of a motor. Novices are advised to master the construction and operation of a glider before attempting to build a fully equipped flying machine. A practical design for a starter glider consists of a 20-foot spread and a 4-foot depth, providing the necessary surface area to sustain a man's weight.

Materials critical to the construction include spruce for the frame due to its lightness and strength, as well as linen shoe thread, metal sockets, piano wire, cloth (silk or cotton), glue, and varnish among others. The construction process involves crafting horizontal beams and stanchions to form the frame, attaching ribs and struts to support and maintain the structure, and covering the frame with cloth to create buoyancy.

The planes are joined using metal sockets and the rigidity of the structure is ensured through the use of guy wires, providing the necessary tension to hold the frames in a fixed position. The final step involves covering the frame with a lightweight, strong, and windproof cloth, treated with varnish to enhance its properties.

The entire process emphasizes the importance of lightness, strength, and rigidity in flying machine construction, with detailed attention to material selection and structural integrity to ensure successful operation. The cost of materials is estimated to remain under \$20, considering the labor is self-provided, demonstrating the project's accessibility to enthusiasts.

CHAPTER VI - Flying Machines Construction And Operation

In Chapter VI of "Flying Machines: Construction and Operation," prospective aviators are advised to start learning to fly with caution, emphasizing the importance of avoiding unnecessary risks due to the inherent dangers of aviation. The text advises novices to commence their flight training on level ground rather than from elevated positions, typical of experienced aviators who understand air currents and have developed skills to manage their machines effectively through body shifts to control direction and altitude.

The process detailed for initiating flight involves running with the glider, assisted by others, to gain momentum, allowing the wind to lift the glider. Gradual movements of the body's weight, front or back, serve to adjust the glider's altitude and maintain it in the air. These movements, crucial for controlling the glider's direction and elevation, highlight the sensitivity of the glider to the pilot's maneuvers.

Addressing the concept of ascent, the chapter elucidates that gliders and flying machines ascend at an angle rather than vertically, influenced by wind force, the machine's weight, and its propulsion. An optimal angle for ascent is noted as being around 23 degrees, underpinning the fact that increased speed can allow for a reduction in this angle by diminishing wind resistance.

The narrative acknowledges the challenges of maintaining equilibrium in flight, particularly under gusty wind conditions. It recommends that beginners practice in steady wind conditions without exceeding twelve miles an hour and in spaces free of obstructions like trees. The chapter transitions into discussing the unpredictability of wind currents near obstacles and their effect on flight control, emphasizing the preference for open, unobstructed areas for practice flights.

Furthermore, the chapter introduces a launching device for gliders, designed by Octave Chanute, which aids in achieving the necessary speed and altitude for takeoff without requiring an elevated position. This mechanical aid highlights the evolving nature of flight training, allowing for greater control and safety during the initial stages of flight.

In summary, Chapter VI combines practical advice with technical insights, fostering a foundational understanding essential for safe and effective flight training. It underscores the significance of mastering control over the machine through gradual, sensible progression in learning, coupled with an awareness of the environmental factors that significantly impact flight dynamics.

CHAPTER VII - Flying Machines Construction And Operation

In Chapter VII of "FLYING MACHINES: CONSTRUCTION and OPERATION," the process of attaching a rudder to a glider is elaborated, highlighting this mechanism's critical role in maintaining direction and stability during flight. Typically, gliders feature a single, static rudder at the rear to keep the device oriented into the wind. In contrast, advanced flying machines employ both front and rear rudders, which the pilot can adjust via wire cables for better control.

For enthusiasts ready to enhance their glider with a rudder, the chapter outlines a detailed procedure. Initially, a 2-foot-long cross piece is inserted between the center struts at the bottom plane, either bolted or braced, though bolting is favored for its strength. This cross piece serves as the foundation for the rudder beam, an 8 feet 11 inches component crucial for the rudder's functionality. The same assembly process is mirrored on the glider's upper frame to ensure symmetry and balance.

Constructing the rudder involves making two sections: one horizontal and one vertical. The vertical section is designed to keep the aircraft facing into the wind, while the horizontal section aids in maintaining equilibrium. The rudder's frame comprises the rudder beams as the top and bottom parts, with two upright pieces, each 3 feet, 10 inches long and 3/4 inch thick, attached approximately two feet apart. These elements construct the vertical rudder's framework.

This chapter provides a seamless guide for those looking to advance from utilizing a basic glider to operating a more complex flying machine by incorporating a rudder. The instructions are clear, methodical, and include specific measurements to ensure the rudder is both functional and properly aligned, underscoring the importance of precision and stability in aerial operation. Through this enhancement, the glider gains improved navigability and stability, crucial for aspiring aviators progressing in their aeronautical endeavors.

CHAPTER VIII - Flying Machines Construction And Operation

Chapter VIII of "Flying Machines: Construction and Operation" discusses the transition from constructing a basic glider to building a real flying machine capable of directed flight with a pilot onboard. It emphasizes the need for a significantly larger surface area to support the additional weight of a motor, propeller, and other equipment. The chapter presents the Wright brothers' biplane, with a 41-foot span and 538 square feet total surface area, as an example, highlighting its ability to carry over 1,000 pounds, which equates to about two pounds per square foot of surface.

Comparatively, it notes the different requirements for monoplanes, pointing to Bleriot's substantially smaller monoplane which successfully crossed the English Channel, demonstrating that smaller surface areas can achieve high speeds and sufficient lift with less resistance to air.

The chapter further details considerations for selecting a machine type, pointing out the advantages of biplanes in carrying capacity versus monoplanes in speed. It guides through the construction process, advising on the sizing of frames, selection of materials (favoring wood over metals like aluminum for its strength-to-weight ratio), and the intricacies of splicing timber for the frame's construction.

