工业和信息化部“十二五”规划教材

航空科技英语

主编 沈 星

TECHNICAL ENGLISH FOR AERONAUTICAL SCIENCE

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前言 PREFACE

作为以航空航天类专业为主干的院校，其学生应具备基本的航空知识和理论基础；再考虑到随着经济全球化的进一步发展，社会对当代大学生的英语水平提出了更高的要求，所以编者希望该航空科技双语教材能够帮助学生了解基本国际航空技术，掌握这方面的英语专业知识和词汇，使学生拥有独立学习和研究的基本技能，为其提高专业水平、阅读相关外文文献、学习国内外先进技术或者出国深造打下基础。

本书以航空航天概论、飞行员手册、世界飞机手册等一系列中英文资料为基础，结合大学本科阶段学生的平均水平，以简明扼要、内容丰富为原则，从航空简史出发，对航空技术作了较为系统性的介绍。其中本书就飞机结构、飞行理论、飞机控制、飞机系统、飞行仪表以及飞行性能等几个方面分章节进行了叙述。本书旨在引入新的学科体系，融合中西文化，固每章都采取中英文结合的形式，配以大量图片资料来增强可读性，并且每章单独设有关键词汇和短语注解部分。在本书的最后有按首字母排序的航空科技方面专业词汇，供读者查阅。

限于水平，书中不妥之处望读者指正，欢迎提出您宝贵的意见。

编　者
南京航空航天大学航空宇航学院

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Chapter 1
Introduction

1.1 History of Aviation

The identity of the first "bird-men" who fitted themselves with wings and leapt off a cliff in an effort to fly is lost in time. But each failure gave those who wished to fly questions that needed answers. Where had the wing flappers gone wrong? Philosophers, scientists, and inventors offered solutions, but no one could add wings to the human body and soar like a bird. During the 1500s, Leonardo da Vinci filled pages of his notebooks with sketches of proposed flying machines, but most of his ideas were flawed because he clung to the idea of birdlike wings *[Figure 1-1]*. By 1655, mathematician, physicist, and inventor Robert Hooke concluded that the human body does not possess the strength to power artificial wings. He believed human flight would require some form of artificial propulsion.

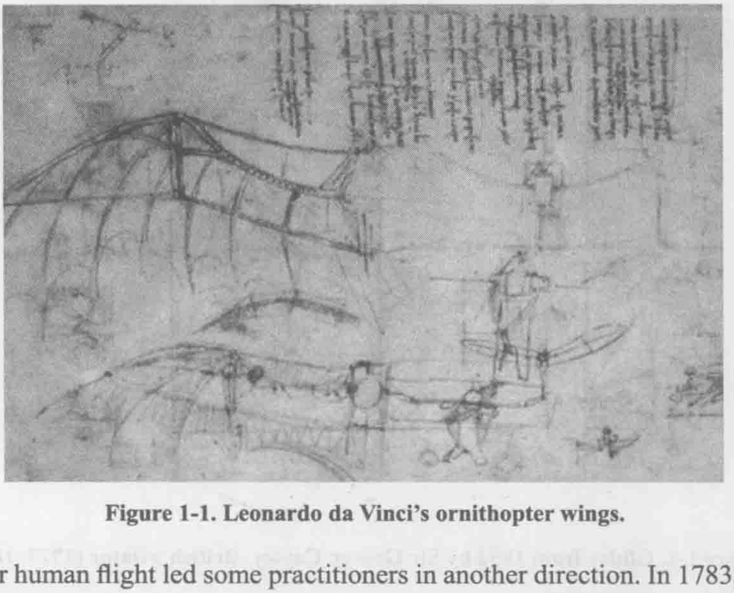

Figure 1-1. Leonardo da Vinci's ornithopter wings.

The quest for human flight led some practitioners in another direction. In 1783, the first manned hot air balloon, crafted by Joseph and Etienne Montgolfier, flew for 23 minutes. Ten days later, Professor Jacques Charles flew the first gas balloon. Madness for balloon flight captivated the public's imagination and for a time flying enthusiasts turned their expertise to the promise of lighter-than-air flight.

Balloons solved the problem of lift, but that was only one of the problems of human flight. The ability to control speed and direction eluded balloonists. The solution to that problem lay in a child's toy familiar to the East for 2,000 years, but not introduced to the West until the 13th century. The kite, used by the Chinese, manned for aerial observation and to test winds for sailing and unmanned as a signaling device and as a toy, held many of the answers to lifting a heavier-than-air device into the air.

