SECTION 1- INTRODUCTION

1.1 Terminology

1.1.1 We shall use boatbuilding terminology throughout as the words usually have precise meanings.

1.1.2 Most of the names of the structural items are fairly clear from the drawings themselves. Rather than give a long list of terms, the names of the various structural elements will be introduced as they occur naturally during the build of the boat.

1.1.3 One name that often causes confusion however is “floor”. In boatbuilding terms a floor is a transverse structural member that lays across the centreline structure and helps to link the centreline structure to the hull skin and other parts of the transverse structures. The “floor” that you walk on in a boat is known as the “sole”.

1.2 Principals of structure

1.2.1 The hull skin is supported by a sub-structure consisting of longitudinal and transverse elements. In this way individual panel areas of hull skin are kept reasonably small and regularly supported.

1.2.2 The transverse structures are the frames, floors and bulkheads (and the transom - which is both a transverse and part of the hull skin).

1.2.3 The longitudinal structures in the hull consist of the backbone/stem lamination and the shelf. And the plank laps themselves also form longitudinal “stringers”.

1.2.4 The deck and superstructure longitudinals are the carlings and stringers. The pattern of longitudinals and transverses is not quite so regular in the deck and superstructure as it is in the hull, because it is more dependent on the internal layout of the boat.

1.3 The Drawings

1.3.1 The drawings and information to build the boat are divided into groups as follows:

001 Proposal drawings
002 Build instructions & specification
003 Longitudinal structures
004 Transverse structures
005 Keel & ballast
006 Engine installation

007 Steering
008 Tanks
009 Sundry structures
010 Interior furniture
011 Spars, sails & rig
012 Deck gear

1.3.2 All dimensions on the drawings, specifications and instructions will be millimetres unless otherwise noted.

1.3.3 The plans are almost always drawn to scale and the scales used are noted on them. However, paper is notorious for stretching, shrinking and generally going out of shape; also printers do not necessarily print entirely true to size. By all means scale off the drawings to get a general idea of size, to check on something that seems to be wrong etc. But all the dimensions that you require to build the boat should be written on the drawings. If a measurement seems to be missing please let us know and we will supply it.

SECTION 2 - THE "LINES"

2.1 What are they?

2.1.1 The boat is designed on a computer and resides in the computer as a sets of data representing 3-dimensional surfaces. However, to build the boat, we have to start with some 2-dimensional shapes and build these up into the 3-dimensional object that is the boat as a whole. The 2-dimensional shapes that we look at for this purpose are known collectively as the "lines".

2.1.2 When boats were designed manually, the design itself was built up from drawing and measuring the 2-dimensional shapes - so the 3-dimensional design was also derived from the lines. Although this is no longer the case, we still tend to draw out from the computer-generated 3-dimensional surfaces the same 2-dimensional views as were previously used to design the boat.

2.1.3 A major difference however is that manually drawn lines were drawn at a reduced scale (so they could fit on a piece of paper) and they needed to be drawn out full size so that they could be checked for accuracy and "fairness". This process is known as "laying off" or "lofting". Computer generated surfaces are inherently fair and entirely accurate dimensions of them can be obtained directly from the computer - so lofting is no longer required.

2.1.4 Another major difference is that, with manually drawn lines, the designer only knew the shape of the hull on the lines. With computer generated surfaces we know the shape of the hull everywhere (or at least almost everywhere - software still has a few bind spots!). This means that we have the facility to extract the accurate position of almost any point on the surface of the hull. It is this facility that allows us to provide accurate dimensions, bevels etc. of the majority of the elements of the boat.

2.2 Datum points

2.2.1 We have to set datum points (or perhaps more accurately datum lines) from which other points on the boat can be measured. The datum points on your boat are as follows:

2.2.2 The Datum Waterline (dwl). This is a horizontal line drawn at the approximate flotation position of the boat. It should not be confused with the Load Waterline (LWL) which is the calculated flotation line under specified load conditions (perhaps two-thirds loaded).

2.2.3 The Zero Point. This is the intersection of the stem face with the dwl.

2.2.4 The Centreline. This is the fore-&-aft centreline of the boat.

2.3 Point measurements

2.3.1 Position. This is measured forward and aft of the Zero Point. Positions aft of the Zero Point are negative. So Position -400 is a point 400mm aft of the Zero Point.

2.3.2 Offset. This is measured out from the centreline. So a point at Offset 870 is 870 mm out from the centreline. If necessary an offset is designated port or starboard. Port is the left-hand side of the boat (when you are facing forward); starboard is the right hand side.

2.3.3 Height. This is measured above or below the dwl. Heights below the dwl are negative. So Height -50 is a point 50mm below the dwl.

