ModelAviation
CONSTRUCTION SERIES

# Balsa builders' parlance

by Paul Kohlmann

**This article is the second in a series intended to introduce new builders to the basics of constructing balsa-framed aircraft. In the March 2015 issue, we learned about filling a toolbox with a basic set of tools.**

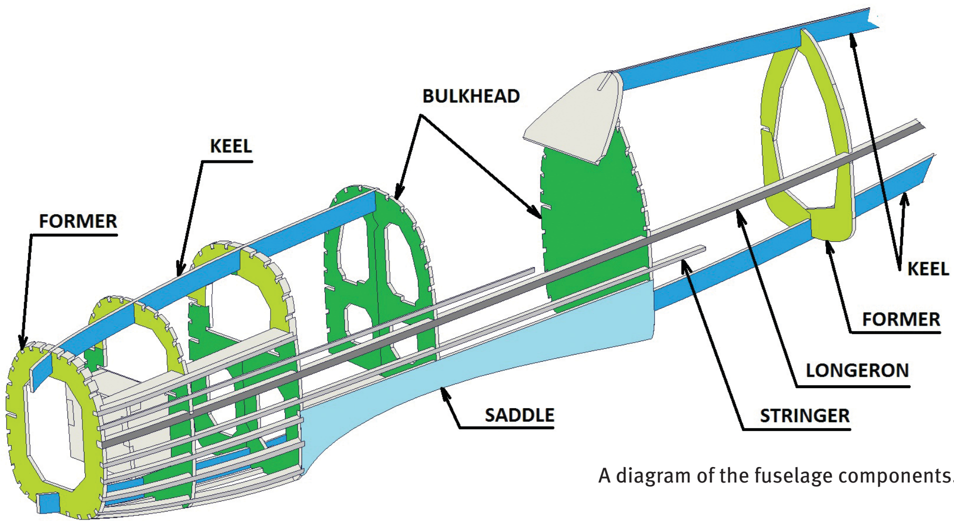
**This month's topic may seem odd, but it will introduce new builders to some vocabulary used in the aircraft industry. Not surprisingly, the terms used to describe full-scale components are the same that are used for our smaller versions. After all, full-scale aircraft often start out as models, just as aeronautical engineers often start out as modelers.**

**It is easier to share information when speaking a common dialect. The purpose of this article is to help new modelers be able to comprehensively discuss problems and ideas with other aeromodelers. After introducing the terminology, this language will be applied to describe several classic model design styles.**

## The Fuselage

The goal of this article is to define the components that form the model's airframe, but the word fuselage could use some attention. It is derived from the French word fuselé, which means tapered.

As for the components that make up the fuselage, much of the terminology was derived from boat building. This shouldn't be surprising because the dawn of aviation occurred when wooden shipbuilding was at its peak. I'll start with the longitudinal fuselage components that run from stem to stern.



A diagram of the fuselage components.

*Keel*: Often a fuselage is started by pinning a keel to the building board. Keels run the length of the fuselage, but may be broken by the cockpit or other openings. Keels are typically the stoutest structural members running lengthwise in the fuselage.

*Longeron*: Similar to keels, longerons span the length of the fuselage. They are normally square stock and lighter than keels. Many lightweight designs eliminate keels and instead rely on a framework of four longerons.

*Stringer*: The lightest longitudinal element of the group, stringer and longeron are used interchangeably in both modeling and aerospace. As a rule of thumb, stringers are lighter, are often interrupted instead of running the full length of the fuselage, and are packed together tighter than the heavier longerons. Stringers may also be found in the wing.

The purpose of keels, longerons, and stringers is to transfer loads on the aircraft's skin to latitudinal elements such as bulkheads and formers.

*Bulkhead*: A firewall is a good example of a bulkhead. In addition to adding shape to the fuselage, it is a robust element that adds significant structure to the airframe. A bulkhead is often solid and may perform an additional function such as providing a mounting location for a motor mount, landing gear, or a wing pin.

