Carvel technique in Norwegian Boat building

Åsmund Kristiansen

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Drawings: Morten Hesthammer

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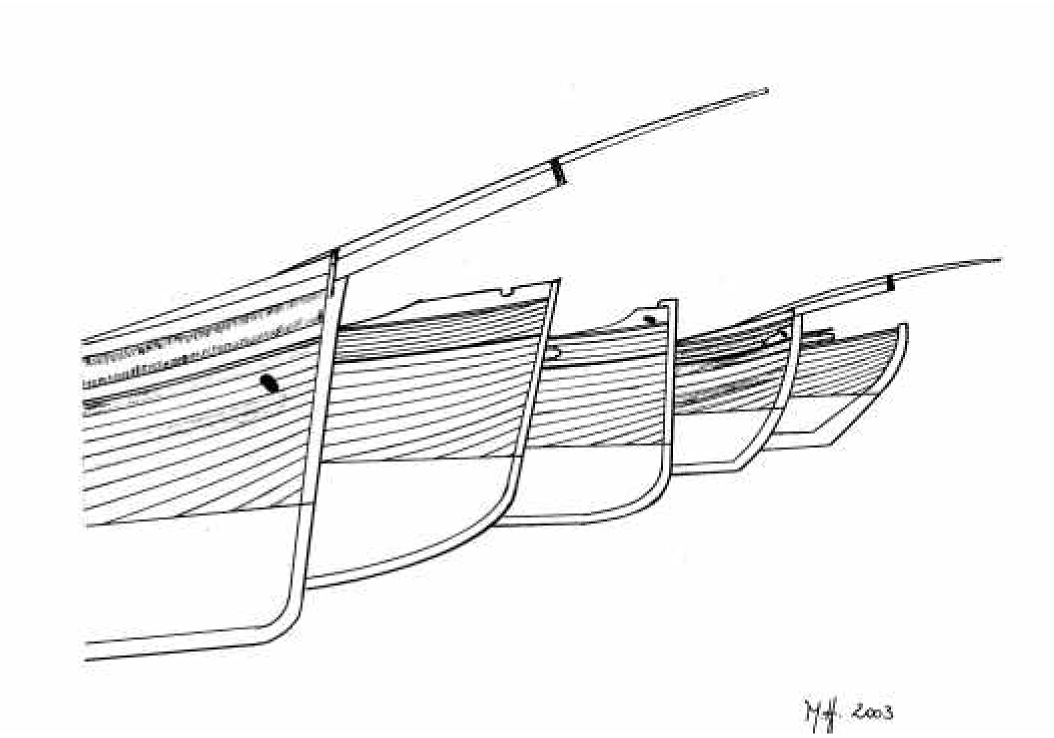


Introduction

The Carvel project

In 1999, the Hardanger Ship Preservation Center began a Carvel Project. The intentions of the project involved the systematization, supplementation, and presentation of information regarding carvel boat building in Norway. This included the history of the technique, its introduction and dispersion, variations within the technique, and technology, etc. Here, the carvel-building technique will be discussed, as it is practiced in Norway; how a carvel-built boat is designed and constructed. This document can be seen as a continuation of the article, ”*Carvel building in Norway 1800-1990”* (Rasmussen og Kristiansen 2000).

The Carvel project does not cover all of the differing types of carvel-built vessels in Norway. In this document we have limited the discussion to vessels that have been least documented; working vessels between 35 and 100 ft. in length. Such vessels are often built by smaller, family-owned boatyards. They are built with relatively simple tools, and designed by the ”master” of the boatyard, using half-models or drawings.

Regulations

The regulations set down by the classification company Det Norske Veritas apply to vessels over 25 gross registered tons, and later over 15 meters. These regulations have been a means to increase safety, and to evaluate vessels regarding insurance, for example. The oldest regulations we have in Norway are from 1859. The existence of these rules implies that there can be greater variations in design solutions and dimension proportions with vessels under this limit than over, but that there are variations with all sizes. The Norwegian Maritime Directorate has monitored Norwegian boatyards concerning these regulations. They have had their local controllers, who have functioned in cooperation with the boatyards.

Formal education in wooden boat building has not been prioritized in Norway. The boat building schools in Saltdal (Nordland) and Jondal (Hordaland) started in 1948, and 1979 respectively. Still, there is good reason to believe that the majority of Norwegian boat builders have received their education through practical experience.

The most extensive training in carvel-building was done through a national “wandering teacher” program, in carvel-building, between 1902 and 1909. This was also an attempt to create a more consistent building methodology. The teacher, Johannes Selsvik, drew up a description of how to build sea-going fishing boats of 21 gross registered tons. This document was meant to be an educational tool and reference material for students participating in Selsvik’s course. In addition, in 1905 he compiled a set of general rules for building sea-going fishing vessels. The intentions behind this were to create a more homogeneous building style for the fleet of sea-going fishing vessels, and to thereby increase safety.

In the 1930s, state subsidies were given for the building of new fishing boats in northern Norway. The Directorate of Fisheries designed these vessels, and it is assumed that this also became part of a learning process for boat builders.

Sources

The descriptions of the carvel-building technique are based upon contact and collaboration with older boat builders, documentation of vessels, and diverse written materials. The most important written sources have been volumes of Veritas regulations and Johannes Selsvik’s rules. Sommerfeldt’s teaching books, from the 1850s, have been an additional source of information, as well as Funch’s Maritime dictionary from the same time period.

Wooden shipbuilders, Torleif Nerhus and Ingvald Vevik, both from an area called Kvinnherad, have acted as mentors for Morten Hesthammer, boatyard foreman at the Hardanger Ships Preservation Center. Hesthammer has conducted many interviews with these two, as well as other boat builders, who have then afterwards helped with valuable advice, when special challenges have arisen. This collaboration has been very fruitful. Under the direction of the Norwegian Craft Development, a 44 ft. fishing vessel was built at the Bremsnes Boatyard in 1995. The author of this article carried out the documentation of that project. Involvement in that project has been a decisive impetus for initiating, and following through, with this further Carvel project.

Other ship and boat builders, from all over the country, have also gladly given to us from their experience and knowledge. They will be presented as they are referred to in the article, and there is a list of sources at the end.

Various vessels have also acted as an important font of information. While under restoration, the vessels are often stripped to the bone. During this process, it is possible to document the techniques that were used. It has been especially fruitful to work with vessels that have shown examples of techniques we had not seen before. Upon closer examination, variations of how things were done have come to light.

Materials for Carvel-building

One of the primary rules regarding materials used in boat building is that boat builders used the materials that were available locally. The main regions for boat building are therefore based in areas where good materials were easily accessible. Yet, materials have also been imported from other regions and countries. In the 1950s and 60s, a number of fishing vessels were built for the Swedish market. These were built in southern and western Norway, following Swedish regulations and controls. In this instance, the primary material used was oak, much of which was imported from outside the country.

Pine is the dominant material used in vessels produced along the coast stretching from western to northern Norway. The exception being in Hemnes, Nordland, where *spruce* has been widely used. South of western Norway, *oak* has been used for making keels and stems. In southern and eastern Norway, access to *oak* has been greater, and has been used in making frames and hull planking.

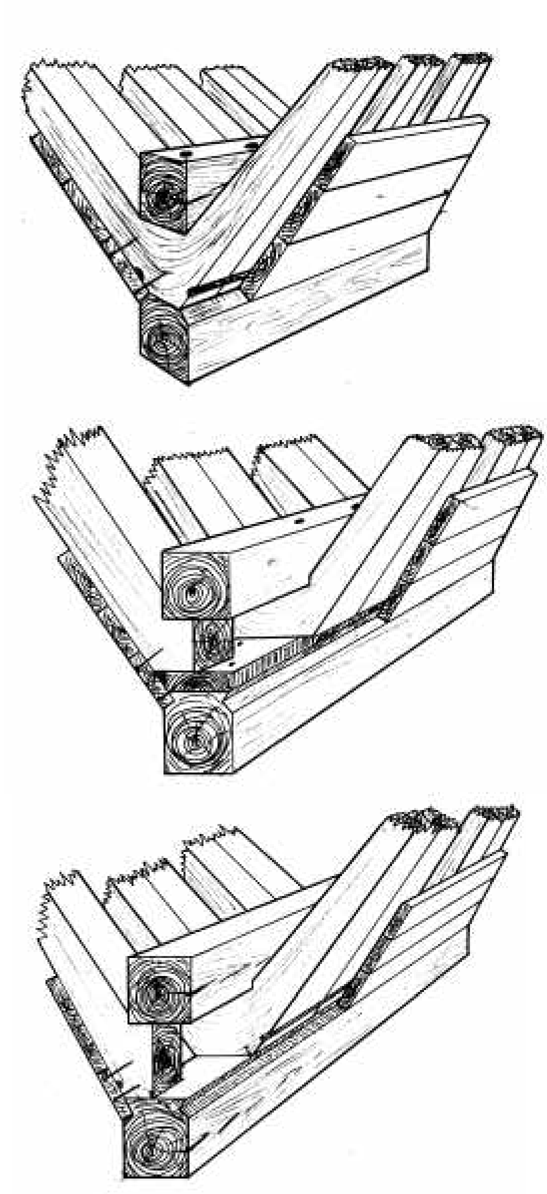
Trunnels have predominately been made of pine, but in southern and eastern Norway *juniper* was the favored material.

The requirements for materials have mainly had to do with strength and resistance to rot causing fungi, and insects. Strength requirements pertain to bending and tension, and to some degree compression strength. But these requirements are not absolute. Often, the discussion has to do with the lowest limits of what is acceptable, rather than what the ideal would be.

The keel

The keel is the backbone of the ship and acts as a beam running the length of the vessel. During building, the keel is the vessel's "foundation".

The keel can be shaped square or trapezoid (in cross-section), before the rabbet is cut into it. There does not seem to be any sort of clear pattern concerning the ages and distribution of the differing keel styles.



The simplest method for making a rabbet is to remove the upper corners of the rectangular keel, (when seen in cross-section).

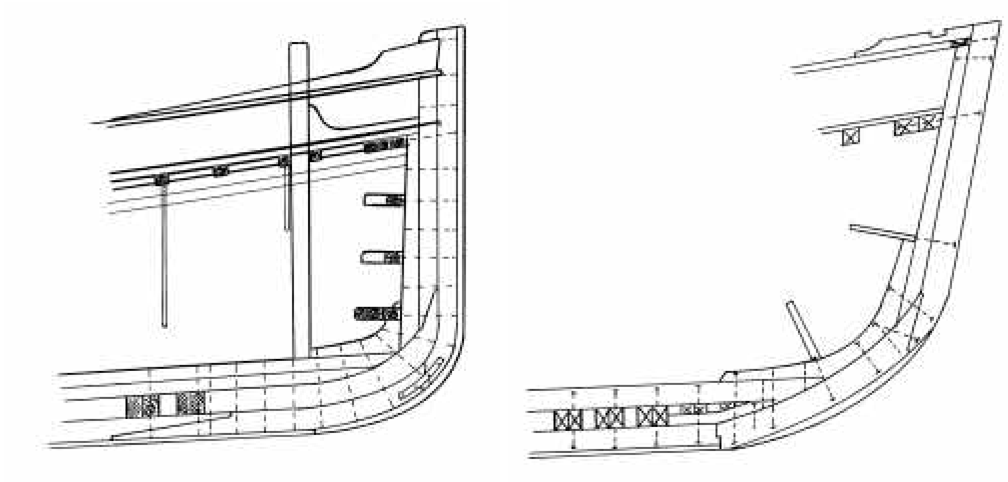
A more advanced type of keel incorporates a hog piece (keel batten). This can be nailed into. Normally, the garboard is not nailed to the keel, but drift bolts or barbed bolts are set through the garboard and into the keel. The frames are also more complicated to make, as they must be shaped to fit over the hog piece in order to meet the hull planking. The hog piece can be made as a separate part that is bolted to the keel.

A third type is something between the first two. The rabbet is cut into the keel so far up that there remains only a sharp edge. This edge is easy to break off during work with the keel and frames.