2.3.5 Thus any point in the boat can be identified by three co-ordinates - Position, Offset and Height. These co-ordinates are often brought together in tabular form - somewhat confusingly known as a “Table of Offsets”. You will see Tables of Offsets on the frame drawings - and as the build progresses, on other drawings as well.

2.3.6 Now we will just identify the various lines we use to find the shape of the boat.

2.4 Sections

2.4.1 A section is a vertical athwartships (across the boat) slice through the boat (like a slice of bread off a loaf).

2.4.2 Sections are designated “s” followed by their position. Thus s -400 is a section through the boat 400mm aft of the Zero Point.

2.4.3 Athwartships elements like frames and bulkheads are drawn using sections.

2.4.4 Frames in this boat take their name from the position of their aft face - so Frame –1375 will have its aft face at 1375mm aft of the Zero Point.

2.5 Waterlines

2.5.1 A waterline is a horizontal fore-&-aft slice through the boat.

2.5.2 Waterlines are designated “wl” followed by their height. Thus wl -150 is a waterline 150mm below the dwl; wl 400 is a waterline 400mm above the dwl.

2.5.3 Waterlines are used to obtain the shapes of horizontal elements of the boat - soles, bunk tops, furniture unit tops etc.

2.6 Buttocks

2.5.1 A buttock is a vertical fore-&-aft slice through the boat.

2.6.2 Buttocks are designated “b” followed by their offset. Thus b 200 is a buttock 200mm out from the centreline.

2.6.3 Buttocks are used to obtain the shape of any fore-&-aft partition, items like bunk fronts, furniture unit fronts, bottom edges of engine beds etc.

2.7 Diagonals

2.6.1 Diagonals are fore-&-aft slices through the boat taken at an angle (i.e. neither horizontal nor vertical - but some angle in between).

2.7.2 Diagonals are designated “d” followed by the height on the centreline of their start point and the angle (usually downwards) that they make to the centreline. Thus d 100 45° is a diagonal that starts on the centreline, 100mm above the dwl and is at an angle of 45° with the centreline.

2.7.3 Diagonals are not often used directly to obtain shapes of items but the offsets on diagonals are often used to help delineate the shapes of other items, particularly sections,

where they cross the hull skin more nearly at right angles than either a waterline or a buttock (thus making measuring more accurate).

2.7.4 An offset on a diagonal is measured down the line of the diagonal from the centreline. Because they are rather a nuisance to set out and particularly a nuisance to mark bevels on, we are seldom going to use diagonals on this boat.

2.8 Body Plan & Grid

2.7.1 The body plan shows the outlines of the sections, with the waterlines, buttocks and diagonals drawn as a grid over them.

2.8.2 If you refer to drawing 077/002/10 you will see a body plan (although only a single section is shown) and a basic grid consisting of just waterlines and buttocks.

2.8.3 This grid is used to obtain the shape of the frame components and to check the frames for shape and accuracy once they are made and assembled.

SECTION 3 - GETTING READY TO SET OUT & MAKE THE FRAMES.

3.1 Setting out the grid

3.1.1 The basic grid as shown on drawing 077/002/10 needs to be drawn out on a flat, level surface. We will call this the “setting-out floor”. The frames can also be laminated directly on the setting-out floor

3.1.2 The best type of surface is a board floor - chipboard or plywood is ideal. This should be thick enough to take small nails to bend battens around and to screw blocks to. 20mm material is about the right thickness. The floor should be emulsion painted white, so that pencil or ball-point lines show up clearly. As the frames are going to be laminated directly on the floor it is important that it is rigid and flat - and preferably level. Make the floor big enough for the largest frame, with some to spare.

3.1.3 You will need a metre folding rule, a 5-metre steel tape, some 20mm wire nails, a couple of battens (one say 2000mm long x 15mm x 20mm and one say 2000mm x 10mm x 15mm - good clean pine with no knots, planed up straight and square) and if possible a few weights (10kg or more). You will also need a straight edge (about 2500mm long x 145mm x 20mm, planed) and a large square (either 30°-60°-90° or preferably 45°-45°-90°). This can be made from part of a sheet of 12mm (or thinner) ply - see ¶3.1.4 on how to construct a right angle.

3.1.4 Draw the grid out on the setting out floor. Use an 'H' pencil or fine ball-point pen. Start with the centreline and then draw the dwl truly at right angles to it. Boatbuilders usually use a 3:4:5 triangle to check for square (90°). So, to check the dwl/centreline for square measure a multiple of 3 (say 900mm) along the dwl from the point of its intersection with the centreline and mark this on the dwl. Now measure the same multiple of 4 (in this case 1200mm) up the centreline from the point of its intersection with the dwl and mark this off on the centreline. Now join the two points and measure this length (the hypotenuse of the triangle). It should measure the same multiple of 5 (in this case 1500mm) exactly. Remember to draw the dwl with reference to the setting-out floor so that there is height above it for the superstructure.

