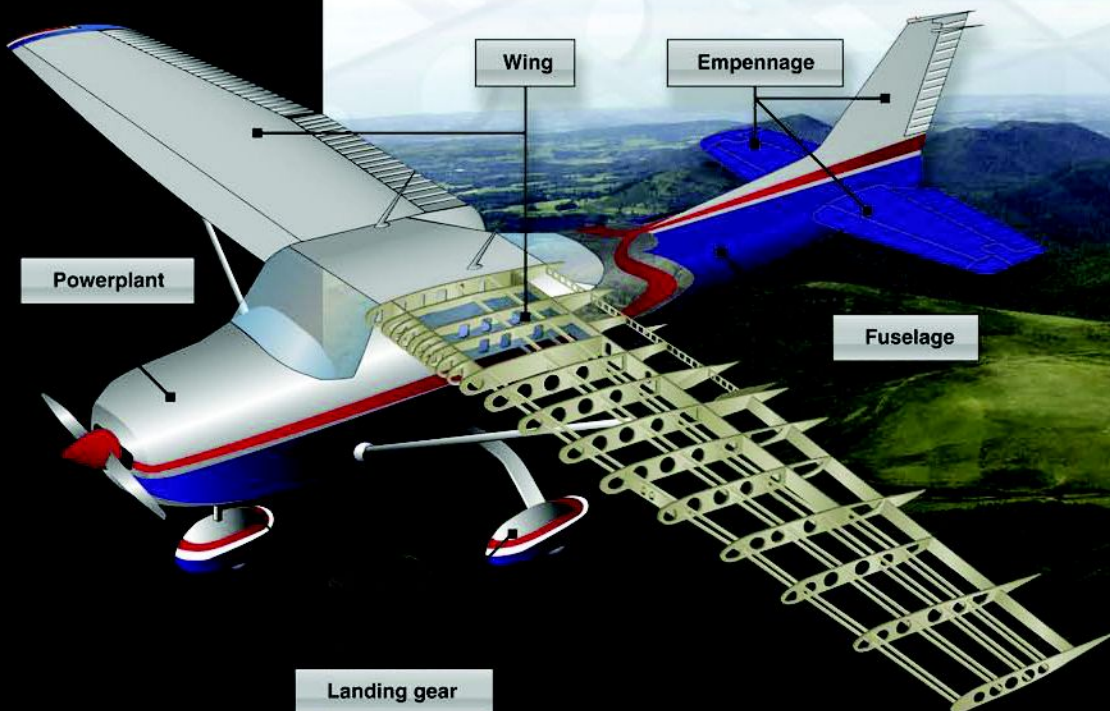
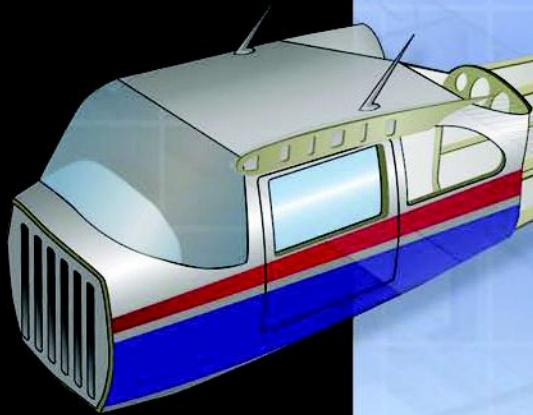


Chapter 2

Aircraft Wing Structure

Introduction

An aircraft is a device that is used, or intended to be used, for flight, according to the current Title 14 of the Code of Federal Regulations (14 CFR) Part 1, Definitions and Abbreviations. Categories of aircraft for certification of airmen include airplane, rotorcraft, glider, lighter-than-air, powered-lift, powered parachute, and weight-shift control. 14 CFR part 1 also defines airplane as an engine-driven, fixed-wing aircraft that is supported in flight by the dynamic reaction of air against its wings. Another term, not yet codified in 14 CFR part 1, is advanced avionics aircraft, which refers to an aircraft that contains a global positioning system (GPS) navigation system with a moving map display, in conjunction with another system, such as an autopilot. This chapter provides a brief introduction to the structure of aircraft and uses an airplane for most illustrations. Light Sport Aircraft (LSA), such as weight-shift control, balloon, glider, powered parachute, and gyroplane have their own handbooks to include detailed information regarding aerodynamics and control.