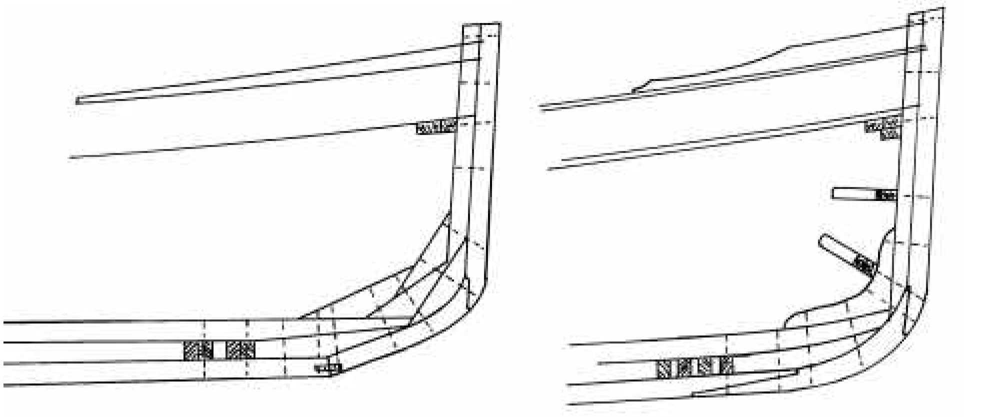
Stem foot

The stem foot is a curved piece between the keel and the stem. Not all vessels have this piece, and the keel and stem are fastened directly to one another. It seems that the stem foot is used most often in western Norway and farther north, and that it is more common on modern vessels. The shape of the stem foot can vary. Some are strongly undercut, while others butt the stem without a gradual overlap. The stem foot is fastened to the keel by a flat scarph. The scarph joint is made watertight with a softwood stop water. This is a piece of wood that absorbs water and swells, pine sapwood, for example.

On the inner side of the stem foot and stem there is a knee to fasten these two parts together. This is called the stem knee. Originally, a piece of bent wood was used, but in later years the use of straight timber is common.



Different junctions between keel and stem. Left: Cutter built 1919 by Stenødegaard, Vestnes in Møre og Romsdal. Right: Cruiser built 1960 by Svege, Vest-Agder.

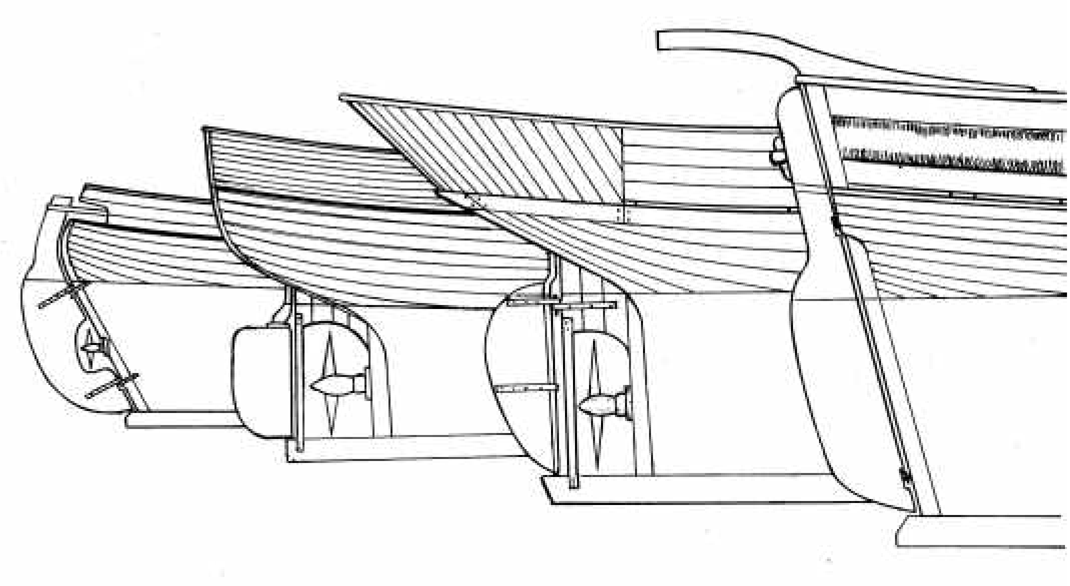


Left: Cutter built 1920 by Salthammer, Vestnes in Møre og Romsdal. Right: Cutter built 1931 by Vevik, Sogn og Fjordane.

Different sterns types

Double-ender stern

The double-ender has the simplest stern shape. The sternpost forms the stern, and the rudder is attached to it so that it hangs behind it. Even though large smacks are built, this type of stern is most often found on smaller vessels.



Double-ender, cruiser, cutter (elliptical stern), "jakt" (transom stern).

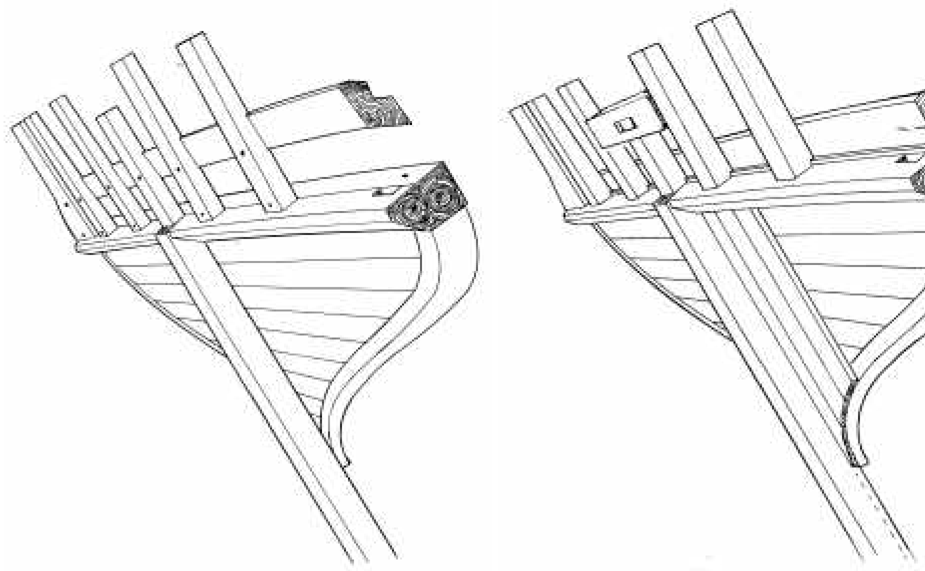
Transom stern

"Jakt"-built vessels with a transom stern have divided stern. Visible, vertical planks make up the counter (lower stern), while the transom (upper stern) has horizontal planking. The counter is flat, while the transom has a slightly convex curve to it. The two sterns are separated from each other by the knuckle.

The transom beam lies on the fashion timber and the counter. It has both camber and curves towards the stern. Because the lower stern should be flat, there is a rabbet for it in the transom beam. Outside of this there is a timber called the knuckle. This has a chamfer creating a transition between the upper and lower stern, as the upper lies at a level outside of the lower stern.

The transom stanchions stand on the knuckle, in such a way as to create a nailing strip for the upper transom.

The deck lies against the waterway on the transom. The waterway can either lie right on or a bit over the transom beam. From the "jakts" we have seen, it would appear to be a newer trend to lay the cover board directly on the beam. This gives a lower and more upright transom.

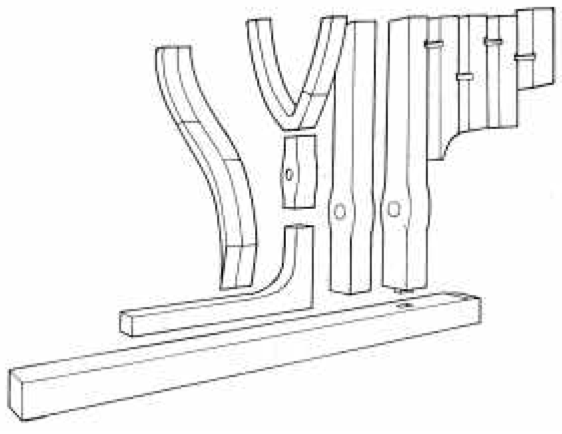


Building the transom stern in different ways, the older way to the right. Frames that lay farthest aft in a "jakt", and which the transom are fastened to, are called the fashion timbers. Sometimes, as on John Børve's *Dyrafjeld (Anna Kristina)* and *Svanhild* the lower transom is rabbeted into the fashion timbers, while on a number of older "jakts" the lower transom lies outside of the fashion timbers. The lower transom has two layers of planking nailed to these, first horizontally and then vertically. The horizontal layer in the lower transom comes in front of the sternpost, so that the sternpost is visible outside of the lower transom.

Elliptical stern

The elliptical stern's shape is formed with the help of several molds, which are called stern rings. The shape of the stern rings are taken from the model or drawing from which the boat is being made. The lowest ring makes up the top of the cover board, while the highest ring forms the top of the railing.

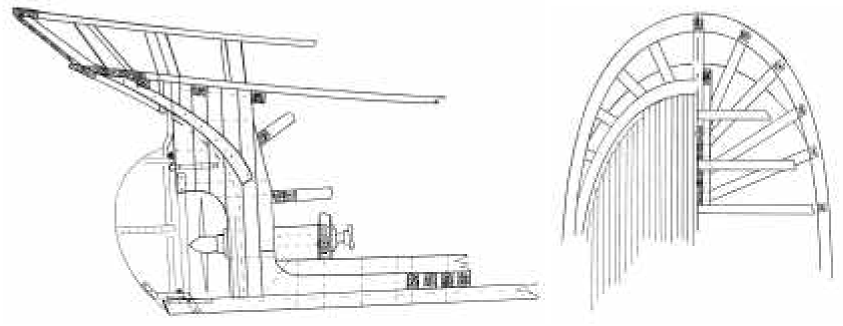
From the stem and aft, deadwood is used to build a post timber. In the region called Sunnhordland, it was normal to have a bulwark stanchion amidships, something missing on vessels built in the area called Møre and Romsdal. From the post timber, the frames lie against the stern ring, in a star formation. The distance between frames can vary.



This is how the elliptical and the cruiser sterns are built up, in principle (western and northern Norway).

The planking on elliptical sterns can vary. In Sunnhordland it is usual to have something called a "vins". This is a timber shaped with an axe, and is a continuation of the topmost strake. As it lies in position around the stern it has to be axed into shape, using three to five pieces. In Saltdal this piece have rabbets for both the deck and hull planking.

Elliptical sterns are different in appearance, depending upon where they come from. In the Hardanger region they are long and with horizontal planking, while a vessel from the Møre region will have a shorter stern with more vertical planking.

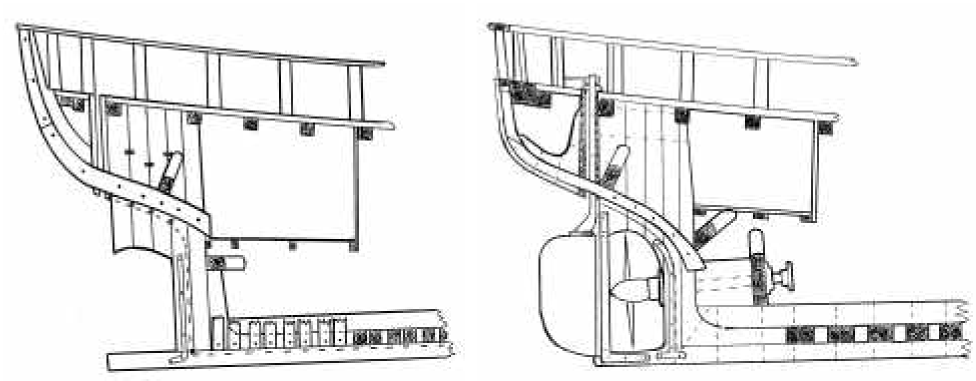


Elliptical sterns have been most common in western and northern Norway, and can vary a bit. This example is from Hardanger, Hordaland.

Cruiser stern

The cruiser stern can be shaped in several ways. One type has a short or long sternpost, (up to the deck beams) and the stern placed in to the sternpost, with a knee in between. The rudderstock is run through a wooden "pipe".

