SCRATCH BUILDING A MODEL SHIP

CHAPTER 1: GETTING STARTED

Introduction

Scratch building a model ship is not as difficult as it appears. You've probably built several models from kits, so you already possess many of the skills required for scratch building. The only additional skills required are interpreting the lines on the plans, selecting the materials to use in the building process, and developing the method of construction.

Over-and-above the manual skills required to build a model from scratch are three more factors: time, patience, and ingenuity. It takes much more time to build from scratch than it does to build a kit, so you must be prepared to devote at least 500 hours to a scratch-built project, probably much more. Patience is an absolute necessity, for you will find yourself spending much time developing new skills, and it is quite possible that you build items that you are not satisfied with and decide to scrap them and do them over again. Ingenuity is a definite plus, because you will constantly be called on to use new, sometimes outlandish, materials or methods. Thus, an open and creative mind will be your greatest asset.

In building a kit, there are no plans to interpret, no materials to buy; the manufacturer gives you assembly diagrams that show you how to fit the supplied pieces together. The method of construction is also supplied by the manufacturer in the form of written and pictorial instructions. You simply follow all the step-by-step directions to finish with the end product.

In scratch building, on the other hand, *you* are in total control of the entire project. *You* make the decisions as to what wood or other material to use for a certain part on the ship. *You* control what you will build next and how you will build it. *You* are the master and commander of every aspect of the building process, from laying the keel to building a case.

Scratch building a model ship to completion is an extremely rewarding experience. It is the ultimate armchair adventure -- a great love affair, if you will. It may take you a year or more to accomplish it, but *you* built it -- everything on it -- *yourself!*

Choosing the Plans

If you've never attempted to build a ship from scratch, it is best to start with a simpler model -- a sloop, for example. If you attempt a more difficult ship on your first try, it may be beyond your skills and lead to eventual frustration. However, if you choose one within your own abilities, you will be more than happy with the results. If you feel you've built a few rather difficult kits and are ready to start a more difficult scratch build, then by all means, do so. It's entirely up to you. Just make sure you have assessed your strengths and weaknesses before attempting your first scratch project.

There are many sources of model ship plans. In choosing a set of plans for your scratch build, make sure they contain, as a minimum, three required views: a body plan, a sheer plan, and a half breadth plan. Without these, it is not possible to build an accurate model. The use of these plans will be discussed in detail in Chapter 2.

Another consideration in choosing plans is the scale, which is the ratio of the size of the model to the size of the real ship. This is mainly a practical consideration. Will you have the space required to display a large-scale model? Will you have the space to build it? A typical ship-of-the-line was nearly 300 feet long in real life, which would make the finished model 37" on a scale of 1/8" = 1'. The same model in a scale of ¼" = 1' would be nearly 75" long. Any plans you do purchase can be enlarged or decreased in size, especially if you own a scanner or have access to a printing shop.

The scale of the model also determines how much detail will be included in the final model. The larger the scale is, the greater the detail that can be included.

Selecting the Materials

In order to build a model from scratch, you will need a wide variety of materials. The list seems daunting, but if you've already built kits, you probably have used many of the materials listed. The materials discussed below will represent the basic requirements for the beginning scratch builder.

Wood: Many modelers use many different kinds of wood in building a single model. For the beginner it is best to rely on the easiest kinds of wood to use and then expand later. Thus, this narrative will address first-time scratch builders.

Basswood: By far, basswood is the most versatile wood for model builders. It is light, almost white, in color. It is very fine-grained, making it easy to saw, sand, drill, carve, stain, and paint. It also bends easily, which makes it ideal for planking curved bows on ships. It can be turned on a lathe as long as it's an eighth of an inch round or larger. After a sanding sealer is applied, it can be sanded to a smooth finish that eliminates the fuzziness associated with unsealed basswood. It can be made to simulate many other kinds of wood by the application of stains. Its only drawback is its softness, so as long as you don't implant your fingernails in it, you've got the ideal modeling wood.

Apple wood: This is a versatile hard wood, brownish in color. It can be used for making small parts and very small carvings. Paper-thin pieces can be sliced off on a band saw. It is especially useful in making parts that will have a great deal of stress, such as mast caps, because it does not split or break easily.

Glue: There are dozens of different glues on the market, but there are two kinds that are indispensable to the scratch builder. The first is white glue, such as Elmer's, which is ideal for basswood, a highly porous wood. For other types of wood it would probably be better to use epoxy. The second is cyanoacrylic glue, commonly called CA or super-glue, which provides an indestructible bond in a matter of seconds. It can glue any type of material to anything else.

Metal: The scratch builder will use copper and/or brass metals for various fittings, such as chain plates. Fine black metal wire will be used for making eyes and stropping blocks. Sometimes, you will find yourself using paper clips or staples or pieces of house wiring, or even the insulation around it.

Plastic wood: This is used as a wood filler. It can also be applied in layers to form a figurehead that can be carved.

Rigging thread: Linen is the best, but it's also the most expensive. Polyester/cotton thread is quite useful, especially if you use a rope-making machine to make your own rigging lines.

Tape: There are several varieties of tape on the market, including self-adhesive, double-sided, and specialty

tapes. It's used for painting waterlines or any straight-line area. Sometimes, you might use it as a clamp. The uses of various tapes are only limited by your imagination.

Paper and cardboard: The scratch builder will find himself using paper and cardboard in myriads of places, including window frames, anchor stock rings, paneling, edgings, etc. Bristol board, index cards, the backs of note tablets, typewriter paper, even cigarette paper -- all have potential uses for the scratch builder.

Toothpicks: These vital items are useful for applying glue in small spaces. They can be used as dowels and staircase pillars. They can be chucked in a drill and turned into belaying pins. Again, let your imagination run rampant.

Other material: There is no end to what might be used on a scratch built model. Tiny beads might be just the right thing for parrals. The heads of pins might be just the right size for rivets. Round-head pins might make cannonballs. Dried spices, such as thyme, could be used for leafy decorations. The cellophane from a pack of cigarettes makes an acceptable small window. As you can see, the scratch builder sees everything around him in a new light.

Developing a Method of Construction

The scratch builder has no step-by-step instructions to follow. Therefore, he must develop his own.

The first decision the scratch builder must make is what type of hull should be constructed. There are several styles of hull construction worthy of consideration, including half-hull models, waterlines models, and whole hull models. This narrative will address only the whole hull models, of which there are three types:

Solid: This type of hull is carved from a solid piece of wood or from built-up laminations. It's usually started by cutting out the basic shape on a band saw, and is then finished with chisels and spokeshaves. A series of templates are made and used to check the shape of the hull at various points while the carving is in progress.

Plank-on-bulkhead: This type of hull is most familiar to kit builders. It consists of a length of wood that represents the backbone of the ship. It usually runs from stem to stern, with the bottom edge representing the keel and the top edge representing the upper decks. It is notched at regular intervals so that it can receive correspondingly notched bulkheads. After the bulkheads have been installed, bow and stern blocks are glued in place so that planking can be accommodated. Then the planking is installed directly onto the bulkhead edges.