One of the men who believed the study of kites unlocked the secrets of winged flight was Sir George Cayley. Born in England 10 years before the Montgolfier balloon flight, Cayley spent his 84 years seeking to develop a heavier-than-air vehicle supported by kite-shaped wings *[Figure 1-2]*. The "Father of Aerial Navigation," Cayley discovered the basic principles on which the modern science of aeronautics is founded, built what is recognized as the first successful flying model, and tested the first full-size manned airplane.

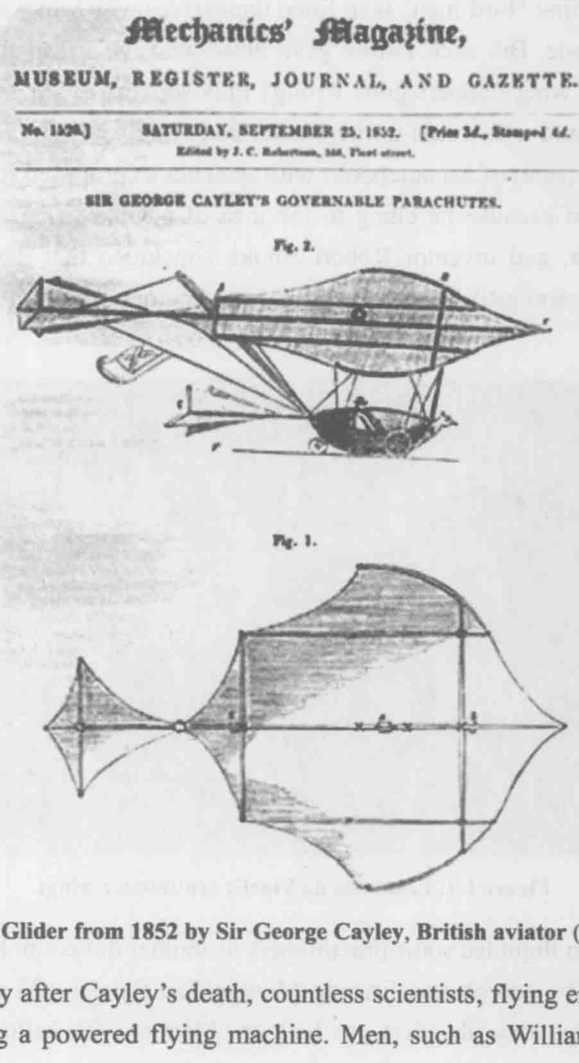

Figure 1-2. Glider from 1852 by Sir George Cayley, British aviator (1773–1857).

For the half-century after Cayley's death, countless scientists, flying enthusiasts, and inventors worked toward building a powered flying machine. Men, such as William Samuel Henson, who designed a huge monoplane that was propelled by a steam engine housed inside the fuselage and Otto Lilienthal, who proved manned aircraft heavier than air was practical, worked towards the dream of powered flight. This dream was turned into reality by Wilbur and Orville Wright at Kitty Hawk, North Carolina, on December 17, 1903.

The bicycle-building Wright brothers of Dayton, Ohio, had experimented for 4 years with kites, their own homemade wind tunnel and different engines to power their biplane. One of their great achievements was proving the value of the scientific, rather than build-it-and-see approach to flight. Their biplane, The Flyer, combined inspired design and engineering with superior craftsmanship *[Figure 1-3]*. By the afternoon of December 17, the Wright brothers had flown a total of 98 seconds on four flights. The age of flight had arrived.

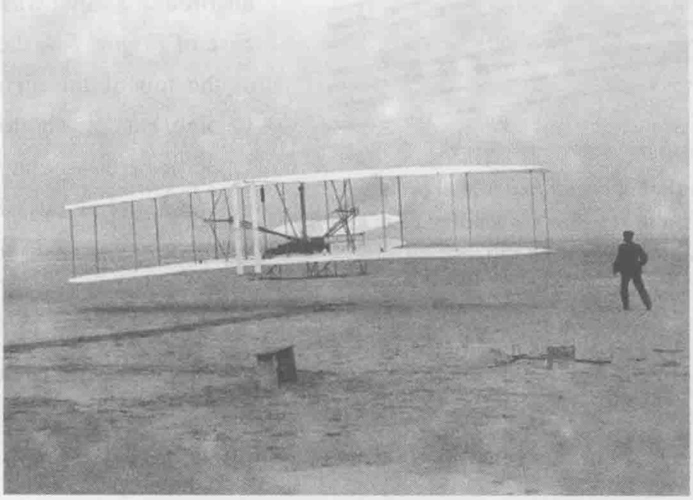

Figure 1-3. First flight by the Wright brothers.