Additionally, it elucidates on motor installation, suggesting flexibility based on the aircraft's design and weight distribution requirements. The placement of rudders and auxiliary planes also varies significantly among aviators, with no consensus on the optimal design, indicating the experimental nature of early aviation.

Lastly, it addresses the practical aspects such as calculating the necessary surface area for lift and the cost considerations for amateur builders. The chapter ultimately serves as both a technical guide and a historical snapshot of the early 20th-century aviation experimentation, emphasizing the combination of theoretical principles and empirical testing in developing functional aircraft.

CHAPTER IX - Flying Machines Construction And Operation

In Chapter IX of "Flying Machines: Construction and Operation," the selection and characteristics of motors suitable for aviation are thoroughly discussed, with a focus on those features that are pivotal for optimal performance in flying devices. To ensure reliability and efficiency, the text highlights that motors must be lightweight, strong, capable of high speeds, and thoroughly dependable. Various types of motors are described, including those manufactured by Renault, Fiat, Farcot, R. E. P., Gnome, Darracq, Wright, Antoinette, E. N. V., and Curtiss, with specific details such as cylinder numbers, cooling methods, horsepower, and weight, showcasing a broad range in design and capabilities.

The chapter delves into the reasons behind the preference for lighter motors, citing the Gnome engine as a notable example for its outstanding power-to-weight ratio, achieved by innovative design choices such as eliminating the flywheel and utilizing special materials. These innovations underscore the technical advancements and creative engineering solutions aimed at maximizing aerodynamic efficiency and performance.

The text further explores the principles behind motor operation, revealing that the number of cylinders doesn't linearly influence weight or power output, a concept counterintuitive to non-specialists. It explains the complex relationship between horsepower, speed, and aerodynamic factors — emphasizing that a motor's raw power does not directly equate to proportional increases in flight velocity.

The chapter also details how aeroplane propulsion is influenced by propeller design, with a comparative analysis of various propeller models used by Curtiss, Wright, Bleriot, Santos-Dumont, and others, highlighting the diversity in design philosophy and the ongoing quest for an ideal balance between thrust, weight, and aerodynamic efficiency.

Throughout, the challenge of developing an ideal aviation motor is underscored, with historical attempts like the Darracq motor, commissioned by Santos Dumont, used as case studies to illustrate the trial-and-error nature of pioneering aviation technology. Despite significant advancements, the text concludes that the perfect motor remains elusive, reflecting the early 20th-century state of aviation technology and the continuous search for improvement in power-to-weight ratios, reliability, and fuel efficiency, essential for the advancement of flight.

CHAPTER X - Flying Machines Construction And Operation

Chapter X of "Flying Machines: Construction and Operation" focuses on the key considerations in determining the appropriate dimensions for flying machines, with an emphasis on the significance of plane surface proportions relative to the load each machine is intended to carry. This complex problem involves not only the weight of the operator, motor, and propeller but also the challenge of estimating the completed weight of other components such as planes, rudders, and auxiliaries.

To aid in this task, the chapter provides detailed specifications of nine prominent flying machines, divided into monoplanes and biplanes, including their surface area, weight, power, passenger capacity, and dimensions. These examples serve as a practical guide for deciding on machine dimensions, suggesting that by analyzing successful models, designers can approximate the necessary specifications for their own projects.

In determining the overall lifting capacity, the weight of the operator is factored into the total weight of the machine, indicating the amount of supporting surface required per pound of load. The chapter highlights differences in supporting power between models, cautioning amateurs not to rely on exceptional instances as typical benchmarks.

The chapter also touches upon the variations in weight-sustaining power among different machines, emphasizing the crucial balance between surface area and engine power. The text explains that the engine's role is paramount in maintaining the machine's motion and, consequently, its ability to stay airborne. A comparative look at various machines suggests a general approach for amateurs: aiming for a total weight-sustaining power of approximately 1,200 pounds, accounting for the operator and equipment, while emphasizing the importance of using lightweight materials for safety and efficiency.

Lastly, the chapter contrasts the flight capabilities of birds, like the albatross and vulture, relating their efficiency to the principles that govern the design and operation of flying machines. This analogy underscores the importance of power and speed in achieving effective flight with reduced supporting surface area, providing a natural benchmark for aviation enthusiasts and engineers.

CHAPTER XI - Flying Machines Construction And Operation

In Chapter XI of "Flying Machines: Construction and Operation," the focus is on the crucial aspect of controlling the machine through various means of manipulating rudders and auxiliary planes. The central idea is that the operator must have instant control over the machine to manage its direction, equilibrium, and altitude effectively. This control extends to adjusting the motor's functioning, particularly in regulating fuel supply, highlighting the need for quick, precise actions due to the critical nature of airship navigation.

The text delves into various methods employed by aviators for control - ranging from steering wheels akin to those in automobiles, which manage both rudder planes and fuel flow, to foot and hand levers. Innovations in control techniques are exemplified by figures like Curtiss, who integrates aeroplane stabilization with a jointed chair-back, and the Wright brothers, who evolved their system from dual hand levers to a single lever for comprehensive control. The narrative also mentions Bleriot's preference for a single lever, Farman's use of a lever for rudder control paired with foot levers for balancing, and Santos-Dumont's unique method of leveraging an attachment on his coat for plane manipulation.

The connection between these control levers and the aeroplane's components is predominantly achieved through wire systems, which allow for precise movements of rudders and planes, emphasizing the simplicity yet critical need for calm and accuracy in operation to avoid danger.

The chapter does not endorse any single method as superior, acknowledging that each has its proponents and successfully meets the needs of navigation. It underscores the necessity for novices to thoroughly understand and master the control mechanisms before attempting solo flights. This mastery can be developed through practice with the machine stationary, ensuring familiarity with the effects of different control movements, which is portrayed as pivotal for safety and effectiveness in airship navigation.