The plank-on-bulkhead hull, when completely planked, looks exactly like the real ship in every way. Only the unseen interior is not built like the real ship.

It should be pointed out that many kit manufacturers do sell plans alone, so the scratch builder can buy those plans and instructions without buying the kit itself.

Plank-on-frame: This method of hull construction should be the ultimate goal for all scratch builders. It consists of laying a keel, building individual frames, and planking the hull -- all exactly like the original ship. Some modelers even go as far as installing the various rooms on the lower decks, along with appropriate furniture and other fittings.

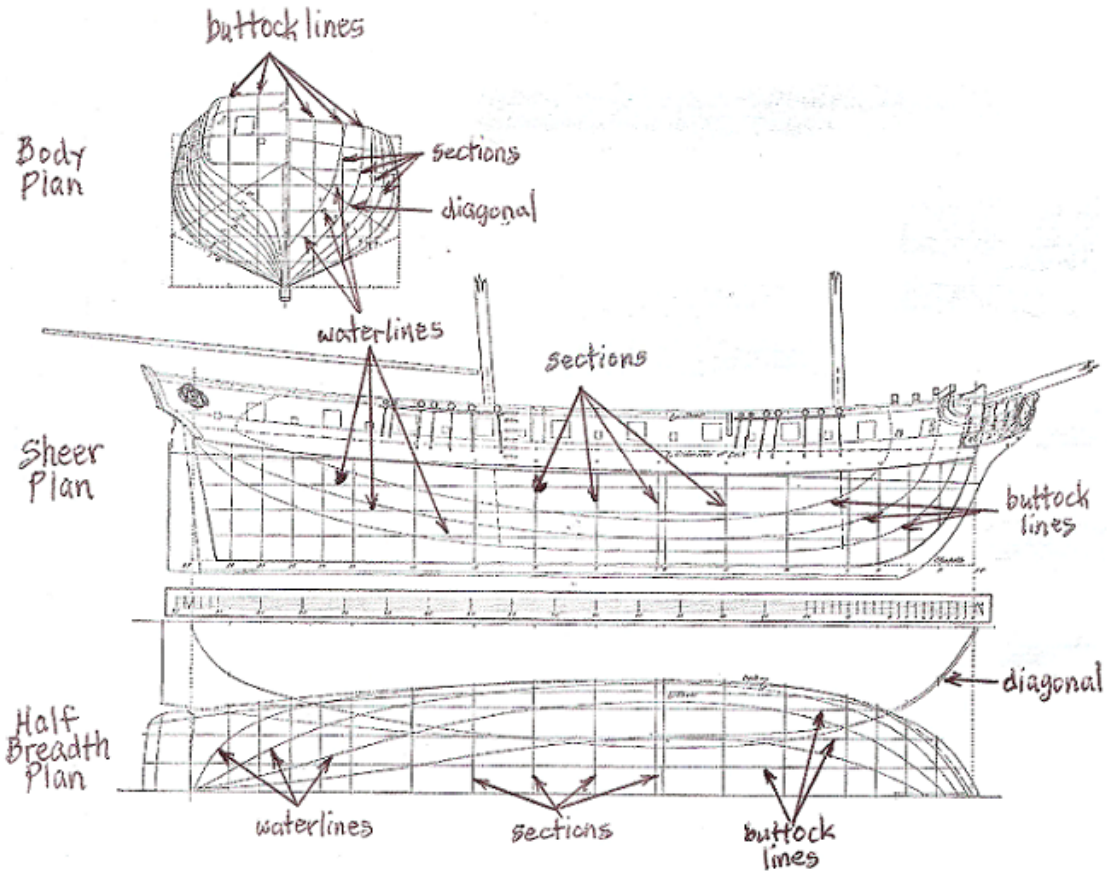
The plank-on-frame hull IS like the real ship. It is the most difficult method of building a model, and it is also the most time-consuming, but it is also the most personally rewarding. Although it requires more skills than the other methods, this should not discourage the scratch builder from attempting such a project. Additional skills can be developed quite easily; all that's requires are time, patience, and ingenuity.

Once the scratch builder has decided on what type of hull to construct, he must them study the plans intensely. Thoroughly understand the plans, and write down a set of your own instructions.

Even after the hull is built, think through the next steps and procedures. Plan ahead. Think through every step of the project, one at a time. Make sure that you don't get yourself in a position where a certain item cannot be installed because you've boxed yourself in a corner and can't get at that location.

You will ask yourself a thousand questions: Should I use planking right on top of the deck beams, or should I first install thin-sheeted plywood as a base? If I use thin-sheeted plywood, have I allowed for its thickness? Should I paint the interior bulwarks before starting the planking? What should I use between the planking to suggest caulking? Should I stain the deck planking or leave it natural? Should I install treenails or merely suggest them? The decision to all these questions are yours, and whatever you decide, keep thinking ahead to the next step.

CHAPTER 2: INTERPRETING THE PLANS



Now that you have acquired a set of plans that you like, it's time to learn to interpret them. The plans used above for purposes of illustration are of the so-called "corsair" brig known as *Hassan Bashaw,* a vessel that was presented to the Dey of Algiers.[1] Regardless of what type of vessel the scratch builder has selected, it is important that the plans contain the three views shown above, which includes the body plan, the sheer plan, and the half breadth plan. All three are necessary in order to build a three-dimensional model with any kind of precision. Each view shows the ship in a different perspective.

[1] *The History of the American Sailing Navy* by Howard I. Chapelle, p. 139.