3.1.5 Now draw the waterlines above the dwl and parallel to it - these are at heights of 100mm, 200mm, 400mm & 600mm above it.

3.1.6 Now draw the buttock lines each side of the centreline and parallel to it. These are at offsets of 100mm through to 800mm out from the centreline at 100mm intervals.

3.1.7 Label up the grid clearly (as it is on drawing 077/002/10). Double check everything because on the accuracy of your grid depends the accuracy of your boat.

3.1.9 This is the basic grid and part or all of it is used to mark out and make every frame. Other waterlines, buttocks and diagonals may be used temporarily for other components and these will need to be marked on the grid as we go along.

3.2 General observations

3.2.1 You will see the terms "sided" and "moulded" used on the drawings. Sided is the thickness of the component measured from side to side; on a frame this will be the fore-&-aft thickness. Moulded is depth of a component measured from face to face; on a frame this will be the athwartships thickness around the hull and the top-to-bottom thickness around the deck.. On a component like the backbone "sided" refers to the width from side to side (athwartships) while "moulded" is the depth from top to bottom.

3.2.2 Before marking out a frame, take a look at the Table of Offsets on the drawing for that frame. Generally there will be a set of offsets for the aft face of the frame and another set for the fwd face. The differences between these two sets is the amount of bevel (angle) on the edges of the frame so that the frame fits in with the curvature of the hull, deck and superstructure. A frame is generally made to the larger dimensions and bevelled back to the smaller.

3.2.3 Up forward, the hull is getting smaller towards the bow, so the fwd face of a frame is smaller than the aft face. Somewhere around amidships the aft face of the frame starts

to become the smaller as the hull tapers in to the stern. The coachroof is at its largest towards the back end so the aft face will be the larger most of the time.

3.2.4 Not all the curves on the boat will change gradient at the same time so there will sometimes be a twisted bevel on a frame edge. This will all fall out quite naturally as each frame is made and bevelled.

3.3 Accuracy

3.3.1 Normally the smallest unit of measurement we shall use is the millimetre. Occasionally you will see half-millimetres marked on a drawing but this is usually when something is in the centre of a component of odd millimetres in size (two measurements of 12·5mm on a 25mm piece of timber for example).

3.3.2 Measure to the exact number of millimetres given - 327mm is not “near enough 325mm” for example; and try to make components accurate to within 1mm.

3.3.3 It is especially important that the frames (and transom) are accurately made and bevelled, and, when the time comes, set up accurately on the building jig. If you get these right, then the rest of the structure will flow easily and accurately, and so will the furniture fit properly.

3.3.4 In traditional boatbuilding using sawn frames (rather than steam bent timbers) it was common practice to cut the frames to shape and then bevel them (with an adze usually) once they were set up on the backbone. The bevels were obtained by bending battens around the hull to see how much bevel was required. Please don’t be tempted do this with the laminated frames for your boat. It is much more difficult than would be imagined and it is not likely to be accurate enough for the smaller bits of timber that we are dealing with. Plane the bevels on the edges of the frames before they are set up on the building jig - see the detailed instructions that follow.

3.3.5 WEST is a wonderful material for boatbuilding and it can have remarkable gap filling properties. However, try to make a good fit of things as this is usually very much easier and more satisfactory that a bad fit made good by a bed of WEST. When things fit nicely, then they can be fastened, cramped etc. while the WEST cures so much more easily and they are much more likely to stay in place without distortion etc. By all means use WEST to gap fill if a mistake is made or in cases where it is not possible sensibly to get a good fit, or of course where structures are designed to be put together on a bed of WEST - but try not to rely on it to replace careful workmanship.

3.4 Timber

3.4.1 The timber intended to be used for the various parts of the structure is shown in the brief specification accompanying these instructions. Alternative timbers can be used; most timbers are suitable for bonding with WEST and durability is no longer of such importance because of the WEST encapsulation. This frees us up to use many excellent timbers that were not previously used much in boatbuilding because they were not able to withstand the ravages of wet conditions and poor ventilation.

3.4.2 Some timbers, while perfectly suitable for bonding with WEST, and plenty strong enough are not always the best choice however for some structures. An example would be a furniture timber like Brazilian Mahogany, which is an excellent timber with an attractive grain. It is not a particularly good timber for bending however and so not very suitable for carlings, shelves, backbone etc. African Mahogany (Khaya) with its less figured grain is much easier to use for these jobs (and its also usually considerably cheaper).