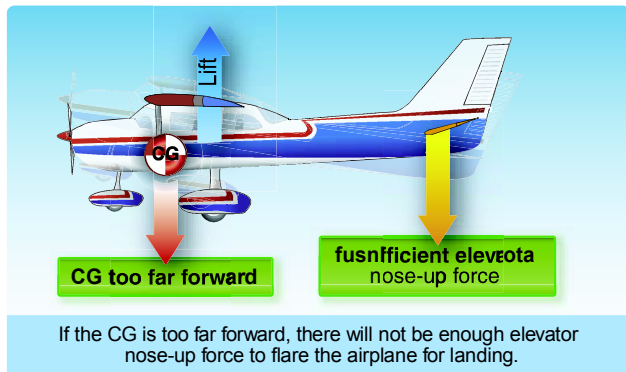
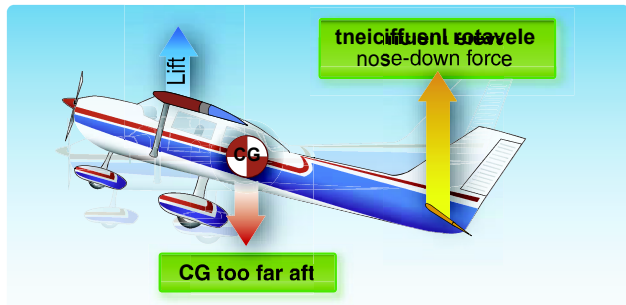
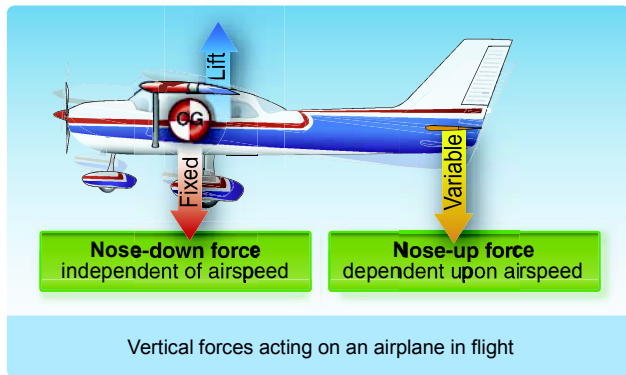


Figure 2-3. Center of gravity (CG).

Major Components

Although airplanes are designed for a variety of purposes, most of them have the same major components. [Figure 2-4] The overall characteristics are largely determined by the original design objectives. Most airplane structures include a fuselage, wings, an empennage, landing gear, and a powerplant.

Fuselage

The fuselage is the central body of an airplane and is designed to accommodate the crew, passengers, and cargo. It also provides the structural connection for the wings and tail assembly. Older types of aircraft design utilized an open truss structure constructed of wood, steel, or aluminum tubing. [Figure 2-5] The most popular types of fuselage structures used in today's aircraft are the monocoque (French for "single shell") and semimonocoque. These structure types

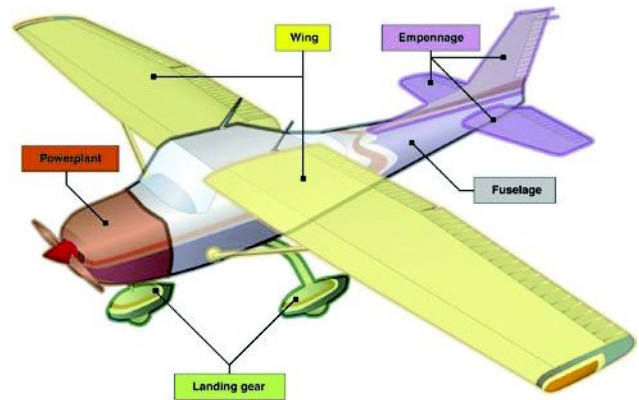


Figure 2-4. Airplane components.