Another construction looks more like the elliptical stern, inside. Behind the stem there is deadwood, then the stern is placed beside these. As part of the deadwood, there is a box with a hole through it, which the rudderstock goes through, called the rudder trunk. Beside the deadwood lies a timber called the post timber.



Different cruiser sterns, both from western Norway (Nerhus and Lothe).

The distribution of these two seems to follow a certain pattern. Smacks built using Swedish drawings have the first type of stern, and it would appear that this type has also been most common in eastern and southern Norway. The Norwegian shipbuilder and constructor Colin Archer used this type of construction on cruiser sterns around 1900. In western Norway and further north, it seems that the last type was more prevalent.

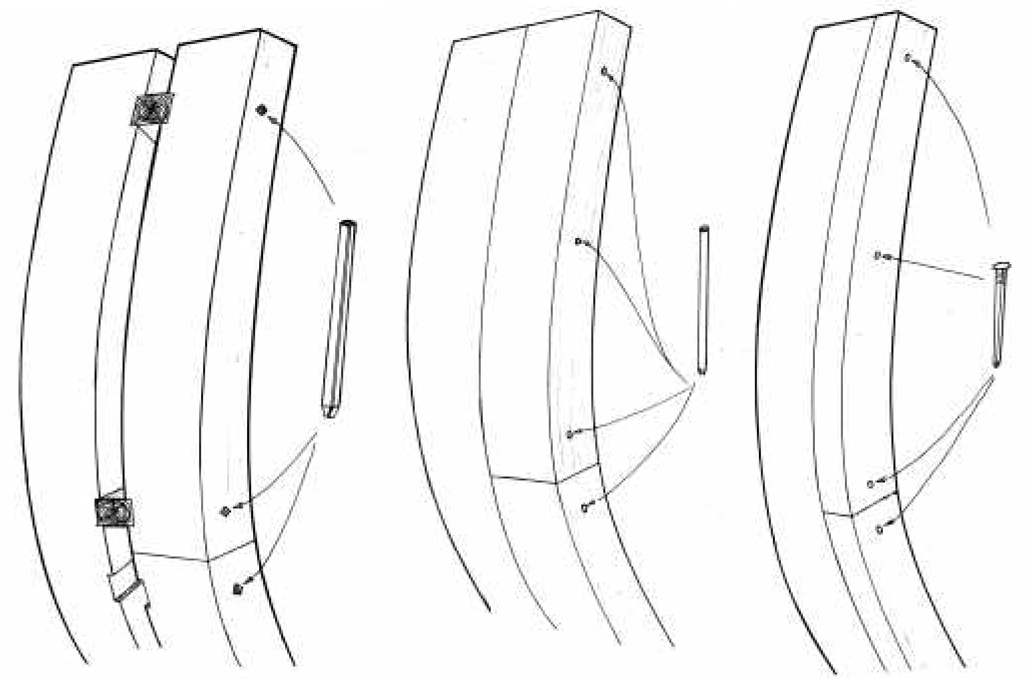
Molds for stern construction can be made using models following the same principles as when making frame templates. From this mold it is possible to find the dimensions for the different parts of the stem.

Frames

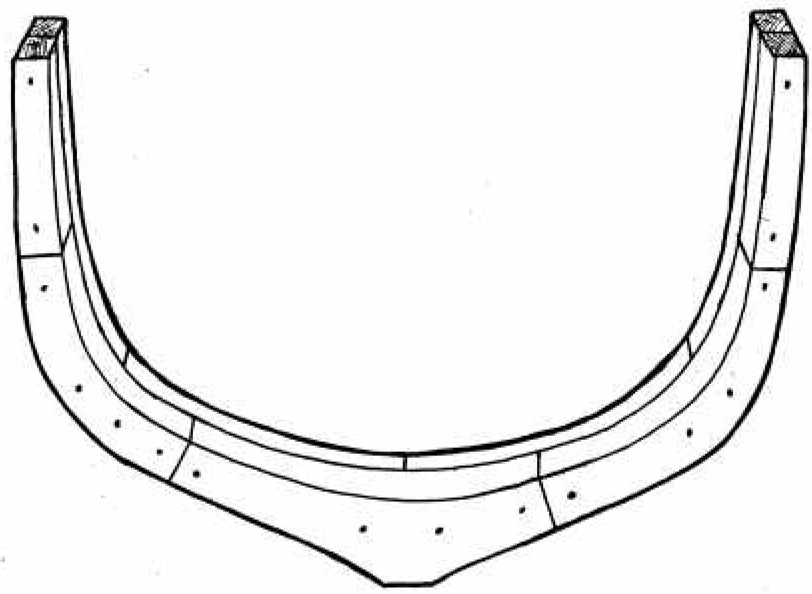
Different types of frames

Carvel-built boats usually have double frames, lying side-by-side, such that the two layers overlap where their respective parts butt. In addition, intermediate frames or bent ribs can be placed between these.

The floor timber is a root grown knee, often with different lengths on its legs. The longer leg is placed alternately to port and starboard. The floor timber layer is usually laid down against the body plan while shaping the frames.



Different frame constructions. The spacing blocks (chocks) are not always mortised into the frames, so that they can be taken away when the frames are raised and the planks are mounted.



Frames are built up of two layers. The pieces in each layer overlap.

The layers, or rings, can lie close together or have spacing blocks in between. They can be fastened to each other by trunnels that go all the way through them, or with coaks, nails or iron bolts. It appears that there has been a development away from frames with spacing blocks and towards close lying frames.

Some boat builders have used floor timber layers and futtock layers of different thickness. This method is described by Johannes Selsvik in his teaching books (1903 and 1906), made in connection with his courses in carvel-building.

Selsvik gives the total dimension for a double frame, so that one can vary the thickness of the two layers, so long as the final dimension for the two layers is correct. Narrow dimensions on the futtock layers will make it difficult to use trunnels. Selsvik also prefers galvanized ships nails for attaching hull planking. However, where trunnels are to be used, the dimensions of the timbers into which the trunnels will be driven, must be increased by 1/10 (Selsvik 1906:15). Boat builder Sverre Haugen says that the minimum frame dimension they used was 3 inches, when the hull planking was to be fastened by trunnels.

Colin Archer used pine in the floor timber layer and oak in the futtock layer on some vessels.

Intermediate frames

Frame shapes can be established in different ways. The most common method used during the 1800s and 1900s, was to make them according to a design model or drawing. One of the old methods was to first erect one, or several, construction frames, and then make the other frames, in full scale, based upon templates taken from the boat.

This method has survived, to a degree, in the technique using intermediate frames. They are single frames that lie between the double frames. In Norway, this type of frame was used right up until WWII. Boat builders in Saltdal explain that the intermediate frames were mounted after the hull planking was in place. Selsvik, in his description of building methods (1903:8), discusses the placement of intermediate frames after the first three strakes were on the boat. The frames should be placed root end up, most likely so as to have the best resistance to rot nearest deck. However, Funch (1852:49) describes the following: The intermediate frames are not lofted on the body-plan, but their shape is obtained by making molds during the building, when the ribbands are marked. Whole or half intermediate frames can be made.

The intermediate frames can therefore be made before or after the hull planking is in place, probably depending upon the distance between the fixed frames. One can thus see the development from few to many constructed frames. The ribbands have gone from being very important shape determining devices, to being tools that hold the frames together and in place.

Colin Archer used comparatively long distances between fixed frames, as well. He installed bent ribs between these when the hull planking was in place.

The body-plan

When a boat is built from a drawing, or model, offset sheets are first made from the drawing, or model. The offset sheets show the coordinates scaled up. The curve for each frame can be taken from the center of the frame, or from where the frame is either largest or smallest. If the curve is taken from the smallest side, the various parts of the frame must be made larger than the template. During the process of hewing out the frame, one must angle inwards towards the line ("under cut"). The opposite is true if one takes the curve from the largest side. When the curve taken from the center, each layer is made separately and put together, more or less finished, on the lofting floor.

One can see these different methods for finding the shapes of the frames by looking at the curves taken from the drawing, or model. If there is an equal distance between the frame lines, the curves were probably taken from the center of the frames (cf. Bremsnes, Hans

Arntzen), or the frames can be "under cut" in the aft part of the boat and opposite in the forepart. If there is greater distance between the frames at the midship section (place of widest girth on a vessel), the curve has been taken from the frames smallest side (cf. Vevik, Nerhus). Even spacing can also mean that the curve is taken from the smallest side of the frame, but from the center of the midship section, since this is made having no bevel (cf. Selsvik, Greenhill 1988:111).

Selsvik writes of the framing system from eastern Norway, "as was customary on larger vessels", as being more difficult and demanding than the system he used, on smaller vessels. These differ from each other in that while Archer took the curves from the center of the double frames, Selsvik took the curves from the smallest side; aft in the aft part of the vessel and fore in the forepart of the vessel. This results in slightly different methods of approach when the frames are hewn out. Archer had to axe out the floor timber layer and the futtock layer of the frame separately, and take into consideration whether the bevel angled outwards or inwards. Selsvik took the mold from the body-plan and added the width of the bevel. Timbers were placed on the lofting floor and fine hewn. Because the curve was taken from the smaller side, the frames were under cut the entire way. When the futtock layer was finished, the futtocks could be rough hewn and placed on the floor timbers, where it could then be fine hewn. This is the same method used by boat builders in the Sunnhordland region, probably even before Selsvik's time.

In the discussion concerning the means for obtaining the curves, one must also talk about regional differences. Selsvik mentions "curves in the center" as coming from eastern Norway, and as the technique used while building larger ships.

Lofting

From the offset sheets one can find the measurements for each frame. These are drawn on the lofting floor, which is a grid system with the waterlines placed horizontally upon it. From the offset sheets one can also find the distance from the centerline to the outer edge of each frame.

To transfer the curves from the lofting floor onto a template one can use several methods. One simple way is to lay a mold, made up of small pieces of wood which are nailed together, or a piece of copper tubing along the curve, and then take the mold out to the timber pile. Another practice is to position nails very closely together with their heads on the line to be transferred. A board is then placed on top of these and walked on, so that the nail heads leave marks in the board. A third method involves placing a spline along the curve on the lofting floor, and nailing it down, temporarily. Then one can mount several hooks, which just fit over the spline and which have a stud in the other end. This stud is then driven into the floor. While the hooks hold the spline in place, the nails are removed and a piece of plywood is slid under the spline and the shape of the frame can be sketched.

The frames stand square to the centerline of the boat. Therefore, it is only the largest frame (where the boat is widest) that has something like a 90-degree angle between the sides of the frames and the edges of the hull planking and ceiling. This frame is called the midship section or main frame. All of the other frames will have different angles between these surfaces, and this is called bevel. The bevel increases towards either end of the boat and decreases from the cover board to the keel. It can be calculated from the lofting floor by using a large angle with the frame spacing on it and an adjustable angle with a readable scale. The bevel is measured, for example, three places along each frame; at the cover board, in the turn of bilge (where the frame's curve is greatest), and between the turn of bilge and the keel. At the keel, all of the frames are in right angles. The angle is placed into a curve and a small straight edge is placed in the curve of the neighboring frame. The straight edge creates an angle between the two frames, which is quite like the bevel. This angle is measured with the adjustable angle. The numbers are read off and written on the corresponding points on the template.

The frames

The Veritas regulations set the dimensions for materials for the various parts of a boat. These presume that the materials are square hewn (meaning without wane). If this is not the case, the dimensions must be increased such that they fit the requirements on average.

The squaring of framing timber, using an axe, is a process that has disappeared due to the use of better sawmills and improved transportation possibilities. In varying degrees, side cut timber is used for frames. Ship builder Torleif Nerhus estimates that a 65' boat requires approximately 600 meters of framing timber. In addition, there are the roots needed for floor timber. One might well have had timber for the frames for half of a boat floating stored in the sea for quite a while. When a new project was to begin, nearly all of the timber needed for the frames was squared. Framing timbers were very likely logs measuring 9" in the middle of their lengths, when the frames were to be 6". The top ends of the logs could be as narrow as 5". "There could be a bit of wane", says Torleif. Sometimes the frames could be nearly round, but that did not happen often. When squaring was finished, the timbers were, as a rule, a little larger than the requirements in the regulations.