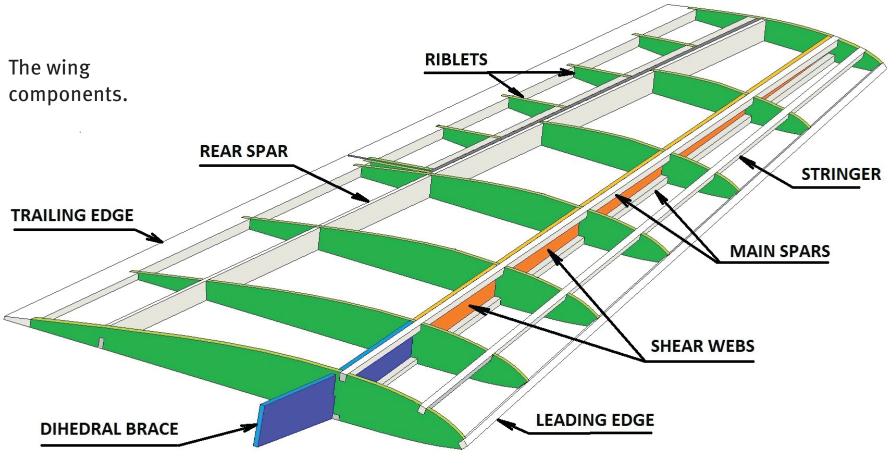
*Former*: Essentially a bulkhead with its center removed, a former helps shape the fuselage but has less strength.

*Sheeting*: A panel of thin balsa that forms the airframe's skin, sheeting may be used on the fuselage, the wing, or even the tail parts.

*Saddle*: The pocket where the wing attaches to the fuselage may require additional structural elements, particularly in the case of low-wing models.

### The Wing

As with the fuselage, let's start with the elements that run the long axis of the wing.




The wing components.

*Leading edge (LE)*: A stout element at the front of the airfoil, the LE needs to be meaty enough to allow it to be shaped into a radius. This may be a simple piece of square stock or a lamination of several strips of wood, depending on the airframe's size and weight.

*Trailing edge (TE)*: The back edge of the wing is often a wide element that allows room for rib notches and tapering to a thin, aerodynamic wedge.

*Spar*: Similar to a keel, a spar is a stout, structural element that normally runs the length of the wing without interruption. Many designs use a main spar near the thickest part of the wing's airfoil, and a rear spar behind the thickest point.

*Shear webs*: The main spar is often made of an upper and a lower spar. These two independent spars may be strong enough for a light airframe, but they can be made much stronger by converting them to a C-channel. A shear web ties the upper and lower spars together and makes the face of the "C." For additional strength, shear webs on both sides of the spars can form a box spar.

*Dihedral brace*: This is two shear webs joined to tie the two wings together. Dihedral braces are normally made from plywood or another strong material.

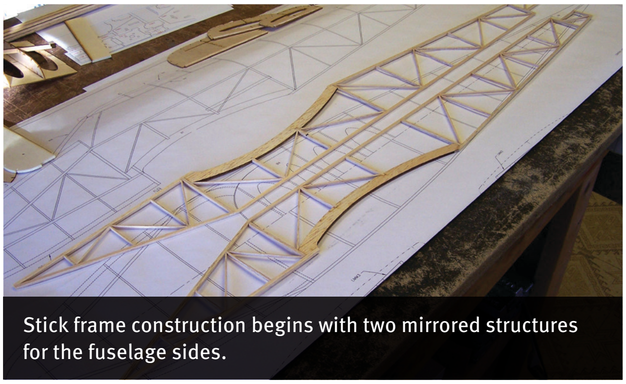
*Ribs*: Similar to fuselage formers, ribs are the airfoil profiles that run perpendicular to the long elements previously discussed. Some designs include half ribs between the full ribs at the LE to improve the airfoil's shape. Short riblets are often used in ailerons, where the full rib is intersected by the aileron hinge line.

*Tail group*: The fin, rudder, stabilizers, and elevators also have LEs and TEs. For small models, the stock inside of the outlines is often referred to as bracing.

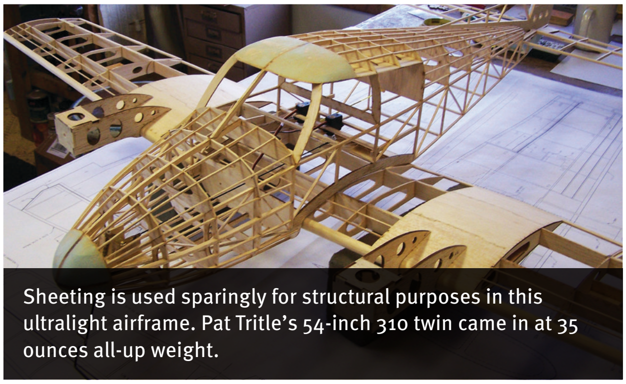
### Construction Methods

In high school Spanish class you may have learned that languages are mastered by speaking them, so let's discuss balsa construction. Many methods have been used throughout the years, but stick frame, keel frame, and sheeted construction are three of the most popular.

## Stick Frame Construction



Stick frame construction begins with two mirrored structures for the fuselage sides.



Sheeting is used sparingly for structural purposes in this ultralight airframe. Pat Tritle's 54-inch 310 twin came in at 35 ounces all-up weight.