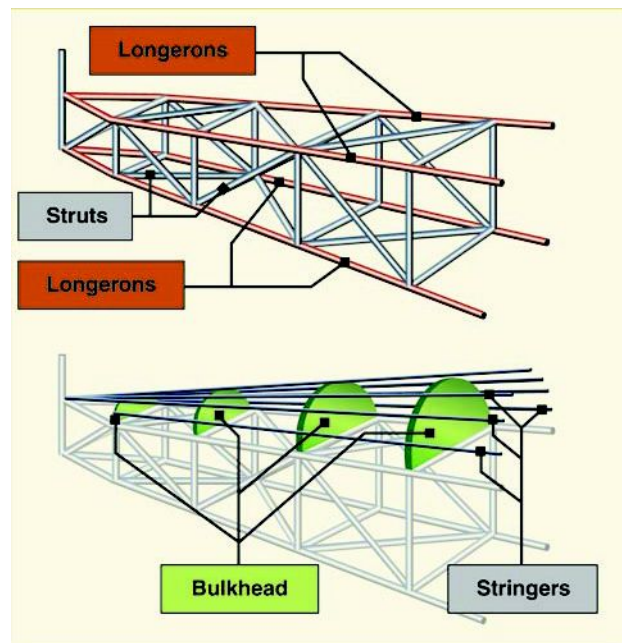


Figure 2-5. Truss-type fuselage structure.

are discussed in more detail under aircraft construction later in the chapter.

Wings

The wings are airfoils attached to each side of the fuselage and are the main lifting surfaces that support the airplane in flight. There are numerous wing designs, sizes, and shapes used by the various manufacturers. Each fulfills a certain need with respect to the expected performance for the particular airplane. How the wing produces lift is explained in Chapter 4, Aerodynamics of Flight.

Wings may be attached at the top, middle, or lower portion of the fuselage. These designs are referred to as high-, mid-, and low-wing, respectively. The number of wings can also vary. Airplanes with a single set of wings are referred to as



Figure 2-6. Monoplane (left) and biplane (right).

monoplanes, while those with two sets are called biplanes. [Figure 2-6]

Many high-wing airplanes have external braces, or wing struts, which transmit the flight and landing loads through the struts to the main fuselage structure. Since the wing struts are usually attached approximately halfway out on the wing, this type of wing structure is called semi-cantilever. A few high-wing and most low-wing airplanes have a full cantilever wing designed to carry the loads without external struts.

The principal structural parts of the wing are spars, ribs, and stringers. [Figure 2-7] These are reinforced by trusses, I-beams, tubing, or other devices, including the skin. The wing ribs determine the shape and thickness of the wing

(airfoil). In most modern airplanes, the fuel tanks either are an integral part of the wing's structure, or consist of flexible containers mounted inside of the wing.

Attached to the rear or trailing edges of the wings are two types of control surfaces referred to as ailerons and flaps. Ailerons extend from about the midpoint of each wing outward toward the tip, and move in opposite directions to create aerodynamic forces that cause the airplane to roll. Flaps extend outward from the fuselage to near the midpoint of each wing. The flaps are normally flush with the wing's surface during cruising flight. When extended, the flaps move simultaneously downward to increase the lifting force of the wing for takeoffs and landings. [Figure 2-8]