When the frame timber was to be squared, the timber was positioned with the huckle down, like a U. A cord was attached to one end and stretched to the other end. From this cord, a plumb bob or level was used to determine the bottom-most point in the huckle. A chalk line was then used, twice, to create a fair line. After this, it was hewn plumb and checked with a level. When the one side was finished, one could sketch over to the other side, which was then hewn finished following the new line.

Evaluating the framing timber using a template, and then sketching the different parts of the frames, is work that is usually done by one with a good deal of experience. It is a great advantage to have a large work area so that the timbers can be spread out, and one does not have to move the materials around often.

Framing up

When the frames are raised, one must take care to get them in right angles to the centerline of the boat. This can be done in at least two ways. In Sunnhordland, they measured from the centerline in the stem or sternpost, and out at an angle to the edges of the frame. At Bremsnes they hook up a straight edge, on two nails, a ways up the frame (cross-wise). Along the keel a long angle was positioned with its one leg out to the side. One person sighted down the straight edge on to the angle. The frame was adjusted until the straight edge was lined up perpendicular over the angle. The frame was then straightened relative to the keel and along the boat's length. It was then standing either plumb with the waterline, or square on the keel.

At both ends of the boat the angles between the sides of the hull are too sharp to allow the use of roots. The frames used here are called half-frames. The expression "half-frame" implies that the two sides of the boat were not connected. Each half of the frame is set up with its "mate" from the other side of the boat, and a 5" nail is driven into the deadwood upon which the frame is standing. When both sides are in place, the cross spall is set in position according to where it is marked. The frame is straightened and two clinker bolts are run completely through the base of the half-frames, holding them tightly together.

The frames are fitted on to the keel one by one. The farther down a frame is fitted, the rounder the shape of the boat. The shape of the hull can therefore be adjusted by how far the frames are fitted. With narrow frames, it is sometimes a good idea to force the frame open by loosening the cross spall and shoving the two sides away from each other.

Ribbands

Ribbands are planks (like hull planking, or a bit thinner) that are temporarily attached to the frames to keep them from being displaced. They are installed outside of the boat in several places, and also usually up high on the inside. Ribbands are also used to help draw the frames into the correct position, relative to one another, so that there is less to plain off each frame, when making adjustments later.

Ribbands have originally had a shaping function. They were placed on the constructed frames and created the shape between the frames and stems. The ship builder could then make templates for several frames by using the ribbands.

Cant frames and knightheads

Between the aft most half-frame and sternpost (or aft stem), and similarly in the bow, there are often single frames that are bolted to the sternpost or stem. These do not stand square to the boat's centerline like the other frames, but more in relation to the boat's curvature fore and aft. These frames are called cant frames. The timbers that are placed against the stems, and bolted to them are called knightheads.

Not all boat builders use cant frames. In southern and eastern Norway, boat builders seem to use double frames along the entire vessel. Knightheads are not used either.

To find the shape of the cant frames, one does not use the model, as with the whole frames, even if it is possible. A spline is set up at approximately the same height as the cover board. This should have a fair curve, and is shored up, until the desired shape is obtained. Farther down, several other splines are attached at 50-60 cm intervals.

Knightheads are fastened to the stem with drift bolts, as long as they are positioned tight to the stem. The hawse pipe is bored through the knighthead. To prevent leaks, a 3-4" stop water is used on deck. The bevel between the stop water and deck is caulked, with the caulking running half way into the stop water (Bremsnes).

Keelson and keel bolts

The keelson is a long piece of timber that lies on top of the bottom frames directly above the keel. It acts as an upward extension of the keel, and works to lock the bottom frames better to the keel. If the vessel is rigged, the masts are often stepped on the keelson. If the keelson is high or wide, it can be made in several stages. Veritas regulations require that the keelson be attached to the stems by knees (inner stem knees). However, this is not always the case with smaller vessels.

According to Veritas, the keel bolts run completely through both the bottom frames and the keel, and are clinked underneath the keel. In modern times nuts are also used as fasteners under the keel. It has never been easy to form solid clinker heads when one is lying under a boat. Smaller vessels do not always have bolts running completely through the keel.

The head of a keel bolt is spread when the bolt is driven into place. The washer should have a larger hole than usual. Skogseide says that they used the next larger size for this purpose.

On a vessel larger than 60', the keelson runs its the entire length. On smaller vessels the keelson often stops aft at the motor. Here, they can use stringers instead, which run parallel to the keel over the engine bed.

Sheer line

In order to find the sheer line of a boat, a cord is stretched between the stem and sternpost at about the height of the cover board. One rule of thumb for establishing the sheer line is that there is ½" per foot. A 70 ft. boat would thus have 35" of sheer line. The sheer line itself is sighted in following measurements taken from the model or drawing. Some have hung a heavy cable to measure from so that the shape was smooth and even.

When building outdoors, it is much easier to sight in the sheer line. One can obtain a little distance from the vessel and look at it from different perspectives. One cannot be completely sure that the sheer line has been made successfully until the vessel is launched, and then it is too late to do anything about it. Ship builder Olav Nerhus, from Ølve, rowed out into the fjord so that he could get enough distance from a vessel when the sheer line was to be set.

Rabbets

On larger vessels, it is not unusual to use an apron forward. The hull planking is then nailed into the apron. Rabbets are hewn on the stems of smaller vessels.

At Bremsnes the rabbets were rough hewn early in the building process, and finished as the leveling advanced. In other places is appears that rabbets, especially along the keel, were hewn out completely before the planking process began. The rabbets in the stem and sternpost can be made one of two ways. If they are beveled in the direction of the planking, there is no need to make bevel on the ends of the planks. Otherwise, they can be formed in such a way that the planks are wedged into them. The last variation was common in southern Norway, though we cannot say that it was not used elsewhere.

Hull planking

Variations

In western Norway and farther north, one rule the boat builders have heard of is that the, ”the pith side of a plank should face inwards”. This holds for deck planking, hull planking and ceiling planks. This rule is also noted in the Veritas regulations. In inspections reports, however, a change has taken place, indicated by the fact that it is now possible to check off whether or not the pith side is in or out. There are several reasons why the pith side is turned facing inwards. The first has to do with esthetics; the pith side often has knots and flaws from the pith. Another reason is that the most rot resistant material should be placed against the frames, where it is not possible to treat it later. When sapwood lies against a frame, rot occurs, making it difficult to caulk the vessel, as the planking below the caulking bevels are no longer pressing tightly against one another. A third reason gives weight to considering the strength relationships within the materials. If the pith side is turned outwards, the planks can more easily break, or splinters can form on the outer surface.

In eastern and southern Norway, it is normal to turn the pith side out, especially over the waterline. This variation exists even though the rule is clear; the pith side should be turned inwards. The reasoning here is that the planks over the waterline will warp, and curve so as to follow the convex shape of the frames.

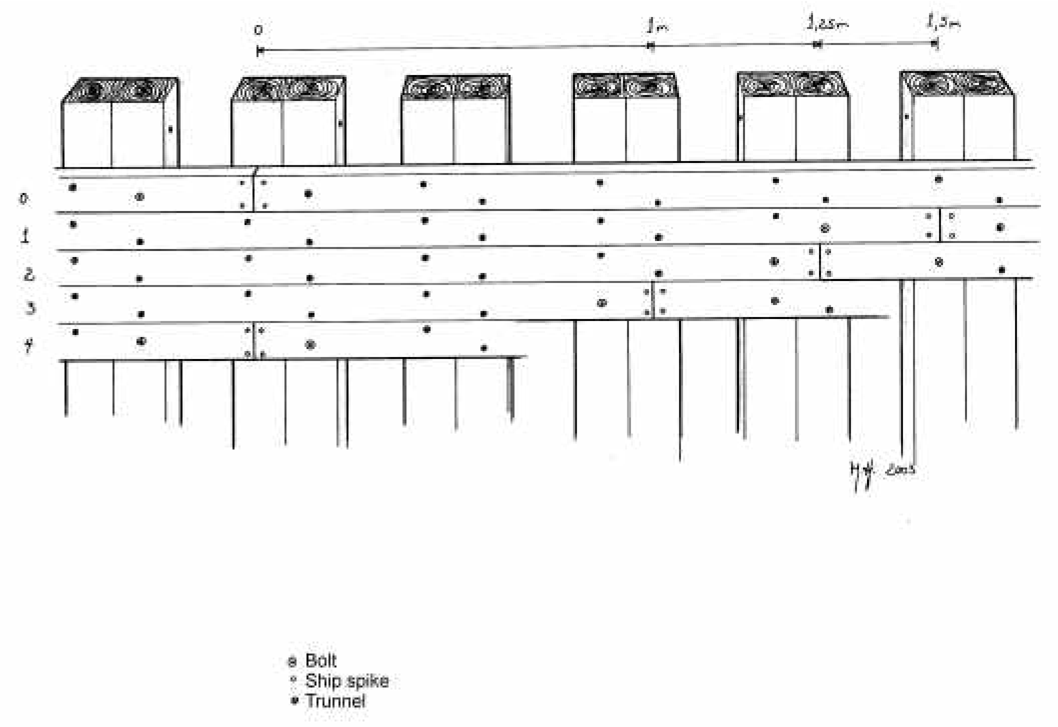
A cruiser stern and an elliptical stern have rather different hull planking. The cruiser stern has a shape, which is difficult to plank up, while the elliptical stern, is almost shaped according to how a plank would naturally bend on the hull. The root end of a plank is usually the strongest. Boat builders often place the root end against the stems, both in hull and ceiling planking. This depends upon what type of boat one is discussing, however. On planks that have little bending or twisting (like those near the stems on a cutter), it would be a waste of materials to use the widest end of the plank at the stem, where the finished plank would be narrowest. The stern on a cruiser, meanwhile, requires strong planks at the stems.

There are variations concerning the shaping of planks. The curve of each plank makes up the lines of the boat and creates the overall impression of how it looks. Though there has been little research done in this area, several rules of thumb can be mentioned:

- Width of planking above water: 6" –6 ½"; approx. 4" near the stems. Some use planks of more than 8" widths over the waterline.
- The uppermost plank is the widest, 1" - 2". One reason for this is that there will be bolts running through it.
- Under the waterline wider planks are used, possibly even up around 9".

The thickness of the hull planking is not always uniform from keel to deck. The Veritas regulations (1971:69) require thicker hull planking above the turn of bilge, than below it. Ship builder Torleif Nerhus is familiar with this rule, but he has always practiced using the greater of the two thicknesses. He felt that it would have been too complicated to use two dimensions. Another rule of thumb regarding plank thickness was that there should be 1mm in width per foot in length.

Individual boat builders, especially those in Sunnhordland, laid the ceiling planks before the hull planking.



Butt joint distribution, bolting, trunnels and nails.

Materials

Veritas (1866:29) prefers hull planking which has been split along the pith, while Hesthammer (1998:92) and Godal (2001:97) have written that when the log is split, the pith plank is used for interior work, the next plank becomes hull planking, and the last becomes ceiling planking. Odd Hundershagen, a sawmill operator in Kaupanger, Sogn og Fjordane, utilizes this method.

How a log is divided also depends upon its size. Torleif Nerhus says that he often split the logs along the pith. This gave him a 2" plank on either side of the pith, and a 5/4" board (for bulwark planking, perhaps) and a 1" board (for flooring, interior use, or roofing).

Hull planking should not be too green, because it would shrink as it dried opening the caulking bevels. Nerhus allowed his hull planking materials to dry for several months, in the spring and early summer, before using them on a boat. The planks were spread out on the bare rock faces near the fjord, so that it was easy to find planks with the necessary shapes. Older photos of Nerhus, and other places, show the planks piled in ”triangles” to dry.

In Saltdal, the hull planking was dried on a “mare”. “Mare” are beams standing on two poles that the planks can be supported against. The root ends are placed down towards the ground, upon some sort of bedding, while the tops lean on the “mare”. The planks stand on both sides, so that they appear to form a large tent. One of the advantages of using this method is the ease with which materials can be retrieved without having to move other materials out of the way.