This section essentially bridges the technical construction of flying machines with the practical challenges of operation, laying a foundation for safe, controlled navigation by detailing the evolution and variety of control methods in early aviation.

CHAPTER XII - Flying Machines Construction And Operation

Chapter XII of "Flying Machines: Construction and Operation" demystifies the process of operating flying machines, emphasizing the practical aspects of flight rather than the quest for record altitudes. It informs readers that contrary to popular belief, flying machines do not need to be operated at extreme heights. Experienced aviators like Farman, Bleriot, and Wright, among others, frequently fly within a safe altitude range—between 500 to 1,500 feet, with the record at about 4,165 feet, held by Paulhan.

A key rule enforced by pioneers like Wright and Curtiss instructs aviators never to exceed 30 feet in height or drop below 6 feet during flights to ensure safety due to the thinner air at higher altitudes which reduces sustentation. The chapter proceeds to guide beginners on making their first flight, emphasizing the importance of understanding the machine's control mechanisms. It suggests that initial flights be done from flat, obstruction-free grounds with the aid of three assistants to ensure a smooth launch and landing.

The authors advise novices to aim for modesty in their flights, underscoring that a short, successful flight is more valuable than ambitious attempts fraught with mishaps. They advocate for a cautious approach, staying around 25 to 30 feet above the ground to build confidence and ensure safety.

Learning to preserve equilibrium is highlighted as an essential skill, drawing parallels with bicycling techniques to help readers understand how to maintain balance in the air, thus preventing falls by adjusting the machine's tilt in response to shifts in the center of gravity or by manipulating the stabilizing planes.

Through practical advice and comparisons to familiar experiences, the chapter offers a comprehensive guide to novice aviators on how to safely and confidently undertake and navigate their initial flights, emphasizing cautious altitude management, the significance of understanding control mechanisms, and the importance of balance in flight operations.

CHAPTER XIII - Flying Machines Construction And Operation

This chapter delves into the specific demands for power in airship propulsion, distinguishing markedly from terrestrial vehicles like automobiles in terms of power requirements for a given load. Unlike cars that rest on the stable ground and require relatively less power to move heavy loads at significant speeds, airships, due to the absence of a solid resting platform, necessitate much greater power to maintain both lift and forward motion. An automobile might carry a load weighing 4,000 pounds at speeds up to 50 miles per hour with just a 30-horsepower engine. In stark contrast, a modern flying machine, carrying 1,200 pounds, requires a 50-horsepower engine to achieve the same speed, demonstrating a significantly higher power demand relative to its load.

The key factor in this discrepancy lies in air resistance or wind pressure. When an object moves through the air, it encounters resistance, with the resistance force increasing exponentially with the speed. This

phenomenon results in dramatically higher power requirements for airships as their speed increases. A table provided in the text shows how horsepower needs surge dramatically with speed due to wind pressure against the moving object. For instance, moving from 60 to 100 miles per hour doesn't merely double the power requirement; it increases it eightfold.

Additionally, it's explained how the engine's horsepower is allocated, with a portion dedicated to overcoming wind resistance and the remainder for propulsion. The chapter further illustrates how these calculations apply to real-world aviation, using the Curtiss aeroplane as an example, where out of a 50-horsepower engine, 12 horsepower is spent overcoming wind pressure alone.

The chapter also touches on the comparison between birds and aeroplanes in terms of supporting area and horsepower required for flight, indicating that while aeroplanes have made remarkable advances, they require substantially more power for the weight they lift compared to birds.

In terms of design implications, the chapter concludes that a larger supporting area can reduce the power needed for lift but at the expense of increased bulk and potential difficulty in handling. Additionally, the chapter introduces fuel consumption as a critical factor, with increased power demands necessitating higher fuel consumption, setting the stage for further exploration of this challenge in aviation.

CHAPTER XIV -Flying Machines Construction And Operation

Chapter XIV of "FLYING MACHINES: CONSTRUCTION and OPERATION" delves into the complexities and unpredictabilities of wind currents, a fundamental challenge for early aviators and balloonists alike. Arthur T. Atherholt, through his experiences and observations, notably in the Aero Club of Pennsylvania, shares insightful reflections on the erratic nature of these currents, likening them to the tumultuous whirlpools of Niagara. His narrative, rich with examples from balloon competitions and solo journeys, emphasizes the inherent difficulties in navigating through shifting air streams that vary not only directionally but also in velocity, often without any apparent warning or pattern.

Atherholt's anecdotal evidence, particularly from the Gordon-Bennett race and his own expeditions, illustrates the sheer unpredictability of these currents, showcasing instances where balloons, though launched from a single point and within the same timeframe, would find themselves scattered over vast geographical expanses due to the whims of the wind. His observations underscore a critical takeaway for aviators: the need for preparedness and adaptability in the face of nature's capricious elements.

The chapter also explores the technical aspects of maintaining balance and control in flying machines, drawing parallels to the adaptability and techniques observed in birds. It presents a variety of methods aimed at achieving stability and equilibrium, from adjusting the angles of wings to the strategic positioning of the machine's center of gravity. The discourse extends into the design intricacies that enable an aeroplane to counteract the disorienting effects of erratic wind currents, suggesting solutions such as dihedral angles and the employment of horizontal rudders.

Through a detailed examination of the challenges posed by wind currents and the innovative strategies devised to navigate them, this chapter not only highlights the complexities of early aviation but also celebrates the ingenuity and perseverance of pioneers who sought to understand and conquer the skies. The narrative weaves together technical methodologies with firsthand accounts, providing a comprehensive overview of the obstacles and achievements in the quest for controlled, sustained flight.

CHAPTER XV - Flying Machines Construction And Operation

In "The Element of Danger," Chapter XV of "Flying Machines: Construction and Operation," the narrative addresses the perceived risks attached to early aviation, debunking myths of excessive danger whilst acknowledging the inherent risks involved. The chapter compares aviation casualties to those of railway operations, suggesting that, relative to its novelty and the nature of flight, aviation's casualty rate is surprisingly low. This comparison is aimed at providing perspective, highlighting both the progressiveness and the challenges of flight.