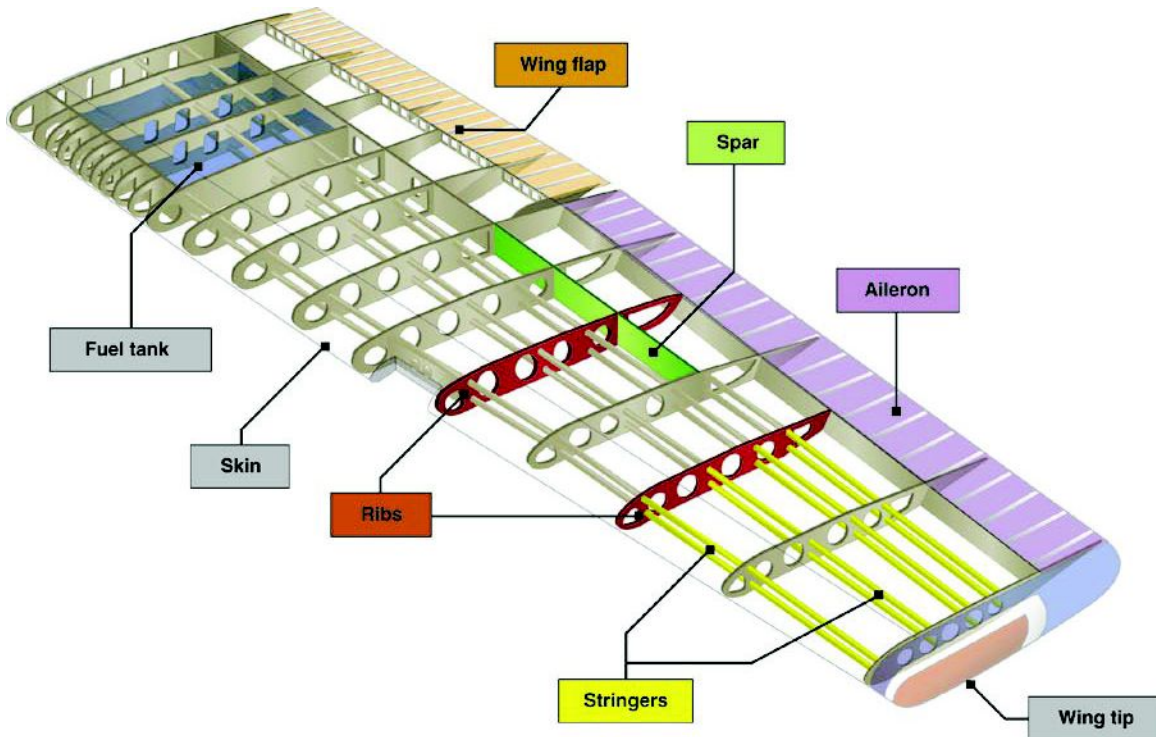


Figure 2-7. Wing components.