A third method involves stacking the planks up on one another with thinner strips of wood separating each layer.

Hull planking made from oak should, according to Hans Arntzen, lie in the dark while drying to minimize checking. Arntzen says that oak hull planking is allowed to dry for up to one year.

The materials intended for hull planking often have a long huckle. The materials are better utilized, as all planks curve to a certain degree. Too much huckle is undesirable because there can then be reaction wood and this material is much too hard.

Many boat builders have preferred to have paired planks (“mates”), or rather, pith planks that have come from the same log. This is an easy way to get planking for both sides of the boat at the same time.

Sheer strake

The upper-most strake is called the sheer strake. The planking process can begin with the top or bottom strake, or with both at the same time. One method documented at many yards, is to start with the three top strakes. Once they are on, it is possible to work on the stanchions, beam shelves, beams and deck inside the boat, while at the same time, continue to plank downwards towards the turn of bilge, and upwards from the keel.

Lining off planks

If planking up begins at the top of the hull, the underside of each plank will be made square, and the top side will be beveled.

Some boat builders do not line off hull planking, but make them by eye.

Lining off is carried out using a thin and bendable wooden mold, called a lining batten.

Garboard and shutter strake

The garboard is set in place using different methods depending upon the type of keel used. On keels without a hog piece, it is not possible to nail horizontally into the keel. In this situation, they bolt vertically into the keel using drift bolts or barbed bolts.

When the garboard is in place, one can divide up the distance between the upper and lower planks, and decide the number of strakes to be used. A balance must be struck. Because it is important to be efficient with both materials and effort, during the planking process, the fewer the planks needed the better. Yet, narrower planks are lighter, easier to handle and easier to force edgewise against their neighbors.

The shutter strake is the last strake to be set onto the boat. It is usually in the turn of bilge because the planks are straightest here, and the opening is wider on the outside than on the inside. The plank is lined off by measuring the width with a pair of dividers every 24”. The inner width is measured near the frames. As the fit is so tight, one must strike hard with a shipwright’s maul to get the shutter strake in place. This takes some skill. One must use the entire face of the hammer to avoid causing ugly marks, or be careful to strike where there are knots.

It is not common to counter-sink the heads of the nails under the waterline. If it is done, often they are sunk less than those over the waterline. It is also unusual to set in plugs here. Usually they are sealed with cement or another appropriate material. Sometimes the planks are gouged out under the nail heads, or the nails are driven in with a shipwright's maul and nail set.

Steaming and mounting

After a plank is finished being planed, it is marked according to which side of the boat it will be mounted on. It is then placed in the steam box. The norm for steaming time is based upon plank thickness; one hour per inch, for both pine and oak. A 2" hull plank would thus need two hours in the steam box.

In order to force a plank in place and make a tight caulking bevel, a dog and two wedges are used. It is sometimes necessary to force them in place with a "planking clamp". This consists of two strong blocks of wood and a threaded rod. One block is placed inside the boat and the other outside. A turnable handle is added. The plank is positioned between the planking clamp and the boat, and the plank is screwed into place. By using pieces of wood and wedges, the pressure on the plank can be distributed correctly. The plank is then drilled, and nailed, and bent into place. The planking clamp is used in other places where it is difficult to use regular clamps.

The hull planking is butted on the frames, unless the frames are too narrow. Veritas regulations state that fish planks must be positioned between the frames where the butt is to be. The butt should be slightly to the side of the slit in double frames. This is to avoid driving the oakum between the frames while caulking.

To insure strength, it is important that the butts are not placed too closely together, but are well dispersed along the strake. The rules regarding the distribution of butts, is that there should be at least three unbroken strakes between butts on the same frame. The butts on neighboring strakes should have at least three frames between them. The rule is also discussed in terms of set distances; 1.5m or 1.25m. The placement of butts is planned out when the plank is lined off. Where too many butts occur above one another, a plank must be set in, between the fore and aft planks. Not all vessels have butt distribution according to these regulations, but usually they fall within the limits set by Veritas.

Fastening

There are mainly three methods for fastening planks. The first is to use nails only in the stems and possibly the butts, with trunnels used everywhere else. The second method involves using nails and trunnels in each frame. The third uses only nails. In addition, there can be some bolting where there are butts. The dimensions of the frames, and what material is to be used, determine the fastening method. Use of trunnels requires larger dimensions on the frames, as trunnels require relatively larger holes. Ship builder Lars Tjørve in Vest-Agder says that he did not use nails to fasten hull planking before he began to build utilizing oak frames. The reason being, that pine is not able to grip and hold the nails as well as oak.

During the building process, the planking can be fastened in several ways:

- Temporarily with "knape" spikes (nails set through small pieces of wood so it is possible to remove them later), and then with trunnels through both hull and ceiling.
- Half nails and half trunnels; nails first into the hull and ceiling, then trunnels through the hull and ceiling.
- With trunnels; half through the hull and frames, and half through the hull and ceiling.

Veritas (1970) specifies the use of butt bolts and two nails in each end of the planks. The butt bolt is placed in the frame timber that is the neighbor to the one where the planks butt (each frame is made up of two timbers). A trunnel can be omitted here. Otherwise Veritas requires the following:

- Planks under 20 cm wide should have 1 nail through every timber. Widths from 20-28 cm: alternately 1 and 2 nails. Over 28 cm: 2 nails in every timber.
- In every fourth frame there should be a bolt of the same dimensions as the butt bolt. The bolts should go through the ceiling.
- All bolts or nails, driven in from the outside of the vessel must have oakum under their heads.

The usual rule for nail length is; twice the thickness of the plank plus 1". The extra inch is not required by Veritas. The diameter of the drill holes should be the same as the smallest side on the nail up near the head of the nail. Ship spikes are the most common type used to fasten hull planking.

One rule, regarding the dimensions of trunnels, which appears to work well, is; half the thickness of the hull planking plus 2-3 mm. At the same time, they should not be thinner than 25mm, and thus far we have not seen them thicker than 5/4". This rule works with clinker built vessels as well, where trunnels have been used in the laps (*Brødrene af Sand* and *Kaia*). There are always exceptions to every rule. *Solstrand* has 25 mm trunnels with 50mm hull planking. *Venus* has 21mm trunnels with approximately 40 mm hull planking. These two vessels have trunnels with heads, and it is possible that this smaller dimension is satisfactory due to the head.

Colin Archer, Nils Skandfer and Svege all used a trunnel right in the middle of a butt. Aside from Skandfer, who appears to have learned this trick from Colin Archer, this seems to be a trait from eastern and southern Norway.

Above the waterline, the nails are counter-sunk approx. 1,5cm into the hull planking, and wooden plugs are used to fill the holes. Under the waterline, the nail heads are set into the hull planking.

When a plank is to be nailed to a pine frame, holes are usually only drilled through the plank. Ship builder Torleif Nerhus explains that sometimes they drill a short way into the frame as well, but only if the material is very dry. The drill used through the plank is of the same diameter as the nail's smallest side under its head. With oak frames, they drill a ways into the frame, but using a slightly thinner drill bit than on the plank. Usually they use a bung bore and both holes are drilled at the same time. The nail is positioned so that it will not split the frame. This means that its widest surface is set crosswise to the fibers of the frame and will cut them rather than force them apart.

Eight-sided trunnels were often used on older vessels. These were generally obtained by splitting logs. Later, trunnels have been sawn from blocks of wood, resulting in the greater risk of getting cross grain and weaker trunnels. Nerhus remembers how they made trunnels before they obtained a trunnel cutter at the end of the 1930s. Trunnel material was found in root logs containing mostly heartwood, and wood that had obviously grown straight and without knots. A good tree trunk could produce quite a few logs. These logs were cut in about 14" (35 - 40 cm) lengths. Suitably sized trunnel blanks were obtained by drawing on the ends of the log sections, using a template, and then splitting the sections along these lines. The trunnels usually measured 9/8" (28mm) while square. On the largest vessels, 80 - 90 ft., the trunnels were 5/4" (33 mm). The split blanks were a little larger than 5/4". The straightest and widest broad axe was placed on the ends of the logs along the lines. A large round wooden club was used to strike the axe head. This wooden club was roughly made and looked like a large baseball bat.

Generally, it is important to use strong dry wood for trunnels. If planking scraps are used there is a combination of sapwood and heartwood in the trunnels. Blue-stain is never allowed to appear above the waterline. Some use only heartwood over the waterline. Trunnel blanks are often cut in double lengths. Above the waterline, the grain in the trunnels is set parallel to that of the hull planking.

On the inside of the boat a wedge is driven into the trunnel in such a way as to expand the end making it tight. The wedge is placed with its widest edge at right angles to the fibers of the plank, so that the trunnel pushes against end grain, and does not split the plank. This is only done when all the hull planking is on, and all of the trunnels have been driven in. The wedges can be made using a special wedge template. They are then cut out on a band saw. The wedges are cut out of boards having the same width as the trunnels. They should be approx 10 cm in length. Some also use the practice of axing off the end of the trunnel, at the same time creating a wedge that is then driven right into the trunnel.

If there is no head on the trunnel on the outside of the boat, one must use pyramidal wedges called "døytler". These are made of oak, about 10cm long, and being ¾" square on the end. The pyramidal wedges are driven in after the hull planking has been caulked with one of two threads, to avoid splitting the planks. They can be made by axe, or with the help of a wedge template.

Bunging and fairing

Before bunging and fairing, all of the nails are set. This means that they are hit one last time before the holes are plugged. Usually wooden bungs are used to cover the bolts and nails that have been counter-sunk. The bungs should fit so well into the holes that it is not necessary to use glue or paint to keep them in place. They will become even tighter when they absorb moisture and swell. Loose, dry knots can also be drilled out and bunged. The grain of the bungs runs parallel to that of the planking.

Bungs should be made of strong materials. They should be cut out such that one can see end grain when looking at them from the side. In this way, they will survive being driven into the hull. A slightly heavier hammer is used to drive them in.

Unevenness in the hull is removed with an adze. The ends of the planks can be too thick and stick out where they meet the stems. The bungs are evened with the surface of the hull using a mortise chisel or an electric planer. After the hull is caulked and wedged, it is finished with a smooth planer, or in more modern times, with an angle grinder or other electric finishing tool.

Bulwark stanchions, materials

The materials used to make the bulwark stanchions are sometimes specially chosen for the task. In eastern and southern Norway, it is common to use oak for the stanchions, but it is important not to use the sapwood, because oak sapwood rots easily. Specifications concerning the use of pine, in stanchion making, state that only heartwood should be used, as well. The only requirement Veritas has, regarding the stanchions, is that they be reasonably proportioned. Several boat builders have explained that a sorting process takes place. When the frames are made, the best pieces of wood are put aside and saved to make the stanchions; those with the most heartwood and fewest knots. Cracks and sapwood in the stanchions can lead to rot and leakage down onto the tops of the frames.

Even though the ideal is that the materials should be of good quality, in reality materials varying quality are used. There are other reasons for using good materials for the stanchions. Using good materials is important relative to contract demands and rot resistance, but also because good quality materials are easier to work with than poor quality materials. Both Skogseide and Nerhus consider this essential, as the rough stanchions are axed and planed into shape after they are set up, on the boat. Skogseide also points out that he tried to put the occasional, unavoidable knot under the cover board.

Beam shelves and square beam shelves

"Square beam shelf" and "beam shelf" are terms that are often used interchangeably. In the Veritas regulations, collective height and width measurements are given for beam shelves. On larger vessels it is most appropriate to discuss square beam shelves, as they are thicker than ordinary beam shelves. The square beam shelf is of one thickness except for at the ends. Underneath the square beam shelf is another beam shelf. The square beam shelf is normally hewn into shape, but some use steaming to obtain the desired shape. It commonly takes up to four pieces to complete a square beam shelf on a 50ft. vessel.

Bilge stringers

In the turn of bilge, 1 - 4 thicker planks are used in the ceiling. These are called bilge stringers. The bilge stringers lie covering the butts on the frames and give an added strength to the vessel, lengthwise. Often there are knees bolted to each end of the stringers, creating an unbroken "belt" around the "waist" of the vessel. The width of the bilge stringers is dependent upon the size of the vessel. Whether there are 1 or 4 planks depends upon the boat builder. The overall width is what is important. The bilge stringers are butted in the same way as the rest of the ceiling planking, and bolted to the frames and through the hull.