The text elucidates on how an aeroplane, contrary to popular belief, does not plummet like a bullet in case of malfunction; instead, it is designed to glide downward, somewhat like a parachute, provided the operator maintains composure and skillfully manages the craft to stabilize its descent. This capability for controlled descent introduces the concept of "two fields of safety" — one at lower altitudes with minimal fall distance, and another at higher altitudes where there's sufficient space to reduce velocity and angle the aircraft for a softer landing.

Specific case studies, such as the fatal incidents involving aviators Antonio Fernandez and Leon Delagrang, serve as cautionary tales emphasizing the importance of thorough testing and adherence to design specifications. These examples underline the fatal consequences of neglecting safety precautions, such as overloading or operating with structural defects.

Despite these incidents, the chapter positions aviation as not excessively hazardous, especially in the hands of experienced and prudent operators. It provides a historical overview of aviation's fatalities up to April 1910, indicating that the fatalities were few, considering the experimental nature of early flights and the limited experience of most aviators at the time.

The chapter concludes by advocating for responsible aviation, likening it to responsible seafaring. Just as a wise captain wouldn't sail in a storm or with an unseaworthy vessel, aviators are counseled against flying under adverse conditions or with untested equipment. This analogy extends to a comparative analysis of railway and aviation accidents, asserting that with appropriate precautions, aviation could be considered safer than railroading, given the vast difference in annual casualties.

CHAPTER XVI - Flying Machines Construction And Operation

The chapter describes significant advancements and alterations in aeroplane design by the Wright Brothers and contrasts their work with that of their contemporaries. The Wright Brothers, motivated by their achievements, aimed for the perfect aircraft, making notable changes to their models between 1908 and 1909. The 1908 model, measuring 40 by 29 feet and featuring a 25 horsepower engine, demonstrated a lift efficiency, but the Wrights sought improvement in speed and structural efficiency.

In 1909, they introduced a model with reduced dimensions and weight but improved aerodynamics and structural strength. This model, despite being lighter, faced challenges in lateral stability that were overcome with advanced piloting skills. Adjustments included a narrower aerocurve and modifications to the engine and structural materials, which contributed to a speed increase from 39 to 42.5 miles per hour, maintaining its passenger capacity while reducing "head-on" resistance and improving propeller thrust.

Additionally, the Wrights introduced wheeled gears to their aeroplanes for the German market, marking a departure from their previous skid-based designs. This innovation facilitated easier learning for pilots, as it allowed for simpler takeoff and landing without the need for starting derricks.

The chapter also highlights the competitive landscape, acknowledging the Wright brothers' three main rivals: the Curtiss and Voisin biplanes, and the Bleriot monoplane. The Bleriot monoplane is singled out as particularly formidable due to its speed records, the ability to cross the English Channel, and its impressive

lift capability.

The narrative underscores ongoing innovation across the field of aviation, with leading figures like Curtiss, Voisin, Bleriot, and Farman advancing the development of flying machines regardless of patent disputes. The Wright brothers retain a competitive edge through patents essential to aeroplane construction, but litigation over these patents poses uncertain impacts on the broader advancement of aviation technology.

CHAPTER XVII - Flying Machines Construction And Operation

In Chapter XVII titled "Some of the New Designs" from "Flying Machines: Construction and Operation," the focus is on the innovative steps inventors are making in the realm of aviation technology. Among these inventors, Frank Van Anden of Islip, Long Island, emerges prominently with his creation, the Van Anden biplane, which has been subject to experimental flights and showcases an automatic stabilizing device that proved its worth during a flight on October 19th, 1909. This device marks a significant advancement by automatically correcting the aircraft's position after a sudden gust of wind caused it to keel over.

The Van Anden biplane's construction features include 26-foot wide main biplanes coated with silkolene and varnish, a structure reinforced with spruce ribs and struts, and the inclusion of a two-surface horizontal rudder both in the front and rear, alongside a vertically hinged rudder at the back. The aircraft incorporates the Curtiss system for elevation and depression control of the main planes through the steering-wheel post, with additional control for turning through the steering wheel itself.

Notably, the Van Anden model introduces an automatic control for the wing tips connected to the engine, which played a pivotal role in stabilizing the aircraft during turbulent conditions. This innovation establishes the machine's distinctive feature amidst other designs.

Another novel aeroplane highlighted is the Herring-Burgess, created by A. M. Herring and W. S. Burgess, which leverages an automatic stability device for balance and sports a unique method for control handled by the aviator. This model also underscores the incredible lightness and efficiency of its 30-horsepower motor, which maintains high performance with minimal weight.

Furthermore, the chapter mentions the initiative by students at the University of Pennsylvania, led by Laurence J. Lesh, who constructed an aeroplane incorporating new ideas like a tandem steering gear design for a practical learning experience under guidance. Their machine, "Pennsylvania I," represents another step forward, featuring dual rear propellers powered by a Ramsey 8-cylinder motor and a novel lateral control system developed by Lesh and Octave Chanute.

These advancements illustrate a period of rapid evolution in aviation, driven by a mix of established aviators and inventive newcomers, all contributing to overcoming the challenges of flight through technological innovation and experimentation.

CHAPTER XVIII - Flying Machines Construction And Operation

The rapid advancement of motor-equipped aeroplanes has surpassed even the remarkable commercial growth experienced by automobiles. This surge in interest and sales is largely attributed to Bleriot's historic flight across the Dover Straits in 1909, which served as a wake-up call to the public about the viability of aviation not just for professional aviators but for anyone with the resources and courage to engage in it. This event marked the entry of the modern flying machine into the commercial business sphere, challenging the previously unchallenged position of the automobile by achieving greater sales numbers within a year of serious commercial consideration compared to the automobile's first year of sales.