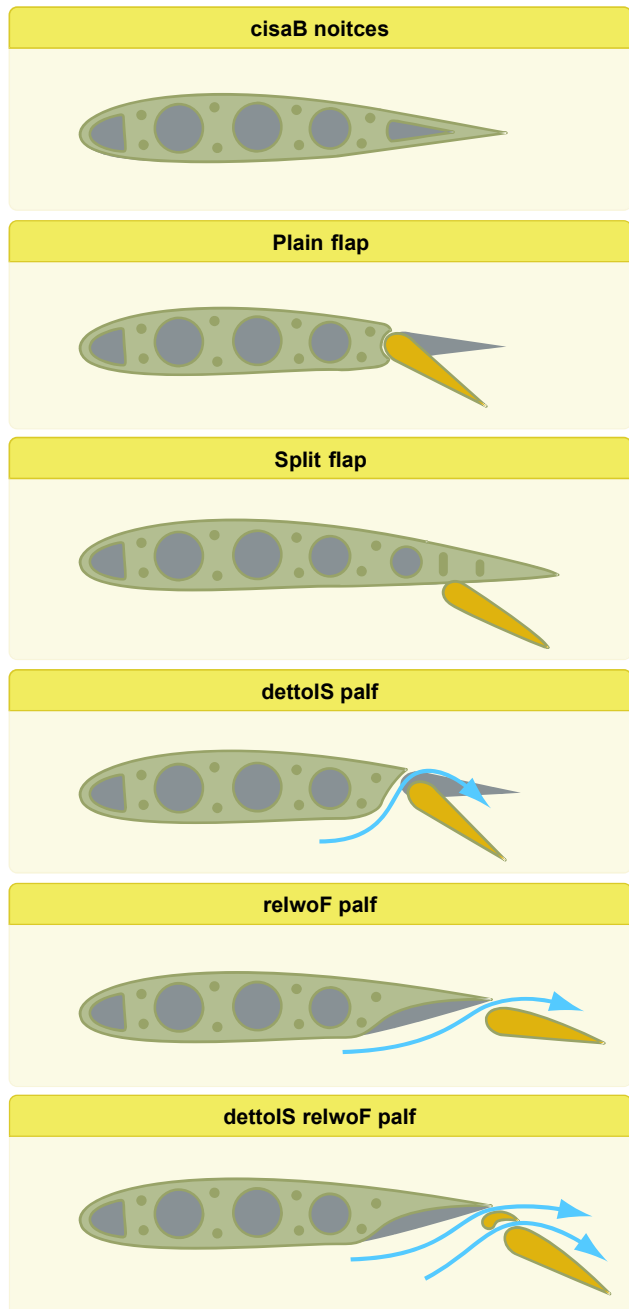


Figure 2-8. Types of flaps.

Alternate Types of Wings

With the Federal Aviation Administration's (FAA) recent addition of the LSA category, various methods are employed to control flight and to produce lift. These methods are discussed in Chapter 4, Aerodynamics of Flight, which provides information on the effect controls have on lifting surfaces from traditional wings to wings that use both flexing (due to billowing) and shifting (through the change of the aircraft's CG). Handbooks specific to each category of LSA are available for the interested pilot. LSA illustrate various lifting surfaces and control methods. For example, the wing

of the weight-shift control aircraft is highly swept, and the shifting of weight to provide controlled flight. [Figure 2-9]



Figure 2-9. Weight-shift control aircraft use the shifting of weight for control.

Empennage

The empennage includes the entire tail group and consists of fixed surfaces such as the vertical stabilizer and the horizontal stabilizer. The movable surfaces include the rudder, the elevator, and one or more trim tabs. [Figure 2-10]

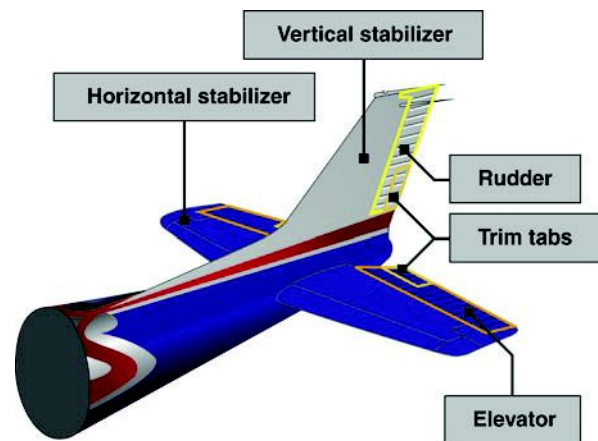


Figure 2-10. Empennage components.

The rudder is attached to the back of the vertical stabilizer. During flight, it is used to move the airplane's nose left and right. The elevator, which is attached to the back of the horizontal stabilizer, is used to move the nose of the airplane up and down during flight. Trim tabs are small, movable portions of the trailing edge of the control surface. These movable trim tabs, which are controlled from the flight deck, reduce control pressures. Trim tabs may be installed on the ailerons, the rudder, and/or the elevator.

A second type of empennage design does not require an elevator. Instead, it incorporates a one-piece horizontal stabilizer that pivots from a central hinge point. This type of