1.2 Basic Aerodynamics

1.2.1 Theories in the Production of Lift

(1) Newton's Basic Laws of Motion

The fundamental physical laws governing the forces acting upon an aircraft in flight were adopted from the postulated theories developed before any human successfully flew an aircraft. The use of these physical laws grew out of the Scientific Revolution, which began in Europe in the 1600s. Driven by the belief that the universe operated in a predictable manner open to human understanding, many philosophers, mathematicians, natural scientists and inventors spent their lives attempting to unlock the secrets of the universe. One of the best known was Sir Isaac Newton, who not only formulated the law of universal gravitation, but also described the three basic laws of motion.

(2) Magnus Effect

In 1852, the German physicist and chemist, Heinrich Gustav Magnus (1802–1870), made experimental studies of the aerodynamic forces on spinning spheres and cylinders. (This had already been studied by Newton in 1672, in regard to spheres or tennis balls). These experiments led to the discovery of the Magnus Effect, which helps explain the theory of lift.

As shown in *[Figure 1-4]*, at point "*A*," a stagnation point exists where the air stream impacts (impinges) on the front of the airfoil and splits; some air goes over, and some under. Another stagnation point exists at "*B*," where the two airstreams rejoin and resume at identical velocities. When viewed from the side, an upwash is created ahead of the airfoil and a downwash at the rear. In the case of *Figure 1-4,* the highest velocity is at the top of the airfoil, and the lowest velocity at the bottom. Because these velocities are associated with an object (in this case, an airfoil), they are called local velocities as they do not exist outside the lift-producing system. This concept can be readily applied to a wing or other lifting surface. Because there is a difference of velocity above and below the wing, the result is a higher pressure below the wing and a lower pressure above the wing. This pressure difference produces an upward force known as the Magnus Effect, the physical phenomenon whereby an object's rotation affects its path through a fluid.

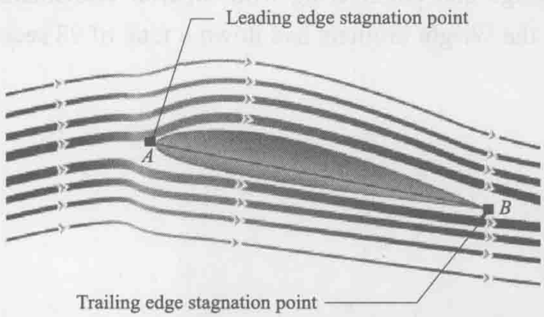

Figure 1-4. Air circulation around an airfoil occurs when the front stagnation point is below the leading edge and the aft stagnation point is beyond the trailing edge.

1.2.2 Bernoulli's Principle of Differential Pressure

A practical application of Bernoulli's Principle is the venturi tube. The venturi tube has an air inlet that narrows to a throat (constricted point) and an outlet section that increases in diameter toward the rear. The diameter of the outlet is the same as that of the inlet. At the throat, the airflow speeds up and the pressure decreases. At the outlet, the airflow slows and the pressure increases *[Figure 1-5]*.

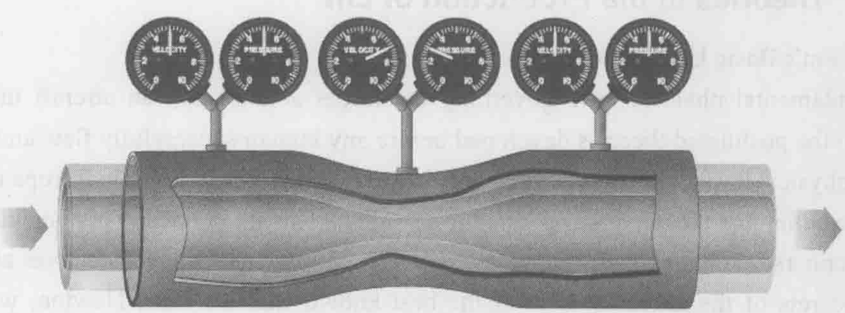

Figure 1-5. Air pressure decreases in a venturi tube.

Since air is recognized as a body and it is accepted that it must follow the above laws, one can begin to see how and why an airplane wing develops lift. As the wing moves through the air, the flow of air across the curved top surface increases in velocity creating a low-pressure area.

Although Newton, Magnus, Bernoulli, and hundreds of other early scientists who studied the physical laws of the universe did not have the sophisticated laboratories available today, they provided great insight to the contemporary viewpoint of how lift is created.

1.3 Basic Engineering Design Process

The complete design process, from start to finish, is often outlined as in Figure 1-6. This iterative process begins with an identification of a need and a decision to do something about it. After many iterations, the process ends with the presentation of the plan which will satisfy the need. Depending on the nature of the design task, several design phases may be repeated throughout the life of the product, from inception to termination. In the next several subsections, we shall examine these phases in detail.