Unlike the automobile industry, which required years of dedicated promotion and development to establish its market, the flying machine industry witnessed an immediate and overwhelming demand shortly after Bleriot's flight, despite the lack of initial intentions to sell flying machines commercially. Manufacturers are now facing an influx of orders, leading to expansions in production capabilities and the initiation of advertisement campaigns similar to those of the automobile industry. Notable sales reported since July 1909 include significant numbers from Santos Dumont, Bleriot, Farman, and other pioneers, with orders either fulfilled or in the process of being completed. This burgeoning demand is being met despite the manufacturers' initial lack of readiness for such a surge, prompting the establishment and expansion of specialized plants and the introduction of modern production methods.

In addition to the sales of machines, prices for these pioneering flying machines range notably, from \$1,000 for a Santos Dumont model, with demand pushing prices higher, to \$5,600 for a Wright model, reflecting the premium prices consumers are willing to pay to secure these innovative devices. The motor stands out as the most costly component, underscoring the technological and financial investment in this nascent industry. Encouragingly, the provision of systematic instruction for amateurs by seasoned aviators like Curtiss and the Wright brothers is becoming a burgeoning facet of the industry, illustrating the growing accessibility and interest in aviation as both a pursuit and a practical mode of transport, sport, and pleasure.

CHAPTER XIX - Flying Machines Construction And Operation

Chapter XIX of "Flying Machines: Construction and Operation" elucidates the intricate interplay between aviation and law, a relationship prompted by the burgeoning successes of aviation. The foundational legal stance is that property ownership encompasses not only the ground but also extends indefinitely upwards into the sky, an interpretation supported by legal luminaries like Blackstone, Littleton, and Coke. This principle grants property owners the right to defend against any unpermitted invasions of their aerial space, save for exceptions like public utility companies which can invoke eminent domain for public welfare.

The text examines scenarios that arise from this legal backdrop in the context of aviation. A notable case is provided where a New Jersey property owner overtly warns aviators against trespassing over his property. This raises complex questions about enforcing property rights against air travel, highlighting practical challenges such as catching and prosecuting offenders and the courtroom dilemma of quantifying damage when an aircraft trespasses without causing tangible harm.

The issue of right-of-way for airships suggests a potential deadlock should property owners uniformly oppose air travel over their lands. A speculative solution hints at regulated air corridors above public highways, aligning with public safety and regulated traffic patterns to minimize invasions of privacy and potential nuisances.

Furthermore, the discourse delves into legal responsibilities and potential liabilities for aviators, stressing the necessity for licensing and regulations to ensure competency and safety. It presents hypothetical scenarios demonstrating the legal nuances in determining liability for damages resulting from aviation activities, suggesting the law's need to evolve in lockstep with technological advancements to address crimes and contractual obligations in airborne contexts.

This exploration into aviation law underscores the balance between property rights and public interest, hinting at the broader implications for the emerging realm of aviation, where traditional legal doctrines are tested and potentially adapted to accommodate the new aerial frontier. Through examples and hypotheticals, it illustrates the complexity of integrating aviation into a legal framework designed for a terrestrial society.

CHAPTER XX -Flying Machines Construction And Operation

The phenomenon of soaring flight, observed in large birds able to glide for hours without flapping their wings, even against the wind, presents a fascinating contradiction to conventional physics. This process, often deemed a form of "negative gravity" by baffled onlookers, has sparked significant interest and speculation among observers and scientists alike.

Octave Chanute, in his meticulous research published in the "Aeronautical Annual" of the late 1890s, delved into the mechanics of bird flight, differentiating between soaring and flapping flight. Through detailed observations and calculations, Chanute highlighted the remarkable efficiency of soaring birds, such as gulls, which can exploit wind currents and variations to maintain flight with minimal energy expenditure. His studies revealed that birds could harness wind energy to sustain themselves, demonstrating this with the example of a gull maintaining an upward angle and extracting necessary energy from upwardly deflected winds beside a steamer.

Chanute's efforts to rationalize the soaring flight's physics concentrated on understanding wind dynamics and the aerodynamic properties of bird wings. Despite initial challenges in explaining the ability of buzzards to soar in nearly windless conditions, Chanute, with the assistance of E.C. Huffaker, identified that subtle wind gradients and air currents invisible to the naked eye played crucial roles in sustaining flight in seemingly calm conditions.

Through a blend of speculative reasoning and empirical data, including wind tunnel tests conducted by Professor A. F. Zahm, Chanute elucidated how buzzards could soar by leveraging slight upward air movements. This breakthrough shed light on the complex interplay between wind currents, wing morphology, and flight dynamics, paving the way for further advancements in aerodynamics and the nascent field of human flight.

Chanute's work predated the Wright brothers' experiments in Kitty Hawk, laying foundational principles that would later inform the development of powered flight. His conclusions emphasized the potential of rising air currents to support sustained flight and anticipated the integration of motors to augment natural wind energies.

The chapter concludes with Chanute outlining prerequisites for successful soaring flight in machines, underscoring the importance of initial velocity, wing configuration, and skillful maneuvering to emulate the natural efficiency of birds. His anticipation of future advancements hinted at the burgeoning potential of aviation technology to adopt and refine the principles of soaring, ultimately contributing to the human aspiration to conquer the skies.

CHAPTER XXI - Flying Machines Construction And Operation

Chapter XXI of "Flying Machines: Construction and Operation" contrasts the limitations and costs associated with dirigible balloons to the advantages and performances of early flying machines. Dirigible balloons require substantial investment not only in their construction, with costs like the Zeppelin exceeding \$100,000, but also in operation due to the need for frequent gas re-inflation, a procedure that can run into hundreds of dollars for a single refill. Moreover, the difficulty in controlling these balloons in heavy winds and their vulnerability to atmospheric conditions, like lightning, which resulted in the destruction of a major Zeppelin in 1908, represent significant drawbacks.