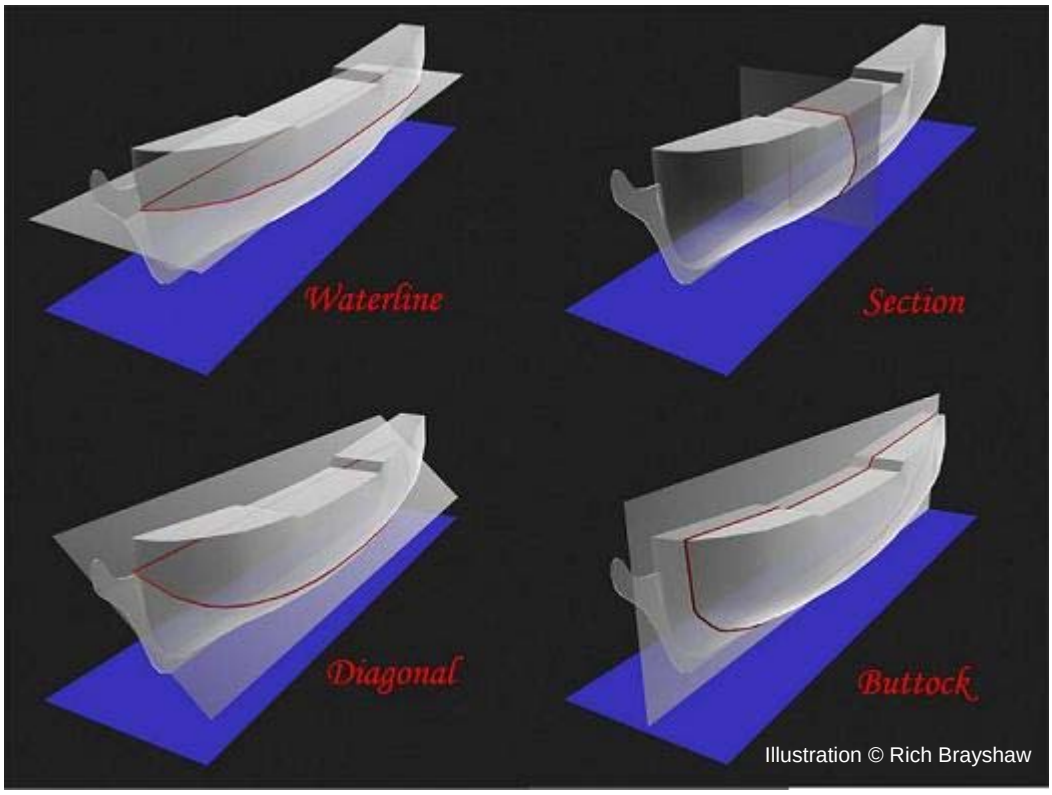
The Three Plans

Body Plan: The body plan, sometimes called section plan, is divided in half and shows two separate views of the ship. The left-hand side of the plan represents the view from the stern of the ship looking forward. The right-hand side of the plan is just the opposite, from the bow looking toward the stern. Note that the lines on the plans are comprised of four types: waterlines, section lines, buttock lines, and diagonal lines, which will be explained shortly.

Sheer Plan: The sheer plan, sometimes called the elevation plan, is a view of the ship from its side. It, too, contains waterlines, section lines, buttock lines, and diagonal lines. It also contains many other pieces of information, including the location of gun ports, wales, masts, chainplates, and deadeyes.

Half Breadth Plan: The half breadth plan, sometimes called simply the plan view, is a view of only half the ship looking from the top down. Only one half is necessary because the other half will be a mirror image of the former. Like the other two plans, the half breadth plan also contains waterlines, section lines, buttock lines, and diagonal lines.

The Four Main Kinds of Lines



Waterlines: The waterlines are horizontal lines that pass through the hull at each area shown. It's as if you have placed a ship model in water at successively lower and lower lines. On many plans these lines are numbered from the keel upward starting with 1, with every plan showing the same number for each corresponding waterline. As you can visualize, the waterline near the midsection of the hull will be wider and slightly longer than the waterline below it.

Section Lines: These lines pass perpendicularly in a vertical plane through the hull. They are very important lines because they define the shape of the hull more graphically than other lines. These are particularly important for building frames for a plank-on-frame model. Of course, not every section line may be the exact placement for a frame, and precise locations of additional frames must be determined. Usually, section lines on plans start with a centerline somewhere near the midpoint of the ship. Moving away from the centerline toward the bow, they are identified with letters A, B, C, and so forth. From the centerline toward the stern, they are identified numerically. Again, the body plan, sheer plan, and half breadth plan will all have the same identifying letters and numbers.

Buttock Lines: The buttock lines are lines that pass through the hull in a position that is parallel to the centerline. The sheer plan shows their true shapes. Note that on the body plan the buttock lines appear as vertical straight lines, and on the half breadth plan they appear as horizontal straight lines. Although the buttock lines are rarely used in constructing the model itself, they are quite useful in verifying section shapes.

Diagonal Lines: These lines pass through the hull at an angle to the vertical plane of the centerline. They're usually not used in the actual construction process, but they serve the purpose of checking the accuracy of other lines.

Other Lines on Plans

There are a few other lines on plans that are important to the scratch builder. They include the baseline, perpendiculars, and rabbet lines.

Baseline: This line, which appears on the body plan and the sheer plan, is usually shown as a dotted line drawn just above the keel, as shown on the *Hassan Bashaw* plans. On this ship, the baseline is parallel to the keel, but this is not always true.

Perpendiculars: These lines also appear on the body plan and the sheer plan. They are drawn at both ends of the baseline, frequently at the ends of the rabbet lines. These lines are always perpendicular to the baseline, which means they are not necessarily perpendicular to the keel.

Rabbet Lines: There are always two rabbet lines shown on the sheer plan. On the *Hassan Bashaw* they are barely visible because the drawing is so small, but they are located above the keel just where the planking begins. There are two lines, an inner and an outer, and they represent the intersection of the planking with the keel, stem, and sternpost. The width between the two rabbet lines is the width of the planking at each point of the rabbet. For a planked model, the rabbet line must be cut as a groove upon the edge of the planking will rest. Of course, the shape of the groove will change will change with the angles of intersection with the planking.

Other Information on Plans

The plans of the *Hassan Bashaw* contain the basic information to construct a model. However, there are a number of things not shown on these plans that are sometimes shown on other plans, and you should be aware of them. Some plans may include a bearding line, which is really an extension of the rabbet line and shows the inner line of the extreme taper of the planking near the rudder of the ship. Some plans indicate the location of the deadwood attached to the keel. Other plans may show you the interior structure of the ship, including deck beams, the thickness of individual frames, and the location of various rooms. Depending of the quality and scale of the plans, a host of other information may also be provided.

Most plans will also contain a variety of written information, including the dimensions of the ship, spar

dimensions, scale, and perhaps historical data. All information is valuable at one time or another, and the more you have, the better the final product.

Conclusion

Now that you understand the lines and other information provided on the plans, it is vitally important that you review those plans to make sure you understand literally everything presented there. Begin no construction until everything is understood. If there is anything you don't understand, follow up with your own research. There are a host of fine books that provide this kind of information, and Model Ship World website has many knowledge-able modelers who are more than willing to answer questions and help you solve problems.

CHAPTER 3: MODIFYING PLANS TO SUIT THE NEEDS OF PLANK-ON-FRAME CONSTRUCTION

Drawing the Frame Lines Directly on the Plans

If you are planning to build a plank-on-frame model, your plans probably do not show the location of all the frames, their width, or the spacing between the frames. Of course, there are plans available that are drawn specifically for plank-on-frame construction in mind, but most plans are not. Therefore, you must determine these measurements yourself.

If you decide to build a model on a scale of ¼" = 1', it is usually best to make all frames ¼" wide, which means they would be one foot wide in real life. A smaller-scale model would require thinner frames. In most warships, the spacing between each frame was equal to the width of the frame itself. This is called **room-and-space**. Thus, a ¼" frame would have a ¼" space next to it, followed by another ¼" frame, and so forth. On the other hand, a merchant vessel did not require such close spacing between frames, mainly because they were not expected to be damaged by cannonball fire.