Ceiling

Boats under 25 gross registered tons, and later less than 15 meters, are not required to have ceiling planking. Many have it anyway, for practical reasons, such as having smoother surfaces in their cargo holds. Where there are requirements, the ceiling runs far down near the keelson.

Under the beam shelf, there is usually an air opening that runs the length of the vessel. Veritas requires an "adequate number" of such openings to secure air circulation between the frames. This opening is usually 2 ½" – 3" in height. The ceiling planks begin just under this opening. In the air-course, 17" – 18" long spacing blocks were placed under each beam. Airing can be arranged in other ways as well. Rescue vessels had caulked ceiling, with air openings in the planking.

Veritas (1955:12) states that ceiling planking should not lay pith side to the frames. Because of this, the planks are permitted to have wane. Nerhus would not allow more than 1/3 wane in order to avoid getting holes in the ceiling from wear and tear.

Gripe and bend irons

"Gripe" was most likely the original name for the stem foot. On vessels without a stem foot, the gripe is a piece of wood lying outside the junction between the keel and stem. At Bremsnes, the gripe is a $1^{3}/_{4}$" piece of plank that is steamed and bent around the stem foot to give added protection in case the vessel is ever run aground. It runs from behind the keel scarph and up to the waterline. It, therefore, binds the keel scarph and the butt between the stem foot and stem. Tarred felt is placed between the parts to stop shipworm.

Bend irons are iron plates, or smithed mountings, on either side of stem and stem foot, and keel and sternpost, that hold together the joints between these parts. They are held in place by clinked bolts running all the way through them.

Deck beams

The main deck beams, cabin and hatch beams, are often a bit larger in dimensions than the other beams, because there should be room on them for both coaming and the ends of the deck planks. Between the main beams are carlings, and from these are short beams called half-beams. On older drawings one can see carlings all the way out to the beam shelf. Some Danish boat builders carry out this practice even today. The reason for this is to provide solid support for the outermost deck planks.

The main beams are made first and put into position. It does not seem to be important whether or not the pith side of the beams face upwards or down, but the ideal would be for the pith side to face upwards. This provides for better resistance to rot. In addition the strongest part of the beam will face downwards (cf. Godal 2001).

The distance between the main beams seems to vary. Veritas states that the largest distance should not exceed 3' 6" (1901). Selsvik (1906:9) recommends having a beam or half beam in each frame.

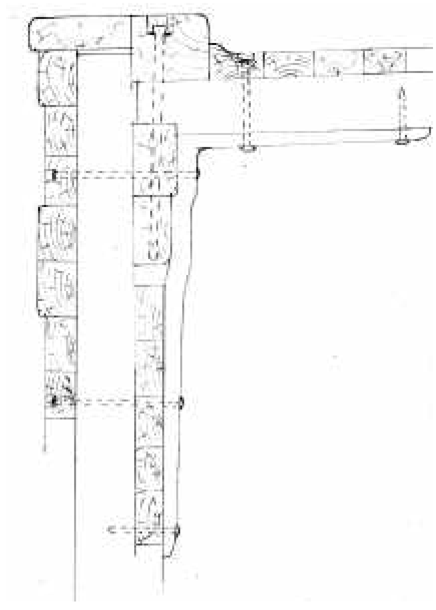
The beams can be fastened with nails on smaller vessels, and drift bolts (Selsvik 1906) or barbed bolts (Arntzen) on larger ones. Veritas requires that the beams must be fastened to the sides of the vessel with knees, either as hanging knees, or lodge knees, or that they be fitted with dovetail joints, or fastened with coaks in the beam shelves.

Knees

Knees placed in the ends of the vessel, bind the fore stem and sternpost via the beam shelf, bilge stringer and cover board. An almost continuous band is formed in this way, around the entire boat. Earlier, the knees were made from roots, but in later times they have been made from straight materials and iron knees. The first knee is found on the beam shelf, or square beam shelf. With larger vessel several more are found farther downwards. The distances between them are stated in the Veritas regulations. The knees should be bolted with a bolt in the middle and then bolted through every timber, all of them running completely through.

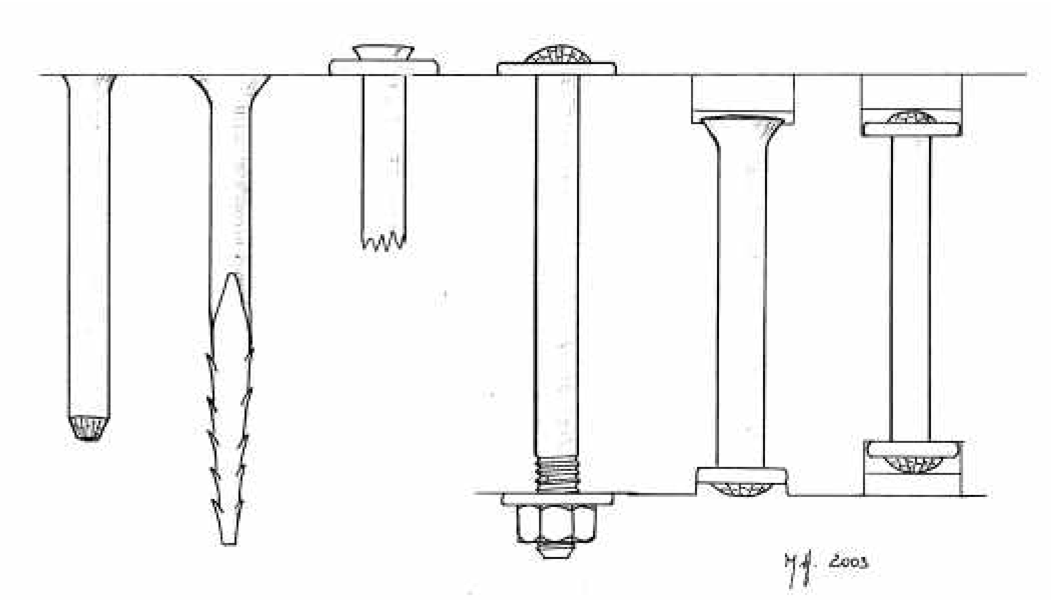
Hanging knees and knee riders

The specifications regarding the number and placement of knees is given in the Veritas regulations. Hanging knees can be made from wood or iron. Iron knees that hang under the beams were often made at the boat yard, from iron blanks. In the smithy, the iron was heated and shaped, bend for bend, following a template. Any twisting would also be decided at this point. One began with the topmost bend, and the huckle, if the arm out on the beam was to be twisted. In the huckle, the iron knee was 31mm thick, but at the ends was only 11mm.



When a boat is over 50 tons, "knee riders" are used in addition to hanging knees. "Riders" are iron knees, which are bolted to the undersides of the beams, and follow the ceiling downward. The lower ends are bolted into the bottom frames. The "riders" are positioned vertically only amidships. Moving towards the ends of the vessel they are canted: forward towards the bow, and aft towards the stern.

Knees are mounted by being shored up from the keelson and into the huckle. One can really exert a lot of pressure using a timber jack. A drift bolt is driven into each end of the knee, the pressure is removed and the remaining bolts driven in.



Different types of bolts (drift bolt, barbed bolt, through-running clinker bolt, counter- sunk clinker bolt).

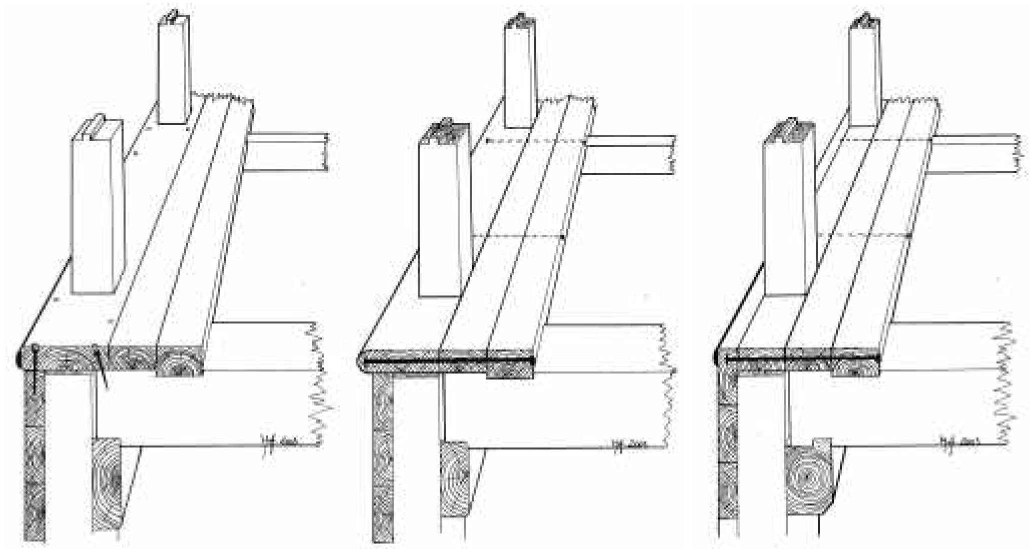
Drift bolts are made quite long and with good points. The point helps to steer the bolt down the drilled hole. This is necessary, because it is easy for bolts to go astray in the woodwork when there are such small surfaces to drill in. The correct length is marked on the bolt with an iron chisel. When the bolt is driven all the way in to the iron knee, the end of the drift bolt is knocked back and forth until it breaks off, where it was marked. The bolt is then clinked down in a counter-sunk hole. Bolts that run all the way through, should not be closer than 1" to a caulking bevel.

After WWII, the bolts were driven in from outside the vessel. On the inside nuts were used to tighten things together. This was much better than clinking, as that did not draw things together much. Hanging knees and "riders" were bolted to the sides and to the beam with bolts in the huckle and in the ends, along with a number of other bolts such that the distance between them was not more than 35 cm. The bolts in each leg that were nearest the huckle could not be more than 25 cm from it.

Deck

Cover board

The cover board is made up of one or more planks that cover the tops of the frames and enclose the bulwark stanchions. There are three ways to make a cover board. One is slid down over the bulwark stanchions ("træskandekk"), while another is slid around the bulwark stanchions from the outside ("smetteskandekk"). The third one is built up of pieces placed between the stanchions.



Different methods of building a cover board: "Træskandekk", "smetteskandekk" and "fyllstykker".

"Træskandekk"

"Træskandekket is slid down over the bulwark stanchions, in one piece. This lies on the sheer strake and is, as a rule, made of oak. It is usually the same thickness as the rest of the deck. With older vessels, the cover board is placed upon the uppermost hull plank. One making this kind of cover board has to be careful with the stanchions. They must stand as parallel as possible, and taper gradually towards the top from all sides. In this way, it is possible to slide the cover board down over many stanchions at the same time. This type of cover board has been commonly used in southern Norway.

"Smetteskandekk"

"Smetteskandekket" is slid around the stanchions from the outside of the vessel. It can be made and mounted before the stanchions. Openings can be cut into it for the stanchions. It is positioned up on the sheer strake. "Smetteskandekket" is, for the most part, a bit thicker than the deck but slightly thinner than the waterway. This type of cover board is common on older sailing vessels built in western Norway.

"Fyllstykker"

Newer vessels have cover boards that are flush with the upper edge of the hull planking. The planks between the stanchions are slid in place from inside the boat, they are called "fyllstykker". Pine is usually used to make "fyllstykker".

Waterway

This lies inside the "fyllstykkene" or "smetteskandekket". It can be made up of one or two planks. One (the innermost) or both of these can be fitted down into the beams approx a ½". The fitted plank keeps the deck from moving too much during caulking.

Margin plank

The margin plank's purpose is to make it possible to end the deck planks without cutting them off into sharp points. Points do not survive well during caulking. There are those who practice laying deck without a margin plank.

The margin plank can be approx ½" thicker than the deck and fitted into the beams. Aft, it can be fitted into the cover board. Not all vessels have this plank fitted into the beam.