Despite these challenges, balloons have achieved notable performances. For instance, in 1907, the *Patrie* traveled 187 miles in under 7 hours, and the Zeppelin No. 3 made a 67-mile trip in just over 2 hours in 1906, both showcasing the potential for dirigible balloons under favorable conditions. However, these achievements pale in comparison to the advancements in flying machines during the same period, which demonstrated higher speeds and greater control. Early flying machines achieved speeds up to 52 miles per

hour, with the Wright brothers covering 24 miles in 38 minutes in 1905 and Lambert flying a Wright biplane 29.82 miles in under an hour in 1909.

The chapter also highlights the expenses associated with producing hydrogen gas for balloons, emphasizing its high cost and the logistical challenges of obtaining it, particularly in remote areas or in sufficient quantities for large-scale operations. The production of hydrogen requires significant amounts of raw materials, such as zinc or iron, and sulfuric or hydrochloric acid, leading to further complications in emergency situations or for military maneuvers.

In summary, while dirigible balloons have their role in the early history of aerial navigation and have demonstrated some impressive feats, they are overshadowed by the greater potential, efficiency, and practicality of flying machines. The chapter underscores the technological, logistical, and financial hurdles that make dirigible balloons less viable for widespread use, especially as flying machines continue to advance in speed, control, and operational feasibility.

CHAPTER XXII - Flying Machines Construction And Operation

In his lecture to the Royal Society of Arts, F. W. Lanchester discussed the complexities of aerial flight, emphasizing that practical flight is a matter of locomotive engineering rather than abstract theory. He criticized the helicopter or vertical screw type for its inefficiency in transport, asserting that only airplanes could meet the demands of locomotion by achieving necessary speeds to counter wind velocities and ensuring fuel economy for longer flights.

Lanchester highlighted the necessity for an airplane to compete with other forms of locomotion by being able to navigate efficiently against air currents, which necessitates a velocity greater than that of the strongest winds. He illustrated this point with diagrams showing how an airplane's movement is hampered by increasing wind speeds, noting that to counteract this, airplanes must achieve high speeds, thus demanding more fuel. The optimal speed for an airplane, he argued, was over 60 miles per hour to combat gusts and ensure rapid damping to stabilize the flight path – a speed already achieved by pioneers like the Wright brothers and Farman.

On the technical side, Lanchester detailed the limitations imposed by fuel consumption on flight range and duration. He pointed out the importance of developing lightweight engines with low fuel consumption rates to enable longer flights without significantly increasing the total weight of the aircraft. He presented data on the weight-to-power ratios of contemporary engines, indicating the progress and challenges in aviation engineering.

Propulsion efficiency was another crucial topic Lanchester tackled. He advocated for the use of screw propellers, which, like their marine counterparts, required careful consideration of diameter, pitch, and position relative to the aircraft to optimize efficiency. By using curves to represent the efficiency of propeller blades, he demonstrated how to determine the best design for an aircraft's propulsion system, favoring propellers positioned at the rear of the aircraft to avoid disrupting airflow and to utilize energy from the wake current.

Finally, Lanchester touched on the potential benefits of soaring flight, which reduces the power needed by utilizing upward air currents found near cliffs or generated by temperature differences. He cited examples from nature, such as the soaring behavior of condors and gulls, to illustrate how aircraft might one day harness similar principles to improve efficiency in flight.

CHAPTER XXIII - Flying Machines Construction And Operation

In Chapter XXIII of "Flying Machines: Construction and Operation," the discussion revolves around the use of Wright patents by amateurs in the realm of aviation. The Wright brothers have clarified that amateurs, as well as professionals not engaged in profit-making exhibitions, are free to utilize their patented technologies without fear of legal action. This decree aims to encourage the use of their inventions for pleasure or scientific advancement rather than for financial gain, which they reserve for themselves as a form of compensation for their labor and innovation in the field of aviation.

The Wright patents focus on specific mechanisms to achieve controlled flight, including the warping of wings for lateral stability and a vertically moving rudder to maintain balance and direction. These innovations were proven to be pivotal in the management of flight dynamics, marking a significant contribution to aviation technology.

Legal battles underscore the chapter, highlighting the injunction obtained by the Wrights against the Herring-Curtiss Co. and Glenn H. Curtiss for patent infringement. The legal discourse explores the nuances of the patents and the alleged infringements, with U.S. Circuit Court Judge Hazel granting a preliminary injunction against Curtiss for utilizing a similar mechanism for wing warping and rudder control, despite Curtiss's arguments of distinct differences in operation and design.

Judge Hazel's detailed explanation emphasizes the broad interpretation of the Wrights' patents, noting that the fundamental principles of their invention were mirrored in Curtiss's design, leading to the infringement ruling. This serves as a crucial acknowledgment of the Wrights' innovative contributions to aviation mechanics and their legal rights over the same.

The chapter also touches upon the Aero Club of America's official recognition of the Wright patents, bolstering the Wrights' position in the aviation community and further solidifying their status as pioneering contributors to the field.

This chapter not only narrates the technical and innovative strides made by the Wright brothers but also delves into the legal challenges they faced in protecting their inventions. It showcases the intersection of innovation, ambition, and the complexities of patent law in the burgeoning field of aviation, reinforcing the Wrights' legacy in the annals of aerial exploration and development.

CHAPTER XXIV - Flying Machines Construction And Operation

Chapter XXIV of "Flying Machines: Construction and Operation" delves into the intricate details of propeller construction, highlighting the specific techniques and considerations that aviators and designers prioritize to optimize performance. The chapter elucidates how every designer aims to achieve maximum thrust—or air displacement—with minimum expended energy, though each incorporates their own unique ideas and adjustments, especially in terms of propeller pitch and twist.