Using the room-and-space rule, measure and draw the preliminary frame lines, starting with the centerline already shown on the plans, directly onto your plans, including both the sheer plan and the half breadth plan, which are usually directly above one another. Proceed from the centerline forward, and then stop at the point where the cant frames will begin. Then proceed from the centerline to the aftermost position where cant frames will start. (Note that it is sometimes not necessary to build cant frames at the stern, especially if the stern does not have extreme curvature. Thus, if you decide no cant frames are necessary at the stern, you can continue drawing parallel lines all the way to the stern. It's your decision.) You should not draw lines beyond the cant frame positions, because cant frames are not at right angles to the centerline. Due to the curvature of the bow, and perhaps the stern, cant frames are set at an angle so that the planking can rest on a consistent angle to the frames.

Another consideration for the placement of the frames is the location of gun ports. Most of the preliminary frames should lie adjacent to the gun port openings, not directly within those openings. If too many seem to lie within the gun port openings, it is best to adjust the frame locations starting at a slightly different point, but still using the room-and-space rule. Unless you have access to the actual plans of the vessel that show the frame locations, many of your own determinations will be purely arbitrary

Some of the lines you've drawn thus far will correspond with some of the section lines already given on the plans, but most will not. Since you will end up with a series of parallel lines exactly ¼" apart from each other, it is difficult to see which are the frames and which are the spaces, so, using a colored pencil, lightly shade in the

frames and leave the spaces plain. Make sure that you do all of this with precision, because the accuracy of the finished model depends on the drawings you make now.

Drawing the Cant Frames on the Plans

To draw the cant frames it is only necessary to use common sense. The outer edge of each frame should be placed in such a way that it will accept planking with as little curvature as possible. The room-and-space rule still applies, but it should only be applied as an approximation. Draw these frames on the half breadth plan. Using a pair of proportional dividers, determine and mark the placement of the cant frame lines on the body plan as well.

Creating a Master Grid

Now we are ready to draw the shapes of individual frames, which will be used as patterns for the actual construction of each frame. First, it is necessary to draw a master grid that will be used for every one of the frames. Using an ordinary sheet of typewriter paper, draw a horizontal centerline from top to bottom. About an inch from the bottom of the page, draw a line perfectly perpendicular to the centerline – this line represents the lowest waterline, which is immediately above the keel. Now draw the remaining waterlines, as shown on the plans, and then mark them 1, 2, 3, etc., on your grid just as they are shown on the plans. Now draw the buttock lines, which are perpendicular to the waterlines, again measuring from the plans. The buttock lines are customarily marked to the left of the centerline as A, B, C, etc., and similarly to the right of the centerline.

Now measure the width of the keel and also the length it extends below the base waterline. Draw your findings on your master grid.

When you have finished drawing all the required lines, your grid should look similar to the photo on page 16.

Now count the total number of frames you will be building on your model, and then make at least that number of copies of your master grid, because you will need one grid as a pattern to cut out each of your frames. A word of caution on the use of copiers: Some copiers do not reproduce exact copies; they make slightly larger or slightly smaller copies than the original. Even a tiny variance cannot be tolerated, so test out the copier you are using before making all those copies.

Lofting the Outer Frame Lines on the Grid

Next, you must make a pattern of each frame by drawing the shape of each frame on a separate grid. This is a tedious and time-consuming task, but it is necessary for the successful construction of a plank-on-frame model. All you will need for this task is a sharp-pointed pencil and a pair of proportional dividers. Use a soft pencil, preferable a 2B, for drawing all framing lines on your grid. A good pair of dividers is mandatory. Patience and accuracy are definite plusses.

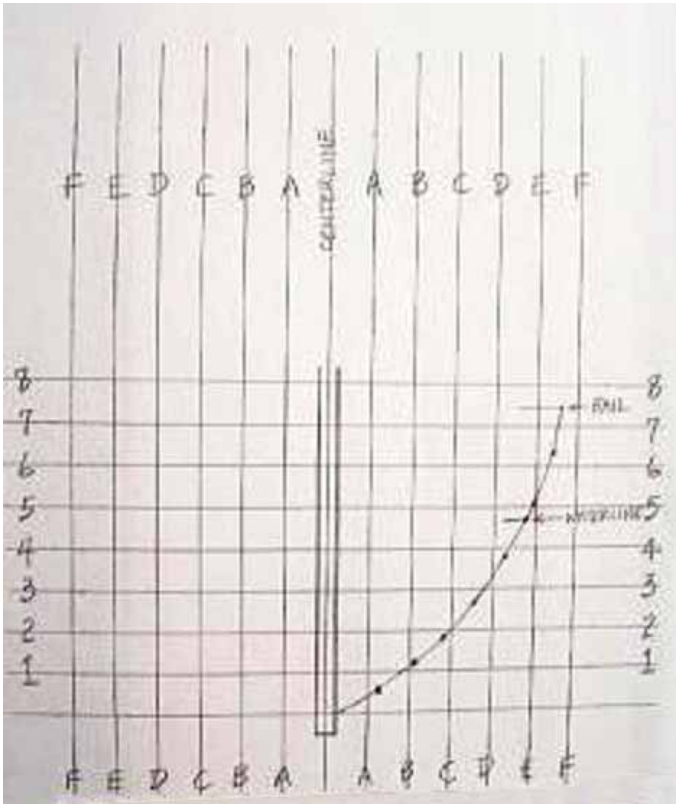
Note that several of the frames shapes will already be known from the plans, but on one side only. You must determine and draw the shapes of both sides of each frame. Of course, those near the center of the hull will be exactly or nearly exactly the same on both sides because there is little or no curvature in the shape of the hull at these points. However, the further you go aft, or the further you go forward, the more the variance you will see because the curvature of the hull changes more and more. These points will become more apparent as we draw the patterns.

Note that the following procedure will describe how to draw frame on your grid. It is only necessary to draw the frame on one side of the centerline of your grid. This will be true for every grid you draw. The other half will take care of itself, as you will learn shortly.

Lines Taken from the Sheer Plan: Starting with the section line on the sheer plan that is designated the center frame, place one end of your proportional dividers firmly on the base waterline where it intersects with the center frame and stretch out the other end of the dividers to Buttock A. Now transfer this measurement to your grid by placing one point at the intersection of the base waterline and Buttock A. Place the other point of the dividers right on the Buttock A line. Press the point in slightly, and then make a dot with your sharp pencil. Return to your plans, and place one end of your dividers on the same point on the base waterline and stretch out the other end of the dividers to Buttock B. Now transfer this measurement to your grid by placing one point at the intersection of the base waterline and Buttock B. Then place the other point of the dividers right on the Buttock B line. Make another dot with your pencil. Repeat this process until you have exhausted the buttock lines.

Lines Taken from the Half Breadth Plan: Now go to the half breadth plan. Using the same center frame, place one end of your dividers firmly on the ship's centerline at the center frame. Stretch out the dividers to Waterline #1. Now transfer this measurement to your grid by placing one point at the intersection of the centerline on the grid with Waterline # 1. Press the other point of the dividers firmly on Waterline #1 and make a point there and mark it with your pencil. Now place one end of your dividers on the ship's centerline at the center frame. Stretch out the dividers to Waterline #2. Now transfer this measurement to your grid by placing one point at the intersection of the centerline on the grid with Waterline #2. Press the other point of the dividers firmly on Waterline #2. Make a point there and mark it with your pencil. Repeat this process until you have exhausted the waterlines.

