

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

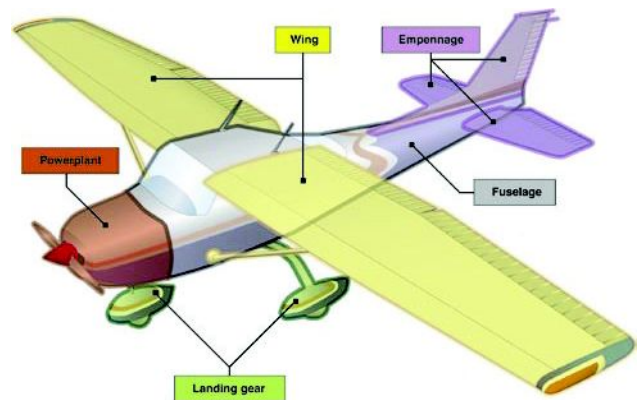


Figure 2-4. Airplane components.

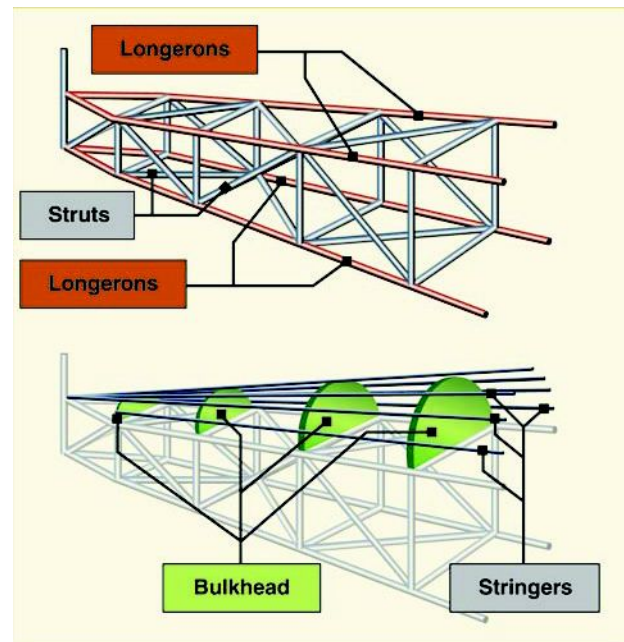


Figure 2-5. Truss-type fuselage structure.

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Types of Aircraft Construction

The construction of aircraft fuselages evolved from the early wood truss structural arrangements to monocoque shell structures to the current semimonocoque shell structures.

Truss Structure

The main drawback of truss structure is its lack of a streamlined shape. In this construction method, lengths of tubing, called longerons, are welded in place to form a well-braced framework. Vertical and horizontal struts are welded to the longerons and give the structure a square or rectangular shape when viewed from the end. Additional struts are needed to resist stress that can come from any direction. Stringers and bulkheads, or formers, are added to shape the fuselage and support the covering.

As technology progressed, aircraft designers began to enclose the truss members to streamline the airplane and improve performance. This was originally accomplished with cloth fabric, which eventually gave way to lightweight metals such as aluminum. In some cases, the outside skin can support all or a major portion of the flight loads. Most modern aircraft use a form of this stressed skin structure known as monocoque or semimonocoque construction. [Figure 2-14]

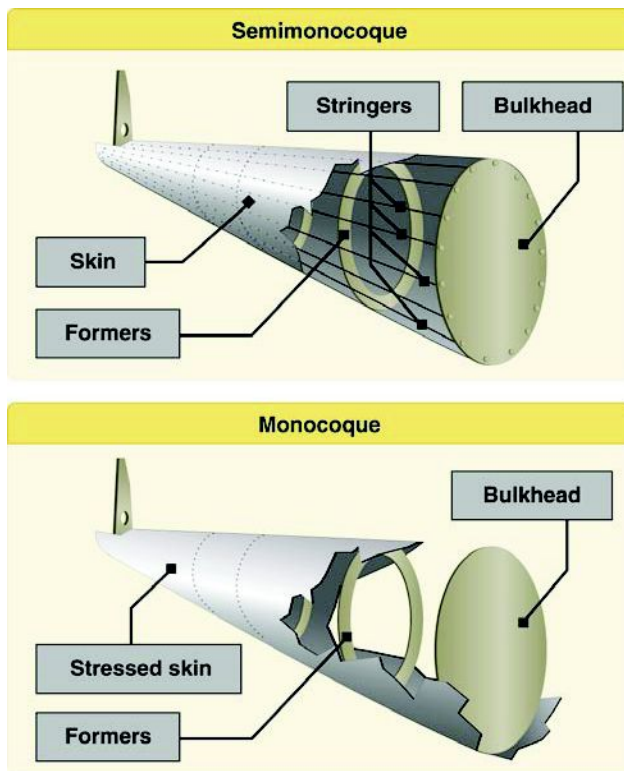


Figure 2-14. *Semimonocoque and monocoque fuselage design.*
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Monocoque

Monocoque construction uses stressed skin to support almost all loads much like an aluminum beverage can. Although very strong, monocoque construction is not highly tolerant to deformation of the surface. For example, an aluminum beverage can supports considerable forces at the ends of the can, but if the side of the can is deformed slightly while supporting a load, it collapses easily.

Because most twisting and bending stresses are carried by the external skin rather than by an open framework, the need for internal bracing was eliminated or reduced, saving weight and maximizing space. One of the notable and innovative methods for using monocoque construction was employed by Jack Northrop. In 1918, he devised a new way to construct a monocoque fuselage used for the Lockheed S-1 Racer. The technique utilized two molded plywood half-shells that were glued together around wooden hoops or stringers. To

construct the half shells, rather than gluing many strips of plywood over a form, three large sets of spruce strips were soaked with glue and laid in a semi-circular concrete mold that looked like a bathtub. Then, under a tightly clamped lid, a rubber balloon was inflated in the cavity to press the plywood against the mold. Twenty-four hours later, the smooth half-shell was ready to be joined to another to create the fuselage. The two halves were each less than a quarter inch thick. Although employed in the early aviation period, monocoque construction would not reemerge for several decades due to the complexities involved. Every day examples of monocoque construction can be found in automobile manufacturing where the unibody is considered standard in manufacturing.

Semimonocoque

Semimonocoque construction, partial or one-half, uses a substructure to which the airplane's skin is attached. The substructure, which consists of bulkheads and/or formers of various sizes and stringers, reinforces the stressed skin by taking some of the bending stress from the fuselage. The main section of the fuselage also includes wing attachment points and a firewall. On single-engine airplanes, the engine is usually attached to the front of the fuselage. There is a reproof partition between the rear of the engine and the flight deck or cabin to protect the pilot and passengers from accidental engine fires. This partition is called a firewall and is usually made of heat-resistant material such as stainless steel. However, a new emerging process of construction is the integration of composites or aircraft made entirely of composites.