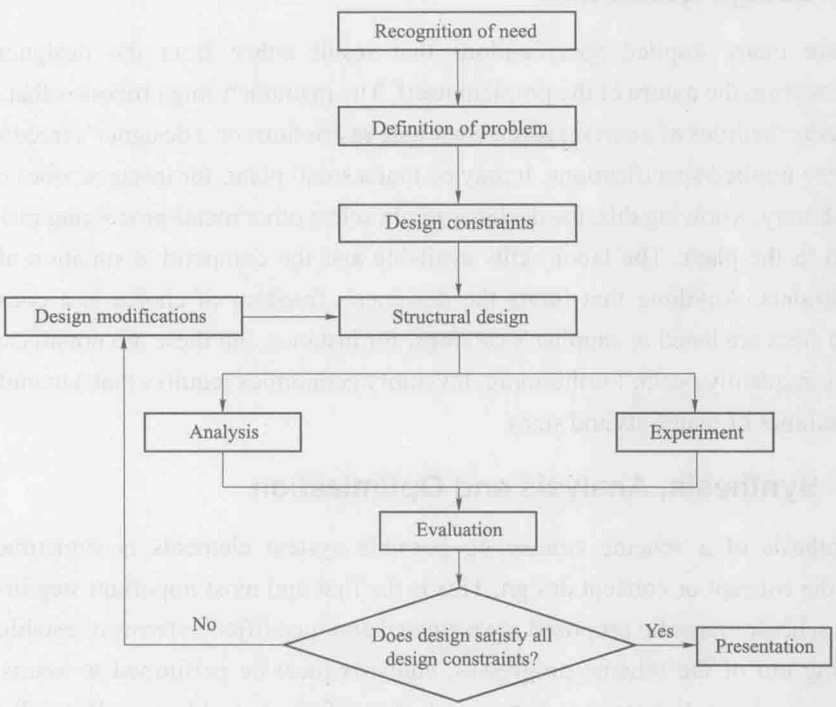

Figure 1-6. The design process.

1.3.1 Identification of the Need

Identification of the need is generally the first phase of the design process. It isn't always obvious that there is a need for a new design. This need may only arise from mild discontent or a sense that something is not right. The need is often not obvious at all; recognition is often triggered by some particularly adverse occurrence or a set of random circumstances that arises almost simultaneously. For example, the need to do something about a food-packaging machine may be indicated by its noise level, by a variation in package weight, or by slight but perceptible variations in the quality of the packaging.

1.3.2 Definition of Problems

There is a distinct difference between the recognition of a need and that of a problem. The definition of problem is more specific and must include all the specifications for the object that is to be designed. The specifications are the input and output quantities, the characteristics and dimensions of the space the object must occupy, and all the limitations on these quantities. We can regard the object to be designed as something in a black box. In this case we must specify the inputs and outputs of the box, together with their characteristics and limitations. The specifications determine the cost, the number to be manufactured, the expected life, the range, the operating temperature and the reliability. Specific characteristics can include the speeds, foods, temperature limitations, maximum range, expected variations in the variables, dimensional and weight limitations, etc.

1.3.3 Design Constraint

There are many implied specifications that result either from the designer's particular environment or from the nature of the problem itself. The manufacturing processes that are available, together with the facilities of a certain plant, constitute restrictions on a designer's freedom, and hence are a part of the implied specifications. It may be that a small plant, for instance, does not own cold-working machinery. Knowing this, the designer might select other metal-processing methods that can be performed in the plant. The labor skills available and the competitive situation also constitute implied constraints. Anything that limits the designer's freedom of choice is a constraint. Many materials and sizes are listed in supplier's catalogs, for instance, but these are not all easily available and shortages frequently occur. Furthermore, inventory economics requires that a manufacturer stock a minimum number of materials and sizes.

1.3.4 Synthesis, Analysis and Optimization

The synthesis of a scheme connecting possible system elements is sometimes called the invention of the concept or concept design. This is the first and most important step in the synthesis task. Various schemes must be proposed, investigated and quantified in terms of established metrics. As the fleshing out of the scheme progresses, analyses must be performed to assess whether the system performance is satisfactory or better, and, if satisfactory, just how well it will perform. The system schemes that do not survive analysis are revised, improved or discarded. Those with potential are optimized to achieve the best possible performance. Competing schemes are compared so that the path leading to the most competitive product can be chosen.

1.3.5 Mathematical Modeling and Evaluation

Both analysis and optimization require that we construct or devise abstract models of the system that will admit some form of mathematical analysis. We call these models mathematical models. In