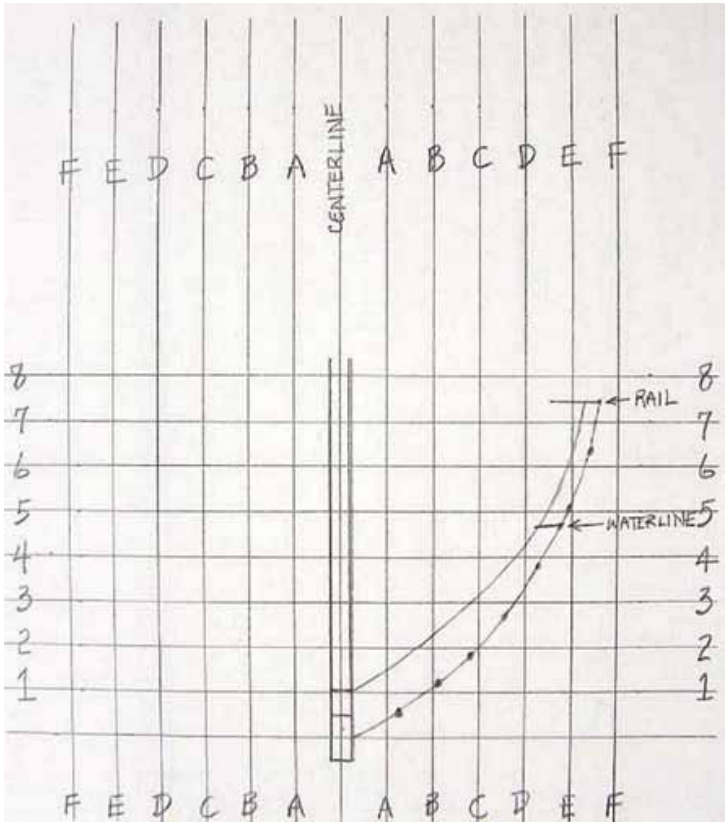
Other Lines to Add to the Grid: It is also a good idea to mark the top of the rail and the location of the exterior waterline onto your grid. These can be found on the sheer plan by placing one end of the dividers on the base waterline and stretching the other end to the top of the rail. Transfer this measurement to your grid by placing one end of the dividers on the base waterline near the outer edge of the frame and the other end at the appropriate point. Do the same for the exterior waterline. Your may also want to add the deck line, too.



All of this may sound quite difficult to the novice, but it is not. It is much more difficult to explain in words than it is to perform. After you've drawn two or three frames on your grids, it all becomes second-nature and can be accomplished with little effort.

After you've taken all your measurements and placed all your dots as described, it is simply a matter of connecting all the dots. The result is the outside curve of your central frame, which will look something like the drawing on the right.

Lofting the Inner Frame Lines on the Grid This only shows the exterior portion of the center frame, so now you must determine the inner portion. Generally, the bulwarks of the vessel are of a consistent thickness throughout its length. The thickness is determined by doing some research for the specific vessel you are building. Once this has been determined, scale its size down to the one you are using, and then plot this on your grid. Of course, the bulwark thickness will be at its thinnest point at the rail, and the thickness will increase as you move toward the keel. The top edge of the frame meets the top edge of your keelson. Determine the location of the top edge of the keelson from your plans and mark it on your grid. Also mark the bottom edge of your keelson on your grid. This will correspond to the upper edge of your rabbet line. The area below the keelson down to the base waterline represents the notch in which the frame will rest directly on the keel. Now your grid will look something like the drawing on the right.

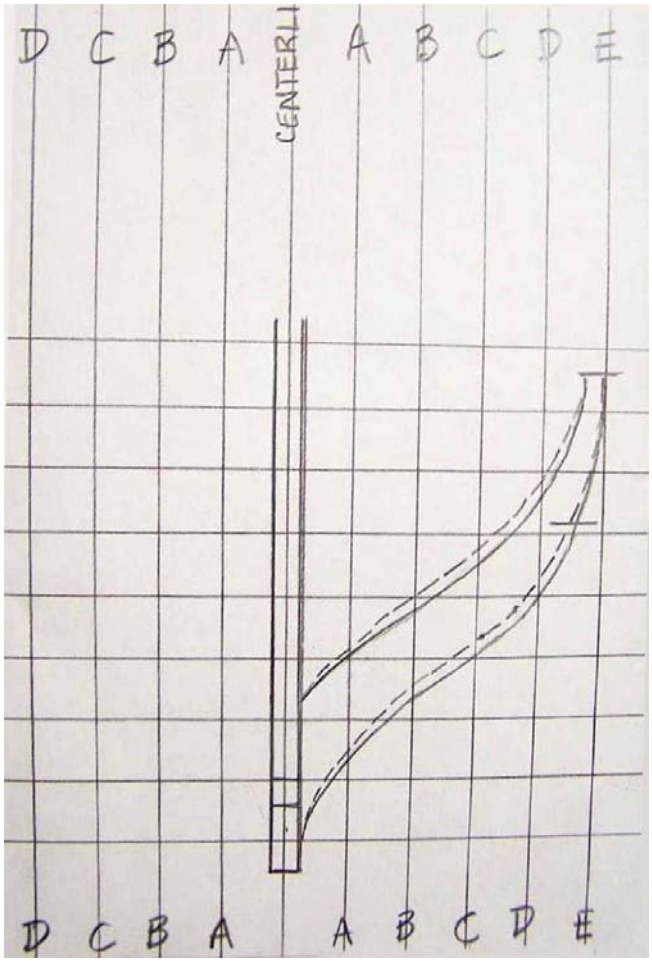


Once you have completed the drawing for a frame, make sure you label it clearly, specifying the frame number and any other information you may find useful.

The above discussion covered the drawing of frames that have little or no bevel at their edges -- in other words, the planking can rest on them directly. Now we will discuss the frames that do have bevels.