The text introduces key terms related to screw propellers, such as "pitch," defined as the theoretical distance a propeller would travel in one revolution without slip, and "pitch speed," which calculates the distance a propeller covers in a minute considering its revolutions per minute and pitch. Another significant concept is the "uniform pitch," where a propeller's blades are designed to ensure all parts travel at a consistent speed, enhancing efficiency.

The chapter further explores the dilemmas of non-uniform pitch, where inconsistent speeds across the propeller's blades can lead to inefficiencies, drawing an analogy to boats connected by a line but moving at different speeds. This mismatch can cause portions of the propeller to resist forward motion, effectively serving as a dead load to the efficient segments, thus undermining the propeller's overall efficacy.

Addressing the concept of "slip"—the discrepancy between a propeller's theoretical and actual travel distance under load—the text explains how both the efficiency of blade design and the load carried influence a propeller's performance. Propellers, likened to nuts moving on threaded bolts, demonstrate increased resistance and demand for power when loaded, emphasizing the importance of optimizing for minimal slip to approach maximum efficiency.

The chapter concludes by discussing the strategic curvature of blades to enhance lift per horsepower, the importance of maintaining correct pitch angles, and the necessity for blade rigidity to prevent distortion from forces like centrifugal pressure. Instructions on calculating the appropriate angle for a propeller's pitch at varying diameter points are provided, culminating in an understanding that precise adjustment and alignment of these elements are crucial in constructing effective flying machine propellers. This meticulous attention to detail reflects the chapter's overarching theme: the optimization of propeller design is critical for the successful operation of flying machines, marrying theoretical principles with practical application for aeronautical advancement.

CHAPTER XXV -Flying Machines Construction And Operation

Since the publication of this book in early 1910, the development of aeroplane motors has significantly advanced, allowing aircraft to operate with much less supporting surface area than was previously necessary. This progress has been marked by both increased speed and reduced weight of the motors, permitting aviators to use substantially smaller plane surfaces. For instance, the original Wright biplane, powered by a 25 horsepower (h.p.) motor and achieving speeds of up to 30 miles per hour, possessed a plane surface area of 538 square feet. Contrastingly, a newer model with a 65 h.p. motor, reaching speeds between 70 to 80 miles per hour, needs only about 130 square feet of plane surface to successfully carry an operator. Demonstrations at Belmont Park, New York, showed that these smaller-surfaced biplanes are faster, more maneuverable, and better at ascending than their larger predecessors.

This reduction in plane area is proportionate to the increase in speed; faster air travel requires less surface area to sustain a given weight. However, ensuring sufficient surface area for safe landings in case of motor failure remains crucial. The "baby Wright" showcased at Belmont Park in fall 1910, measuring 19.5 feet in length and 21.5 feet in width with a total surface area of 146 square feet, featured a new Wright 8-cylinder, 60 h.p. motor and two propellers, setting the speed record for the event.

The front elevating planes previously used for altitude control have been phased out in newer Wright machines, with regulation now solely through rear or "tail" controls. In addition to Wright's advancements, the Detroit Aeronautic Construction and the Roberts Motor Co. have developed light yet powerful aviation motors. Detroit's aeromotors come in four models, ranging from 30-75 h.p. and are notable for their light weight and 4-cycle, vertical, water-cooled design. On the other hand, the Roberts Motor Co. offers motors in 4- and 6-cylinder configurations, achieving remarkable power-to-weight ratios by eliminating unnecessary components, rather than merely reducing material thickness, which could compromise safety. These developments collectively herald a new era in aeroplane design and capabilities, driven by innovation in motor technology.

CHAPTER XXVI -Flying Machines Construction And Operation

Chapter XXVI of "Flying Machines: Construction and Operation" delves into the realm of monoplanes, triplanes, and multiplanes, highlighting the shift in American aviation from a focus primarily on biplanes to exploring and embracing these alternative designs. At the 1910 International meet in Belmont Park, N.Y., American participation in monoplane competitions was minimal, with notable aviators like Moissant, Drexel,

and Glenn Curtiss being exceptions, the latter presenting his own single-decker construct. This chapter underscores the growing interest in monoplanes in the U.S., spurred by Curtiss's success and innovation, marking a significant evolution in American aviation design preferences.

The text provides intricate details of various monoplanes, including those by Bleriot, Antoinette, and Curtiss, noting their dimensions, engine types, and operational capabilities. For example, the Bleriot operated by Moissant had a length of 23 feet, a breadth of 28 feet, and was powered by a 7-cylinder, 50 h.p. Gnome engine. Similarly, detailed are the specifications of other aircraft like the Antoinette and Curtiss's creation, emphasizing the diversity and innovation in monoplane design during this era.

Monoplanes' competitiveness and capability are highlighted through discussions of their successes at Belmont Park, where they secured significant winnings, demonstrating their viability and performance. The chapter expands upon this with a focus on the most popular monoplanes of the time—the Santos-Dumont, Antoinette, and Bleriot—providing specifics on their construction, performance, and unique features, proving each as a testament to early 20th-century aeronautical engineering and design ingenuity.

In transitioning from monoplanes, the chapter briefly explores innovations in triplanes and biplanes, mentioning the Stebbins-Geynet Co.'s combination triplane and biplane, which offered versatility and efficiency with its unique design allowing for easy conversion between the two forms. This section continues to broaden the reader's understanding of the period's aviation industry's experimental and versatile nature.

Furthermore, the chapter introduces other significant aviation advancements, such as the Cody biplane, noted for its automatic control system and the Pressey automatic control, showcasing early attempts at stabilizing aircraft. Lastly, the Sellers' multiplane is presented, an exemplar of innovation using minimal horsepower for flight, embodying the era's experimental spirit and the relentless pursuit of aerodynamic efficiency and control in early aircraft design.