The margin plank can run from the aft-most beam and forward. It should be a bit wide, approx. 5-6". As the deck planks are cut into it, this width is reduced. The margin plank is nailed to the beams with ships spikes, but using as few as possible to avoid hitting them when the planks are cut in.

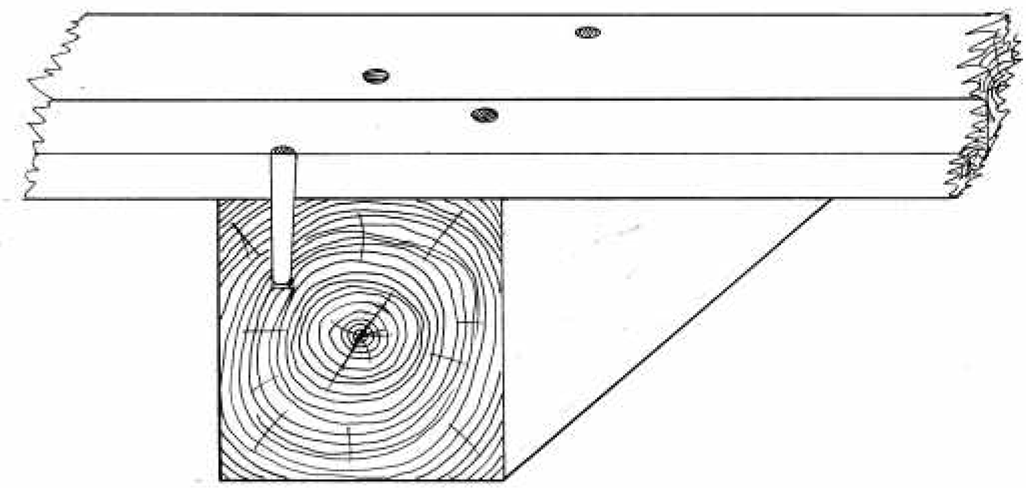
Deck

In eastern and southern Norway, and generally on smaller vessels, milled or "ploughed" materials have been used to lay deck. Hans Arntzen says that they used ordinary floorboards, 5/4" or 1 ½" in thickness. Redlead (lead paint) was used between them. The boards could be nailed at an angle in the tongues, and then fastened vertically afterwards. This kind of deck requires extra upkeep to avoid leakage, according to Hans Arntzen. It does not seem to have been used on vessels built in western Norway, or farther north. It was common there to use planking with bevels for caulking. Beveled and caulked deck will be described further.

Materials for the deck must be dry and without blue-stain. There should also be few loose, dry knots. The less sapwood there is, the better. There should not be any knots along the edges of finished planks, as they are difficult to caulk around. The Veritas regulations state that the pith side should lay facing the beams.

Deck planks should be beveled for 2/3 of their thickness, so that the planks lie tightly together for the lowest third. After WWII, many shipbuilders used a small track at the bottom of the bevel. This will fill up during caulking, making it difficult to drive the caulking past it. The bevel openings should be 2-3 mm wide on a finished deck prior to caulking.

Deck planking has earlier been fastened with nails and trunnels (not running all the way through). 2" deck planks are nailed with 4" ship spikes.



Fastening deck with trunnels.

Butt joints on deck are dispersed so that they do not come close together. There should be two beam distances between the butts on neighboring planks. In other words, there should be at least one beam between these butts. If there is one row of planking between two butts, there should be at least one beam distance between the butts. On beams where planks butt, there should be three rows of planking between each butt.

Bow rail

The shape and proportions of the bow rails vary, as do the materials used to make them. They can be made of both pine and oak. Ship builder Ingvald Vevik, explains that there were differences between cruisers and cutters. On the cruisers they were rounded on top and without fair leads. The bow rail normally thins as it runs aft, down to 1 ½"- 2". On some cruisers the bow rail tilts outward with the same angle as the bulwark planking. By the stem, the angle follows the angle of the rabbet line of the stem. On older "jakts" and ketches, the bow rail is rounded on top, stretches relatively far aft, and thins gradually.

At Bremsnes they make the bow rail out of three pieces, and it is approx. 1" narrower than the top rail on both the inner and outer edges.

Top rail

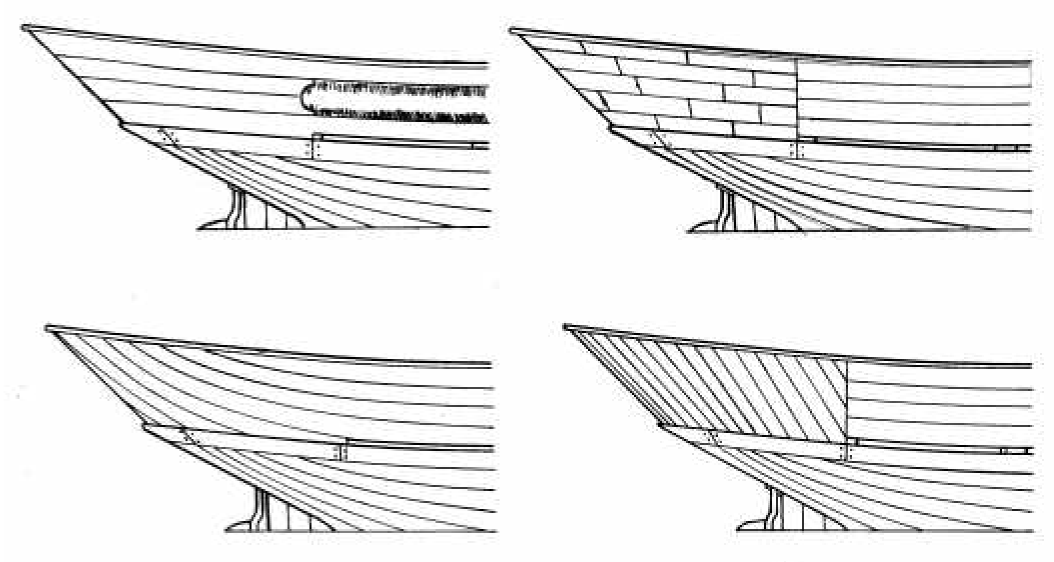
The top rail is often made from a slightly curved, 2 ½ " pine plank, but oak has also been used. The pith side of the planking faces downward. The rail should tilt slightly outward. Some incorporate the same angle as on the hull, where others have a pitch of about ¼", for example. The plank is fitted onto pegs in the bulwark stanchions and fastened with spring bolts. The pieces of the top rail are connected using scarph joints.

On older vessels, the edges of the top rail are normally rounded. On fishing vessels, the top rail is rounded on the inside, but flat on the outer side, because an iron molding is mounted there. The inner and outer edges are at right angles to the top edge.

Bulwark planking

Bulwark planking has been made in different ways. The old way is to use relatively wide boards, often with some sort of beading on them. Nerhus states that the bulwark planking was made with a bowed panel in the middle, up into the 1930s. Arntzen, in Langesund, used this type of bulwark planking into the 1970s. The panel was planed from a wide 5/4" board. Towards the ends of the boat, the panel gave way to flat planking. In order to make a fair finish to the planking, a point was shaped forward, and a half-circle was formed in the stern. This was done after the planking was finished. Above and below the panel there was a 1" board with a beaded edge. These two boards were equally wide and had a rabbet on the inside, which went outside the panel. Arntzen fastened the lowest plank with wedges, so that it was simple to remove when they were to caulk and maintain the cover board around the stanchions.

On elliptical sterns there are several ways to lay bulwark planking. One method involves making half-moon shaped planks that cover two stanchions, such that not all of them are butted on the same stanchion. Another method uses vertical planking in the stern. A nailing strip is mounted between the stanchions, approx. 1" above the deck, and a collar is fastened underneath the top rail. Ploughed boards are attached from the bow towards the stern. Rounded planking was considered the stronger of the two alternatives. A third alternative was to build the bulwark planking using wooden blocks.



Bulwark planking variations on elliptical transoms.

There is an opening under the bulwark planking, so that the deck may be cleared. The opening should be small enough that a knife or spring herring could not slip through. The common measurement is 1”. In order to sweep the deck clean of fish guts and other debris, there are two freeing ports on each side. The freeing ports are positioned between two stanchions, and are hinged to the bulwark planks in such a way that they can be opened outwards. To hold the ports closed, there are hooks in the stanchions that fit into rings on the ports.

Hatches

Hatches are openings in the deck, through which cargo is loaded into or out of the cargo hold. On smaller vessels, hatches can also be used to stand in (steering hatches), or to go below (forepeak hatch). The deckhouses on a vessel are usually set on openings in the deck. This is not the case with the wheelhouse, which is mounted on a casing. The placement of deck openings is decided as the deck beams are laid.

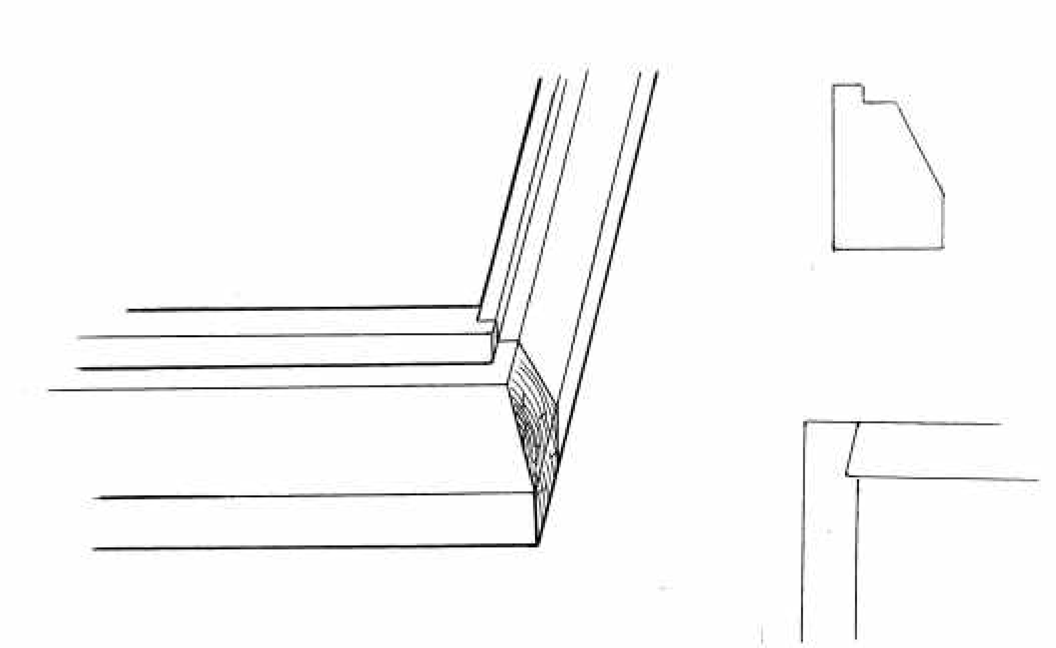
The deckhouses are positioned on framing, which lies directly up on the deck beams or carlings. The actual carlings are sometimes omitted, allowing the side framing to act as carlings.

The Veritas regulations set certain requirements for buildings on deck, but they are not extensive. In 1955, a table for wooden hatch framing proportions appeared. It was not repeated again when the regulations were updated. On the other hand, there are detailed regulations regarding hatch battens, tarpaulins, and hatch cover beams, etc. The dimensions for steel and aluminum plating, used for casings are given. Threshold and framing heights are given as well.

Roofing and casing

A casing is an enclosure, and is often used with another term, such as “engine casing” or “boiler casing”. They are deck structures having to do with the mechanical aspects of the vessel. A structure built for the motor can also be called roofing, but one would not call the roofing of an aft cabin a casing.

Engine casings were built of wood up until WWII. After this time it became more common to build them of steel. However, this varied, probably depending upon the type of boat and what type of equipment a boatyard had available. The heat from an engine makes it difficult to keep wooden casings watertight. This is most likely the reason for the transition to steel, and later to aluminum.



Roofings or casings are usually placed upon a frame.

The Veritas regulations (1970) state that deck openings, to the engine, must be covered by casings of steel or aluminum, and that these should be protected by a deckhouse, or some other deck structure. Openings to the engine should be as small as possible. Further, the regulations give the dimensions for the metal plates and weld joints, etc. The casings are attached to the beams and carlings with 16 mm bolts at a maximum distance of 200 mm from each other.