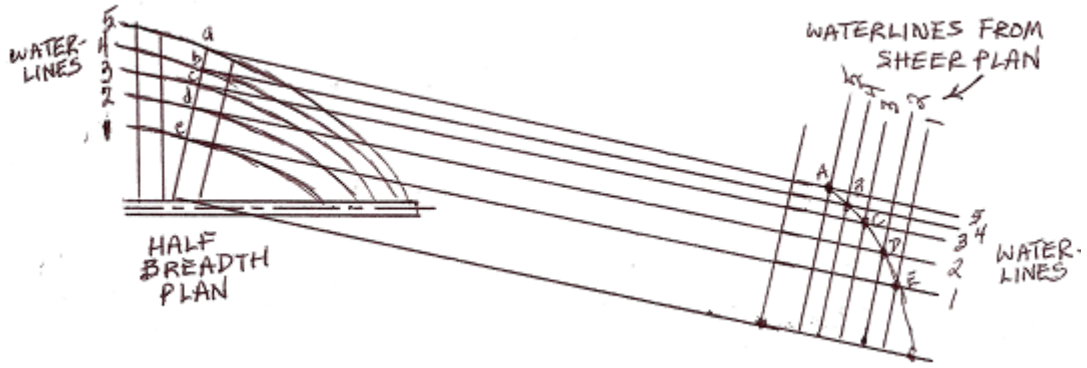
Lofting Both Sides of Frames with Bevels For all frames that require bevels it is necessary to draw both sides of each frame on a single grid. This is necessary so that the modeler can bevel the edges of the frame as required by the drawing. If this is not done, the modeler will be unable to bevel the frames, with the result that the planking cannot be installed properly. It is customary to use a solid pencil line for the widest side of the frame and a dotted line for the other side of the frame. The area between the solid line and dotted line represents the amount of wood to be beveled off. Going toward the bow of a ship, the widest side of the frame will be toward the stern side, and going toward the stern of a ship, the widest side will be toward the bow.

If the modeler has followed the directions correctly, a frame toward the stern of a vessel may look similar to the drawing on the right.



Lofting the Cant Frame Lines

Because the cant frames lay at an irregular angle to the keel, lofting them requires special consideration. You have already marked the locations of the cant frames on the half breadth plan, so now you must determine the curves of the outside edges of these frames (the area where the planking material will rest. The following illustration will be used to describe the drawing of one of the cant frames:



1. At the exact point where each waterline intersects the cant frame, draw an extension of that waterline at a precise 90-degree angle to the edge of that frame. Extend the line several inches. Repeat this for each of the waterlines. All of these lines must be parallel to each other. See line Aa, Bb, Cc, etc., in illustration.
2. Now draw all the waterlines as taken from the sheer plan onto your extended lines, making sure that they are exactly perpendicular to the lines you've just drawn and spaced exactly as they are in the sheer plan.
3. Note the points at which both lines intersect in the drawing now. Connect these points with a slight curve as shown. This is the shape of the cant frame on one side of it.
4. Repeat the above process for the other side of the cant frame to determine the bevel line for that same cant frame.
5. Draw all this information on your grid.

Finishing the Grids

You have completed only half of the drawings for all the required frame grids. The best way to complete the other half is to use the following procedure, which ensures that all of your frames will be perfectly symmetrical. Finish one frame grid at a time.

1. Using a steel ruler and sharp-pointed X-Acto knife, gently score a line directly down the centerline of the grid. This scoring line must be precise, because the goal is to make both halves perfectly symmetrical. Do not cut all the way through the grid, only enough to be able to fold it in half easily.
2. Crease the grid carefully down this scored line, with the drawn lines on the inside of the fold.
3. Hold the grid over a light source and you can see the frame lines through the paper. Taking a pencil, trace heavily over the frame lines you can see. Make sure you trace over all of them.
4. Open the grid and you can see faint lines on the other half of the grid.
5. Now fill in these faint lines with a pencil to make them as visible as the other half.

Repeat this procedure for each of your grids. When you have finished all of them, you are ready to use them as patterns to construct your frames.

CHAPTER 4: ESTIMATING MATERIALS

If this is your first scratch building project, you may have a problem in estimating the materials you will need. Your first estimate will probably not be very accurate, and you may be finding yourself with a significant oversupply of certain material, or you may find yourself returning to your sources to purchase additional amounts. As you build more and more models, your experience will improve to the point where your estimates will become quite accurate.

Your largest single purchase for material will consist of wood for the hull. If you have decided to build a plank-on-bulkhead hull, measure out the length, width, and thickness of the "backbone" piece. You might want to draw out your measurements on a smaller scale, such ¼"-graph paper. Will the bulkheads be of the same thickness? If so, lay out each bulkhead on your graph paper. Will any other parts, such as the rudder or keel, be of the same thickness? Lay this out, too. When you have completed your layout on the graph paper, add up all the wood you will need. You might also want to add about 15% or so for wastage.

Now make your estimate for your planking material. Will all of it consist of 1/16" wood, or will some be thicker? Remember to take into account a significant amount of wastage for planking, especially for spiled planks (those that are curved, especially at the bow). Again, lay out your measure-ments on graph paper. Particular when estimating planking material, it is best to overestimate because there is so much wastage. Any material left over can always be used on a future project.

Do the same estimating for all of your materials. Will you make fittings from scratch, or will you build all or only some of them yourself and purchase the remainder from catalogs? Write all these facts down. Of the fittings you will make yourself, what kinds of materials will you use, and how much of each material is required? How many blocks and deadeyes will you need, and will you make these yourself? Again, write down all your findings. Will you be using dowels for your masts and spars, or will you turn your own on a lathe or shape them on some other device? What about finish materials: paint, stain, and sealer? Don't forget glue and sandpaper, or beeswax for the rigging. If you will be installing sails on your model, how much tulle fabric will you need? How about the rigging material? What kind of thread will you use, and how much will be required? The rigging material is probably the most difficult item to estimate, because there is usually a great deal of wastage. However, make your best estimates, and always write them down on your "bill of materials."

You final bill of materials might be quite intimidating, but don't let this bother you. Many of the materials can be purchased piecemeal; for example, you might begin by purchasing only the materials necessary for building the hull itself, which is likely to take you at least a hundred hours, especially if you chose to build plank-on-frame style. After you've finished the hull, then you can buy the materials necessary for the next step. Remember that *you* control the entire project.

