

Boat Building

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Boat Building

Boat building, one of the oldest branches of engineering, is concerned with constructing the hulls of boats and, for sailboats, the masts, spars and rigging. So let's start with understanding hull

Each part of the hull has a different name and purpose:

- * **Bow** - the front and generally sharp end of the hull. It is designed to reduce the resistance of the hull cutting through water and should be tall enough to prevent water from easily washing over the top of the hull.

- * **Bulkhead** - the internal walls of the hull

- * **Chines** - are long, longitudinal strips on hydroplaning hulls that deflect downwards the spray that is produced by the hull when it travels at speed in the water. The term also refers to distinct changes in angle of the hull sections, where the bottom blends into the sides of a flat bottomed skiff, for instance. A hull may have 2 or more chines to allow an approximation of a round bottomed shape with flat panels. It also refers to the longitudinal members inside the hull which support the edges of these panels.

- * **Deck** - the top surface of the hull keeps water and weather out of the hull and allows the crew to stand safely and operate the boat more easily. It stiffens an enclosed hull.

- * **Gunwale** - The upper longitudinal structural member of the hull. Cannons were bolted to this in the earliest gun armed warships.

- * **Keel** - the main central member along the length of the bottom of the boat. It is an important part of the boat's structure which also has a strong influence on its turning performance and, in sailing boats, resists the sideways pressure of the wind

- * **Keelson** - an internal beam fixed to the top of the keel to strengthen the joint of the upper members of the boat to the keel

* **Rudder** - a steering device at the rear of the hull created by a turnable blade on a vertical axis

* **Sheer** - the generally curved shape of the top of the hull. The sheer is traditionally lowest amidships to maximize freeboard at the ends of the hull. Sheers can be reverse, higher in the middle, to maximize space inside or straight or a combination of shapes.

* **Stem** - a continuation of the keel upwards at the front of the hull

* **strake** - a strip of material running longitudinally along the vessel's side, bilge or bottom

* **Transom** - a wide, flat, sometimes vertical board at the rear of the hull, which, on small power boats, is often designed to carry an outboard motor. Transoms increase width and also buoyancy at the stern.

Construction Materials and Methods

A wide variety of materials and materials are used in boat building:

* **Wood** - The traditional boat building material that was and is still used for hull and spar construction. It is buoyant, cheap, widely available and easily worked. It is not particularly abrasion resistant and it can deteriorate if fresh water or marine organisms are allowed to penetrate the wood. Rot resistant woods such as cedar and oak are generally selected for wooden boat construction. Glue, screws and/or nails are used to join the wooden components. Some types of wood construction include:

o **Carvel**, in which a smooth hull is formed by wooden planks attached to a frame. The planks may be curved in cross section like barrel staves. Carvel planks are generally caulked with oakum or cotton that is driven into the seams between the planks and covered with some water proof substance. It takes its name from an archaic ship type and is believed to have originated in the Mediterranean.

o **Another** method of building wooden boats is lapstrake, a technique originally identified with the Vikings in which wooden planks are fixed to each other with a slight overlap that is beveled for

a tight fit. The planks may be mechanically connected to each other with copper rivets, bent over iron nails, screws or with adhesives. Often, steam bent wooden frames are fitted inside the hull. This technique is known as clinker in Britain and also as clench built.

o **Another** method uses sheets of plywood panels fixed to a frame. Plywood may be laminated into a round hull or used in single sheets. These hulls generally have one or more chines. A type of the plywood panel boat building method is known as the stitch-and-glue method, where pre-shaped panels of plywood are edge glued and reinforced with fibreglass without the use of a frame. Metal or plastic wires pull curved flat panels into three dimensional curved shapes. These hulls generally have one or more chines.

* **Steel (and before that iron)** - Either used in sheet for all-metal hulls or for isolated structural members. It is strong, but heavy. The material rusts unless protected from water. Modern steel components are welded or bolted together. Until the mid 1900s, steel sheets were riveted together.

* **Aluminium** - either used in sheet for all-metal hulls or for isolated structural members. Many sailing spars are made of aluminium. The material requires special manufacturing techniques, construction tools and construction skills. While it is easy to cut, aluminium is difficult to weld, and also requires heat treatments such as precipitation strengthening for most applications. Corrosion is a concern with aluminium, particularly below the waterline.

* **Fiberglass (Glass-reinforced plastic or GRP)** - Typically used for production boats because of its ability to reuse a female mold as the foundation for the shape of the boat. The resulting structure is strong in tension but often needs to be either laid up with many heavy layers of resin-saturated fiberglass or reinforced with wood or foam in order to provide stiffness. GRP hulls are largely free of corrosion though not normally fireproof. These can be solid fiberglass or of the sandwich (cored) type, in which a core of balsa, foam or similar material is applied after the outer layer of fiberglass is laid to the mold, but before the inner skin is laid. This is similar to the next type, composite, but isn't usually classified as composite, since the core material in this case doesn't provide much additional strength. It

does, however, increase stiffness, which means that less resin and fiberglass cloth can be used in order to save weight. Most fiberglass boats are currently made in an open mold, with fiberglass and resin applied by hand. Some are now constructed by vacuum infusion where the fibers are laid out and resin is pulled into the mold by atmospheric pressure. This can produce stronger parts with more glass and less resin, but takes special materials and more technical knowledge.

* **Composite** - While GRP, wood, and even concrete hulls are technically made of composite materials, the term "composite" is often used for plastics reinforced with fibers other than (or in addition to) glass. Cold-molded refers to a type of building one-off hulls using thin strips of wood applied to a series of forms at 45-degree angles to the centerline. This method is often called double-diagonal because a minimum of two layers is recommended, each occurring at opposing 45-degree angles. "Cold-molding" is now a relatively archaic term because the contrasting "hot-molded" method of building boats, which used ovens to heat and cure the resin, has not been widely used since WWII. Now almost all curing is done at room temperature. Other composite types include sheathed-strip, which uses (usually) a single layer of strips laid up parallel to the sheer line. The composite materials in question are then applied to the mold in the form of a thermosetting plastic (usually epoxy, polyester, or vinylester) and some kind of fiber cloth (fiberglass, kevlar, dynel, carbon fiber, etc), hence the finished hull is a "composite" of fiber and resin. These methods often give strength-to-weight ratios approaching that of aluminum, while requiring less specialized tools and skills.

* **Steel-reinforced cement (ferrocement)** - Strong and long lasting. First developed in the mid 19th Century in France. Used for building warships during the war. Extensively refined in New Zealand shipyards in the 1950s and the material became popular among amateur builders of cruising sailboats in the 1970s and 1980s, because the material cost was cheap although the labour time element was high. The weight of a finished ferro-cement boat is comparable to that of a traditionally built wooden boat. As such they are often built for slower, more comfortable sea passages. Hulls built properly of ferrocement are more labor-intensive than steel or fiberglass, so there are few examples of commercial ship-yards using

this material. The inability to mass produce boats in ferro cement has led there to being few examples around. Many ferrocement boats built in back yards have a rough, lumpy look, which has helped to give the material a poor reputation.

The ferro-cement method is easy to do, but it is also easy to do wrong. This has led to some disastorous 'home-built' boats. Properly designed, built and plastered ferrocement boats have smooth hulls with fine lines, and therefore are often mistaken for wooden or fiberglass boats. See also concrete ship, concrete canoe.

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