The oldest, lightest, and most elegant form of balsa construction is stick frame. Ivan Pettigrew and Pat Tritle are two designers known for building incredibly lightweight structures using this method. The stick-frame fuselage is created from two identical flat frameworks of longerons with crossbraces. The frames are made from square balsa. When complete, the frames become the sides of the fuselage when joined with additional crossbracing.

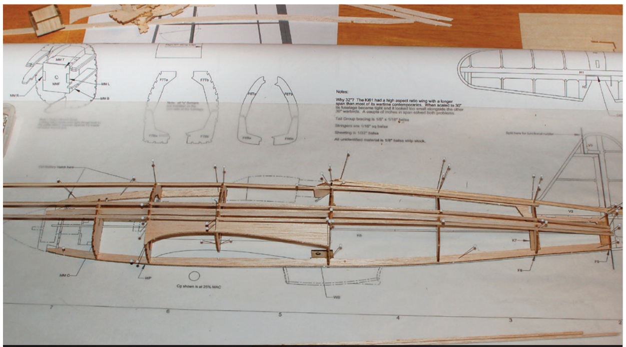
The result is a boxy framework reminiscent of most World War I aircraft. That's not a coincidence because most aircraft of that era were built the same way.

For airplanes with more shapely fuselages, formers are attached to the latitudinal crossbraces. Stringers are then secured to the formers to round out the fuselage.

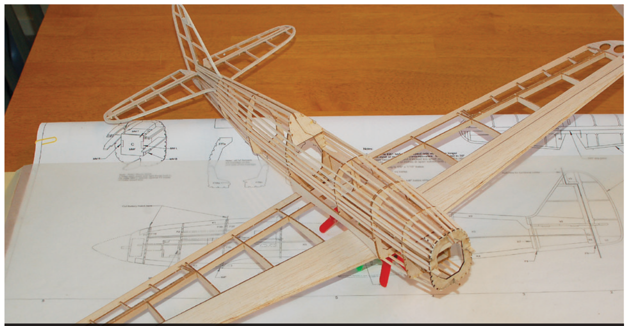
The tail parts are often started by laminating thin, flexible strips of balsa into strong, but lightweight, outlines. Balsa strip stock is used on each side of the parting line of the elevator and rudder. Square balsa is used for bracing between the laminated outlines and the parting stock.

The wing is built from lightweight ribs and spars. Keeping the focus on lightness, a few stringers might be used to smooth the upper airfoil between the LE and the main spar.

## Keel Frame Construction



Keel frame construction begins by tying keels together with former and bulkhead halves.



Paul Kohlmann's 32-inch Ki-61 uses slightly more wood than stick frame construction with its keels and sheeted LEs, but comes in at a respectable 9.5 ounces all-up weight.

This method is slightly heavier than stick frame construction, but it is easier to build and slightly less fragile. It is commonly seen in designs by Guillow's, as well as most of my own.

The fuselage is started by pinning keels to the building board. Bulkheads and formers are attached to the keels, and these might be tied together with a longeron running along the fuselage's midline. Numerous stringers run the length of the structure to give it shape.

After completing the first half of the fuselage, the structure is unpinned and the other half is built directly onto it.

The tail group might be built with laminated outlines, but it is more common for the outlines to be built from several pieces of flat stock. Construction of the wing is also generally the same as for the stick frame, but the use of sheeting from the LE to the main spar is more common.

Photos by the author

## Sheeted Construction

Wing ribs glued directly to sheeting, and sheeting in lieu of fuselage stringers, are the hallmarks of sheeted construction.

The sheeted 32 Raiden by TDM Models is tougher and looks more scale without the stringers, but weighs a bit more than other types of construction at 24 ounces all-up weight.

A third popular construction style is the sheeted airframe. This uses the same internal components, such as fuselage formers and wing ribs, but fewer. The wings and fuselage are skinned with sheet balsa instead of stringers.

Sheeting the entire airframe results in more weight than other construction methods, but sheeted structures are stronger and quicker to build. Another benefit is that these structures look more scalelike if the subject is a full-scale aircraft that was sheeted with aluminum rather than linen. Terry Majewski of TDM Models is a designer who has mastered this method.

### Conclusion

No one likes to sound like a newbie, but now that you speak balsa, you can run with the pack. It is important to practice as much as possible to stay fluent. The best way to do this is to choose the construction style that suits you and find plans. Next time we meet, we'll discuss how to read plans.

*—Paul Kohlmann*
*ptkohlmann@aol.com*

SOURCES:

Pat's Custom Models
(505) 296-4511
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Guillow's
(781) 245-5255
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Manzano Laser Works
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TDM Models
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