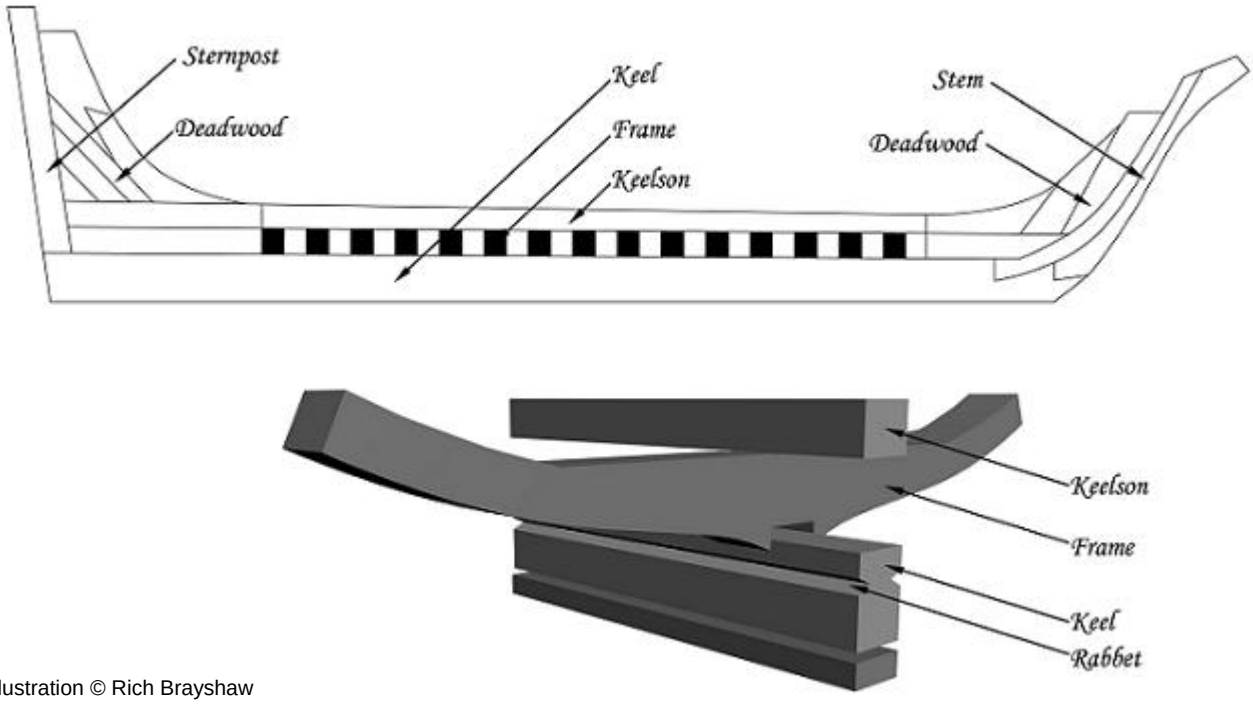
CHAPTER 5: CONSTRUCTING THE HULL

This narrative will concentrate on plank-on-frame hulls. If you have read this far in the narrative, you have accomplished the most difficult task in plank-on-frame hulls – understanding the plans and drawing the frames. The actual building of the frames is no more difficult than building a kit or a plank-on-bulwark model. It merely requires more patience because there are many more pieces to make.

This type of hull is not difficult to build as long as the modeler under-stands a few underlying principles. In building the plank-on-frame hull the modeler is attempting to duplicate the original ship as closely as possible, starting by laying a keel assembly, building frames onto the keel, and then adding planks across the frames, much like the full-sized ship itself.

The Components of the Keel Assembly

The keel assembly starts with the **keel** itself, which is the backbone of the whole ship. It also includes the sternpost and the stem. The **sternpost** is a piece of wood mounted on the after end of the keel; it terminates the stern of the hull and is a place for holding the rudder. The **stem** is another piece of wood mounted at the fore end of the keel, usually rising to a slightly curved shape just below the projection of the bowsprit. The keel, sternpost, and stem will also contain the **rabbet** for the planking, which is a groove cut into the areas where the **garboard strake** (the first group of planks next to the keel) and other planking strakes end. The keel assembly also includes **deadwood**, which are pieces of wood attached at both fore and aft ends of the keel; the deadwood is usually built up with multiple pieces of wood, and provides an extension of the keel to which other timbers, including planking, is attached. Finally, the **keelson** is an internal keel that is mounted immediately above the main keel on the upper edges of the bases of the frames. The keelson secures the frames in place and provides additional strength to the "backbone" of the ship. The **frames**, which are sometimes called **ribs** or **timbers**, cross the keel assembly between the keel and the keelson; they are curved components that branch outwards and upwards from the center of the keel, and they determine both the shape and strength of the ship as well as providing a framework for the ship's planking. All these components are illustrated below.

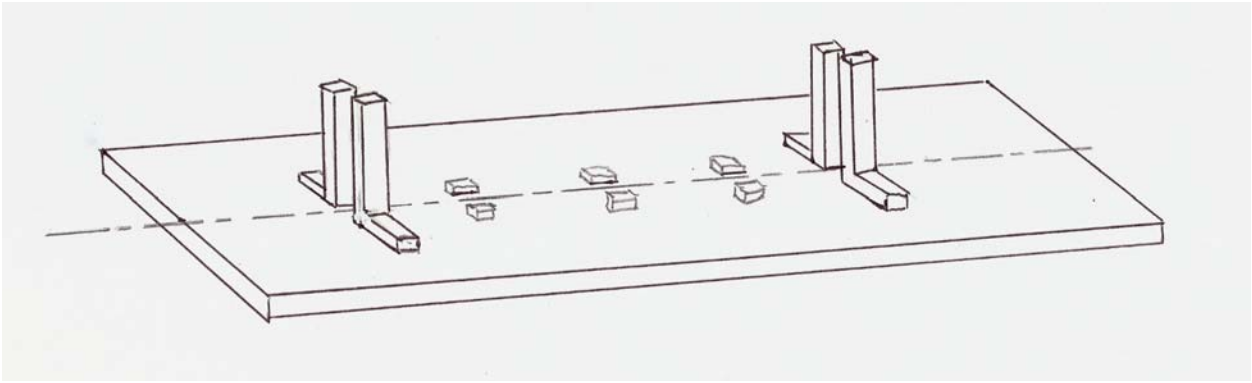


Making a Jig to Hold the Keel Assembly

The purpose of the keel assembly jig is to provide a supporting framework for the entire ship throughout its construction. It will ensure that the keel is always aligned properly, and it allows the modeler to check the accuracy of each stage of the framing process. In addition, it provides a temporary stand for the model, which can be viewed from any angle during the entire building process. A well-constructed jig can be used over and over again for other models, so it pays to invest the time necessary to build it as accurately as possible.

Basically, the jig consists of a straight, rigid plank of wood several inches longer and several inches wider than the length and width of your model. A centerline is drawn down its lengthwise middle point. Two sets of angle irons are secured to the plank. It is required that their angles measure precisely 90 degrees; any other measurement

is unacceptable. The first set is attached such that they hold the stemhead snugly in place, and the other set is attached such that they hold the top of the sternpost. Small pieces of wood are installed along both sides of the centerline right up against the keel to prevent the keel from warping. When the keel assembly is inserted into the jig, it should be firmly and evenly held in place by the jig and should have not even a slight wobble in any direction.



Constructing the Keel

Lay the keel on a flat working surface. It is a good idea to cut the keel a few inches longer than necessary, so that both ends will fit on the keel assembly jig; the extra lengths can be cut off at a later time. Check to make sure you are using a perfectly straight piece of wood. Cut out and glue the stem and sternpost in place. Build all of this on a perfectly flat surface, so that there won't be the slightest bend in the finished keel. Some modelers like to set the glued parts of the keel assembly right on top of the plans. Apply weights while the glue is drying, if necessary.

After the glue has dried, drill two small holes from the bottom of the keel directly into the sternpost, and then glue two dowels into those holes. This will provide good strength for the assembly. Do the same for the sternpost.

Now mark and identify the locations of each frame on the keel. The deadwood areas at both the stem and sternpost will support the cant frames of the vessel, which are set at an oblique angle rather than at right angles to the keel. Those at the stern will incline aft, and those at the stem will incline forward. You may choose to cut frame-wide grooves where the frames will rest, but be sure to add the depths of the grooves to your frame measurements when you build them. Between these two groups of cant frames are the notched frames that fit directly onto the keel, and that are exactly perpendicular to the keel. They are also the frames that the keelson will rest upon.