The framing is fastened to the carlings and beams with trunnels, coaks and bolts that run all the way through. Coaks are trunnels that do not go all the way through the materials, but are approx. 2-3" long, wooden cylinders of even thickness between two pieces of timber.

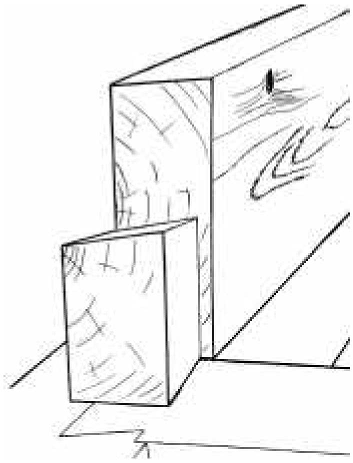
Wooden roofing is constructed with four wooden posts having rabbets for the planking. Roofing usually standings at right angles to the waterline. After the corner posts are raised, the sides are built, often utilizing double ploughed planking.

Cargo hatches

The term hatch coaming refers to the walls, or sides, of the structure surrounding the hatch opening. The hatch cover is just that; it covers the hatch opening.

Beams for the hatch cover are often placed over the hatch. These shall, according to Veritas (1955) have a minimum of 7,5 cm support on the ends of the hatch and on the beams.

Hatch coaming is usually constructed with dovetailed corners, but can also be constructed the same as with the framework to a deckhouse. They are



Typical mortise joint for hatch coaming.

fastened to the carlings and beams with coaks and bolts running completely through, or perhaps the coaks are omitted. Drift bolts can also be driven through the sides.

Trunnels and coaks are considered better than bolts for withstanding the pressures during caulking. However, bolts are better at holding the hatches tight to the deck beams and carlings.

Companionway hood

On the old "jakts", the companionway could be box shaped, with a flat, hinged cover, or it could have a half-round roof.

The 1955 edition of the Veritas regulations requires that companionways shall be made of steel. Only vessels having limited operating territories could have wooden companionways. In the 1970 edition, wooden companionways had completely disappeared. In earlier editions (1919-1943) it states: "Forward companionways must be of extra solid construction and preferably of steel or iron."

Skogseide explains that at Ottesen, they used vertical planking on the sides. Along the top edge a nailing strip was mounted for the cover. Eventually they changed over to placing the planks horizontally, because it was then easier to set bolts through the planking and down into the carlings.

Wheel house

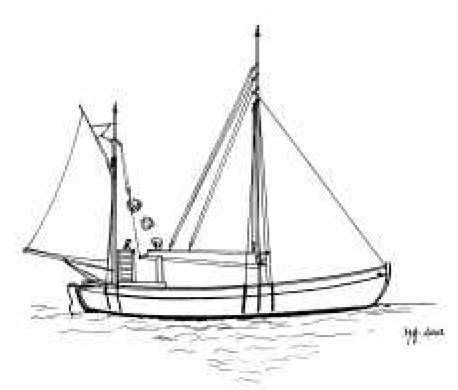
The wheelhouse, or rudder house, is built in many different ways. The size, shape, materials used, placement, and style have all been dependent upon their intended use and the fashions of the time they were built. Fishing vessels have generally had small wheelhouses, while pilot and rescue vessels often had somewhat larger houses. Ferries, hunting vessels (whalers/sealers), and cargo vessels, etc, have generally had larger wheelhouses.

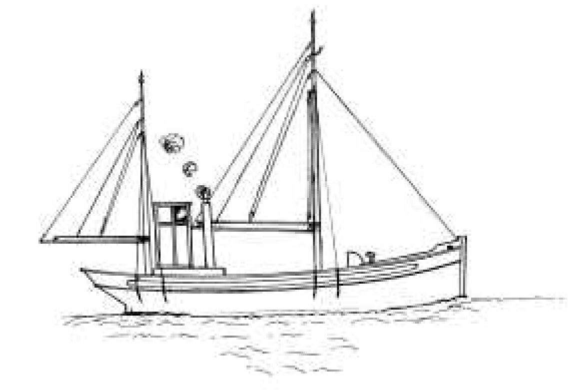
It is important not to have too much weight high on a boat, as this affects stability. Therefore, they often emphasized keeping the weight to a minimum in tall deck buildings such as the wheelhouse. Often this is achieved by using light materials such as spruce and aluminum, but there are no hard and fast rules.

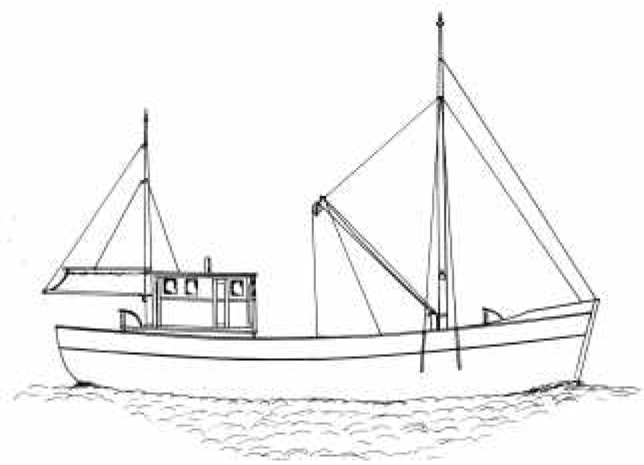
On boats of up to 30-40 ft., the wheelhouses were made up of three panels that were placed around a cockpit. This is known as a "steering box ". These wall panels were fastened in place with hooks. On top was another panel acting as a roof, also fastened with hooks. This arrangement was common up until around the end of the 1930s.

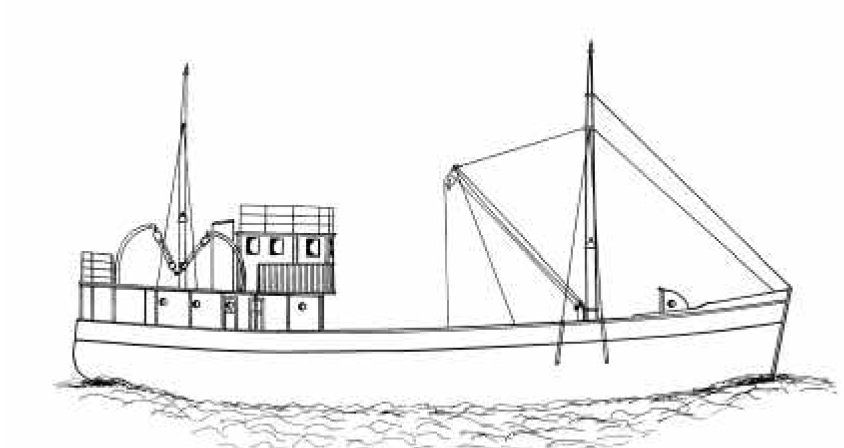
In the beginning, the wheelhouse on larger vessels consisted of a little room, where there was only space enough room for one man to stand and steer. The wheelhouses were very simple constructions. Gradually they grew and developed better space for both crew and navigational equipment.

Added onto the wheelhouse, there is often a chart room, used to store charts and similar paraphernalia necessary for navigating the vessel. Larger wheelhouses can also have a galley attached.









As new materials have come onto the market, they have gradually been taken into use in making the wheelhouse. Building contracts from Bremsnes Boatyard, from the middle of the 1950s, mention the use of both wood and aluminum for the fronts of wheelhouses.

One widely used technique for opening the front windows of wooden wheelhouses, was to lift them over a notch and allow them to slip down to rest on a crosspiece.

In order to anchor a wheelhouse solidly to the deck, or its casing, it has to be bolted fast. Up on the roof flat iron or half-round iron bands are mounted, and from these long bolts, stay rods, run down to the deck. The bolts can run all the way through the carlings or be fastened onto the casing, which has a welded fastening. They can be hidden in the walls of the wheelhouse, but are often visible on the outside. Nuts are used up on the roof. The bolts can then be used to anchor the mizzen shrouds.

The front is paneled with teak or mahogany paneling. Some have placed flat moldings outside of the teak paneling. The flat moldings are bent by heating them with a blowtorch, while oiling them at the same time. The moldings were very impractical when the fronts were to be maintained, so they went out of use in the 1950s.

The rest of the wheelhouse is usually painted white.

The doors of the wheelhouse are, as a rule, made of teak. They can be solid plank doors or raised panel doors, and they can open inwards or out. There are also sliding, or pocket doors.

Glossary

Apron (*innerstevn*) A piece of timber fayed on the after side of the stem from the head down to the deadwood. It provides the necessary surface for securing the hood ends of the planking and strengthens the stem.
Batten (*malbord, rei*) Length of flexible wood used for lining off planks and fairing.
Bevel (*svai*) A surface of timber which has been shaped at an angle so that it can fit another timber.
Bilge (*kiming*) The part of a vessel which lies below the upward turn of the floors or first futtocks. "Turn of the bilge" is the general area in both the inside and the outside oft the vessel where the change in shape from near horizontal to near vertical takes place.
Blue-stain (*blåved, blåmann*) A fungal microorganism causing the sapwood in pine to get blue.
Body-plan (*spanteplan*) A drawing showing the half breadths, the curves of the sides of the ship's transverse frame lines.
Bunge (*propp, karpun*) Plug. A cylindrical piece of wood set over the head of a bolt or nail and cut flush with the surface. To plug with a bung.
Butt (*støt*) The end of two planks meeting squarely.
Coak (*dopp*) Wooden peg which not passes through all the parts being joined, but are approx. 2-3" long, wooden cylinders of even thickness between two pieces of timber
Cover board (*skandekk*) A horizontal fore-and-aft-timber which forms the outer limit of the deck at the sides. The bulwark stanchions can either be cut through the cover board, or the cover board can be fitted in short lengths between the stanchions.
Dead-wood (*dødtømmer*) Solid timbers built in at the extreme bow and stern of a ship when too narrow to permit framing. The inner timbers which give additional strength to the junction of stem and sternpost with keel and keelson.
Fay (*tilpasse*) To fit closely.
Floor timber (*botnstokk*) See frame timber
Frame timber (*spantetømmer*) The frames are the ribs in a carvel built ship. A wooden frame is formed of several curved pieces of timber. The floor timber (*botnstokk*) is the lower piece which extends across the keel. The next piece is the first futtock (sitter), the lower part of

which laps on one side of the floor, with the upper part lapping on one side of the second futtock (*første opplanger*), the lower end of the latter is butting against the upper end of the floor timber. The successive pieces are called third, fourth … futtocks.
Futtock (*sitter*) See frame timber
Gouge (*huljern, skjølp*) A chisel with a concavo-convex cross section
Knee rider (*reider*) A hanging iron knee for hold beams and strengthening the lower part of the hull. The lower arm is running round the turn of the bilge and fastened through the frames and planking, at least one bolt should pass through the floor timber.
Knuckle (*brekken, gillingsknekken*) The angle formed by the intersection of the upper and the lower part of the stern.
Lofting floor (*spanteplan*) The curves of the frames scaled up and sketched on the floor.
Mould (*mal*) A wooden pattern used to convey different shapes (like frames) from the lofting floor to the sawyers.
Offset sheets (*avslagningstabell*) Offsets are the coordinates used to determinate the outer form of a ship, the frames. The offsets are arranged in tabular form in the offset sheets.
Plank (*planke, hudplanke*) A component of a strake (*gang*). Planking refers to the whole outer skin (*hud*).
Rabbet (*sponing*) A channel or groove cut out of the edge or face of the keel and stem to accept the sides or the end of the planking.
Spline (*rei, lekt*) A thin wood strip used in design and building of ships.
Stern (*hekk*) The afterpart of a ship or a boat.
Transom (*speil*) The upper part of the stern above the counter in a square sterned vessel.
Counter (*gilling*) Term applied to that portion of the ship's stern between the knuckle and the waterline. The underside of the stern overhang abaft the rudder. Also known as fantail.
Trunnel (*trenagle*) Wooden peg which passes through all the parts being joined.

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