CHAPTER XXVIII -Flying Machines: Construction and Operation

Chapter XXVIII of "Flying Machines: Construction and Operation" serves as a comprehensive glossary, aimed at elucidating the terminology commonly used in the field of aeronautics. This chapter meticulously defines a range of terms, starting with "Aerodrome," described as a machine operating in the air, encapsulating the essence of airborne machinery. The term "Aerofoil" is introduced as the advancing transverse section of an airplane, indicating its critical role in flight dynamics.

As the glossary progresses, it distinguishes between "Aeroplane" and "Dirigible balloon," highlighting the former as a glider-like flying machine, thereby underlining the fundamental differences in aviation technology. The term "Aeronaut" is straightforward, referring to an individual who travels through the air, encapsulating the human aspect of aerial navigation.

The glossary further delves into technical aspects with "Aerostat" and "Aerostatic," the former pertaining to any machine that sustains weight in the air, typically a balloon, and the latter relating to the art of maintaining suspension in the air. This is followed by an introduction to "Ailerons," minor yet vital stabilizing planes attached to the main plane structure, crucial for maintaining equilibrium during flight.

Intricate mechanisms of flight are explained through terms like "Angle of Incidence" and "Angle of Inclination," both of which are essential for understanding the dynamics of flight and the conditions under which flying machines ascend or maintain flight. "Auxiliary Planes" and "Biplane" highlight the variations in plane design, emphasizing the importance of stability and structure in aeronautical engineering.

The chapter transitions into more specific components, such as "Blade Twist," a critical factor in propeller design, and "Cambered," detailing the curvature integral to plane or wing structure for optimal aerodynamics.

The "Chassis" is identified as the foundational framework of a flying machine, underscoring the importance of structural integrity.

Lastly, the glossary explains "Control" systems essential for maneuvering, and "Dihedral" configurations that offer two-sided angles for enhanced stability, concluding with "Dirigible," signifying the controllability aspect crucial for navigational precision.

This chapter not only serves as a foundational knowledge base for aviation enthusiasts but also as a technical reference, bridging the gap between layman curiosity and aeronautical expertise, thus embodying the critical terminology necessary for understanding the principles and operations of flying machines.

NOTABLE CROSS-COUNTRY FLIGHTS OF 1911

In 1911, the field of aviation witnessed significant advancements and remarkable feats, with numerous flights aimed at testing the boundaries of distance, speed, and endurance. A notable achievement was made by Orville Wright at Killdevil Hills, N.C., where his flight against a 52-mile per hour wind reached an elevation of 225 feet, staying aloft for 10 minutes and 34 seconds. This period saw a surge in cross-country flights as aviators flew between cities worldwide for various reasons, including exhibitions and personal challenges. Remarkably, flights by Harry N. Atwood from Boston to Washington and C.P. Rodgers' coast-to-coast journey from New York to Los Angeles stood out for their distance and the challenges they presented.

Calbraith P. Rodgers' flight from New York to Los Angeles set new records for cross-country aviation. Spanning from September 17 to November 5, 1911, Rodgers' journey in a Wright biplane covered approximately 4,231 miles, necessitating numerous repairs due to the demanding nature of the trip. This endeavor underscored the challenges of early aviation, including mechanical reliability and the physical toll on the aviator. Rodgers' notable day saw him covering 231 miles from Sanderson to Sierra Blanca, Texas. Despite suffering a severe accident in Compton, Cal., which delayed his journey, Rodgers' achievement marked a significant milestone in aviation history.

Europe also saw its share of aerial competitions in 1911. The European Circuit Race, starting from Paris, involved a challenging 1,073-mile route through several countries, ending back in Paris. This race, however, was marred by the deaths of three participants, highlighting the dangers of early flight. The Circuit of England Race and the Paris to Madrid Race further illustrated the competitive spirit and ambition of aviators at the time, despite the risks involved. These races not only tested the capabilities of the aircraft but also the endurance and skill of the pilots, contributing to the rapid advancement of aviation technology and techniques in the early 20th century.

AEROPLANES AND DIRIGIBLE BALLOONS IN WARFARE

The chapter outlines significant advancements and events in the early days of aviation, particularly focusing on the practical use of airplanes and dirigible balloons within the realms of competition and warfare. It begins with recounting two notable races: a flight from New York to Philadelphia won by L. Beachey in a Curtiss machine with an average speed of 45 miles per hour, and a more demanding tri-state race culminating in E. Ovington's victory in a Bleriot machine, which earned him a \$10,000 prize.

The narrative then transitions into a detailed discussion on the role of flying machines in military applications. It highlights the enthusiastic adoption of aircraft technology by the leading world powers for both experimental and operational purposes. Governments have not only been purchasing aeroplanes but also establishing instructional schools for their military personnel. France and Germany are noted for having the largest airship fleets, which includes dirigibles equipped for extensive ranges and capable of carrying

significant payloads.

A British naval airship, notable for its size and lifting capacity, is mentioned as a recent completion, underscoring the international effort to advance aerial capabilities. The text deliberates on the comparative merits of dirigibles and aeroplanes in warfare, acknowledging the safety and range advantages of the former, despite notable disasters, and the proven utility of aeroplanes in reconnaissance and communications, as demonstrated by Italian military operations in Tripoli.

Further, the potential of aircraft to revolutionize war tactics is discussed, with contemplation on their ability to scout enemy movements, identify naval formations, and even the debated utility of deploying airborne explosives. Innovations like converting aeroplanes to operate with floats for water landings and takeoffs illustrate the evolving adaptability of flying machines, highlighting remarkable feats by aviators like Mr. Curtiss.

This chapter showcases an era where aviation was rapidly becoming integral to both commercial competition and military strategy, marking a significant period of technological innovation and tactical exploration in the early 20th century.