Adding the Deadwood

To build the deadwood at the bow and stern, several pieces of wood should be fitted snugly together and glued in place. It is recommended that angular joints and scarf joints be employed in the process, similar to those shown in the illustration on page 24, because these simulate the construction of the actual ship. Once again, drill holes and dowel the deadwood pieces to the keel, stem, and sternpost.

Insert the keel in the keel assembly jig and check it for trueness. Look at it from every angle. Are you satisfied with it? Use sandpaper and files to remove excess glue and minor imperfections.

Cutting the Rabbet

The width of the rabbet not only depends on the thickness of the planking you have selected but also on the angles at which the planking intersects the rabbet. For a ¼" = 1" scale it is typical that the planking is made from 1/16" wood. The rabbet you cut will also include the bearding line, which is an extension of the rabbet at the stern where the planking material will lie. Here it will taper smoothly at the sternpost.

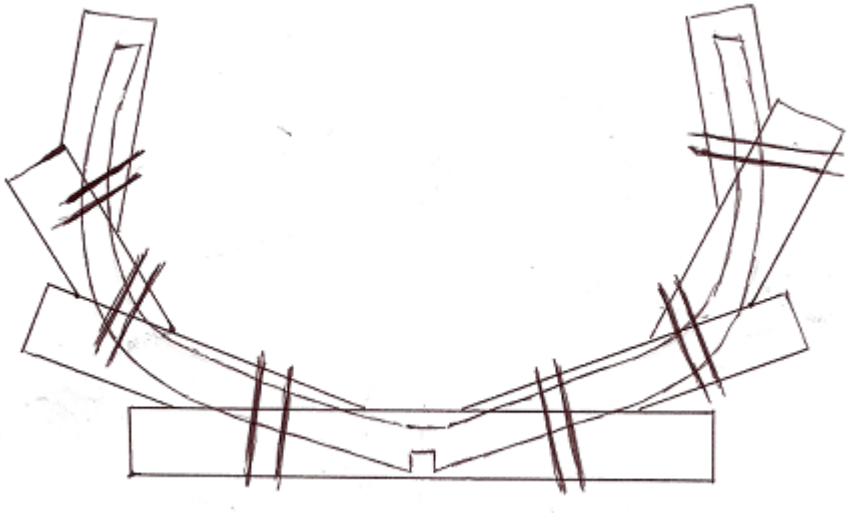
A steel ruler and an X-Acto knife can be used to cut the linear part of the rabbet. Cut both sides of the rabbet and gently remove unwanted material. Remember to adjust the angle of the cut as your approach either end of the model. Imagine the planking resting on the hull in its proper positions at various points, and make the groove take that shape. Cut the rabbet at the bow area by hand, making sure you follow your lines precisely. Miniature files can be used to clean out the rabbet. Test the groove by inserting planking material into it and sliding it along at the appropriate angles. Does it fit nicely? Does it snag anywhere? Are the angles shaped correctly?

Making the Frames

There are many ways to make frames. Some modelers cut out each frame from a solid piece of wood. Others use two layers of wood for each frame, with each layer having pieces jointed in different areas, which provides a sturdy frame that is not likely to warp. Still others like to model them exactly as they did in the real ship, using double layers of wood along with chock blocks between joints.

This narrative will discuss frames made from small pieces of wood joined together will glue and then double-doweled at each joint.

Using the patterns you've drawn for each frame, you will now determine how to cut small pieces of wood so that the grain of the wood follows the curve of the frame nicely. In the example below, the frame consists of seven pieces of wood, with each piece glued at the joints. Do all of this right on your pattern, which you will rubber-cement directly on top of the frame so that all lines on the pattern can be easily seen. Make sure all of the frame patterns rest fully on the wooden pieces. After the glue has set, drill two small holes at each joint and insert small wooden dowels. These are shown below by the double black lines. This will give strength to all the joints.



The frames that rest on the deadwood areas at the stern and at the bow are made the same way, with the exception that each frame will be two haves of a frame.

The cant frames are made similarly, but remember to bevel an angle at the point where the frame rests against the deadwood area. If you decided to make a notch in the keel assembly for these frames, make sure you've made allowance in the frames, too.

Once you have finished laying out all the frames in the manner described, they are ready to be jig-sawed out. Remember to saw to the outer edges of all frames, which includes the outer edges of the bevel lines.

After the frames are all jig-sawed out, the proper bevels must be cut on all frames that require them. This can be accomplished in many different ways. Some people like to do it on a disk sander. If the wood is basswood, it is soft enough to complete with sanding sticks. Others like to install most of the frames and perform the entire operation with a pad sander. Whatever method you choose, the object of all the bevels is to make sure the planking material rests firmly and snugly on each frame from bow to stern, with no gaps or other flaws. Care must be taken to ensure this.

Now is the time to remove your paper patterns and any glue residue from the frames. Do it carefully, making sure you don't sand off too much at any point. Smooth them up, and make sure you mark your frame information on each frame, including you identification number or letter, the location of the deck line, and any other information from your pattern.

Installing the Frames

Now that your bevels have been cut, you are ready to install all the frames on the keel assembly. The frames between the two deadwood areas are the easiest to install, so let's start here. With the keel assembly placed in its keel-assembly jig, take an amidships frame in hand and place glue around the keel notch. Then place it firmly in its proper position. Using a square with a perfect 90-degree angle, make sure the frame stands perpendicularly to the keel. Now, from the sheer plan, mark the precise height of the deck line on a piece of measuring wood. This height of this mark will correspond precisely with the height of the deck line marked on the frame *on both sides of the keel-assembly jig*. In other words, the frame must be perfectly aligned in all respects. Make adjustments where necessary. The goal is to position the frame as precisely as possible. Repeat this procedure for each of the frames. Some modelers like to use temporary spacer blocks between each frame as they are being installed. The blocks made are placed centrally on each frame with a touch of rubber cement, so that they're easily removed later.

After the glue has set, it is recommended that a small hole be drilled where the frame meets the keel, and then install a small dowel with a bit of glue. This provides additional security.

The frames located at the deadwood areas and the cant frames are installed in similar fashion, with the exception that they do not rest on the keel assembly as easily without some assistance. Whether you've made notches or not makes little difference. It is recommended that you use a quick-drying glue for these frames, installing and aligning them as quickly as possible. Jigs can be built to hold them in place if necessary.

Installing the Keelson

After all the frames are in position and all bevels have been checked to make sure the planking will rest snugly on each frame, it is time to install the keelson. The keelson is simply a length of wood the same width as the keel that rests atop all the frames located between the two deadwood areas. It should be glued and doweled in place at each of the frames.

Summary and Conclusion

This narrative described how to modify and adapt plans for a plank-on-frame model. It also described the basics of plank-on-frame construction.

The planking is accomplished just like it is done for any other type of model. Making decks and deck structures are the same for all types of models.

I highly recommend plank-on-frame construction for any model. It is more challenging and much more fun, as well as being far more realistic than any other construction method.

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