3.4.3 Some timbers are not very easy or satisfactory to bond with WEST, so should not be used for primary structural purposes. The most common of these unsatisfactory timbers are Teak (too much oil), Oak (too much tannin) and Pitchpine (too much resin). Iroko is satisfactory, but for most purposes African Mahogany with its more open grain structure, is a preferable substitute.

3.4.4 Thus, while WEST has opened out many new timbers for boatbuilding, some of the old ones are no longer so suitable and there are still timbers which are more suitable for some purposes than others. So if you are moving away from the timbers noted in the specification, please give us a call first to make sure that they will be OK.

SECTION 4 - FRAME -695

4.1 Setting the frame out

4.1.1 This frame consists of a laminated ring 25 sided x 36 moulded, with a solid timber floor.

4.1.2 The frame is marked out to the larger dimensions, which are those for the aft face (except for the sheer height which is larger on the fwd face).

4.1.3 The coachroof front is bonded to the aft face of this frame - You can make it immediately after making the frame or - perhaps better make it later on when the boat is skinned and is the right way up.

4.1.4 Mark in the sheer point by measuring 695mm up from the dwl (the larger of the two sheer heights) and 580mm square out from the centreline (the larger of the two sheer offsets).

4.1.5 Mark in the hull offsets on their appropriate waterlines, using the larger offsets which are all those for the aft face. So, on wl 600 measure out 570mm, on wl 400 measure out 531mm, on wl 200 measure out 462mm, on wl 100 measure out 409 and on the dwl measure out 329mm.

4.1.6 Now mark in the hull heights on their appropriate buttocks. On b 300 measure 25mm down from the dwl; on b 200 measure down 84mm; on b 100 measure down 117mm.

4.1.7 The rebate is a constant 30mm offset (like a 30mm buttock) so we shall be measuring heights for this. So, measure out 30mm and measure down 134mm below the waterline. The keel offset are not required for the frame.

4.1.8 Drive a small nail into the setting-out floor at each point marked and bend a batten around the outside of the nails. The batten should lay fair around the nails. At the rebate. continue the batten fair on to the centreline. If the batten won't lay fair, check that you have measured correctly and put the measurements on the correct waterlines. If all is correct and the batten still won't lay fair, then call us so that we can check that we have given you the correct measurements. While the dimensions are all computer generated, they are not directly transferred from the surface generating programme to the drawing programme and thus they have to be typed in on the drawings - so there is opportunity for error!

4.1.9 Hold the batten in place with weights, or nails driven on the outside opposite those on the inside - don't drive nails through the batten. Draw around the inside of the batten.

4.1.10 Repeat these procedures for the other side of the boat, so that the whole hull outline is marked in on the setting-out floor.

4.1.11 Now measure out the foredeck heights - these are larger on the fwd face. On the centreline measure 775 (the larger of the heights) up from the dwl. On b 100 measure up 773, on b 200 measure up 765 and on b 300 measure up 752; on b 400 measure up 734 and on b 500 measure up 713mm; the sheer is already marked. Measure the heights on the other side of the boat as well Join the points with a batten as before, right across the boat in one go. Across the deck (and the coachroof top) don't mark one side and then the other as you will get a "hard" join on the centreline, whereas the curve should continue smoothly across the centreline and down the other side..

4.1.12 Mark in the line of the top of the floor - 15mm above the dwl. There is no need to mark the various notches etc. on the setting-out floor.

4.1.13 To mark the sheer corner radius, mark and cut out a circle of the required radius from stiff card and lay this on the setting-out floor, pushing in into the sheer corner until the periphery of the card just touches the deck and hull outlines; draw round the appropriate bit of the card. It is sometimes useful to push a sharp pencil through the centre pin prick on the card once it is in position as this will give you the centre of the sheer corner radius on the setting-out floor as well. It is not the inner radius that is usually required but the outer radius, which is found by adding the frame moulded depth to the inner radius (in this case 150 + 36 = 186mm radius)

4.2 Laminating the frame

4.2.1 The frame is laminated up from 12 off 3mm khaya laminations, which should make up a moulded depth of about 36mm. Contrary to the remarks regarding accuracy in §3.3, the actual moulded depth of the frame is not absolutely vital. We chose frame dimensions to provide sufficient strength for their purpose but there is some flexibility in this choice. What is important is that the outside of the frame is the correct shape and the edge bevels are correct, so that the hull skin lays nice and fair on the frame and bonds properly to it.

4.2.2 The frame needs to finish at 25mm sided (and it should not really be less than this). So cut your laminations to say, 30mm width to allow for cleaning the frame up after lamination.

4.2.3 It is unlikely that the Khaya veneers will be long enough to go round the frame in one without joins. Drawing 0776/002/11 gives three methods of joining laminated frame sections up.

4.2.4 With the ‘plain scarph’ method, the frame parts are laminated up separately and then scarphed (and WEST bonded) together afterwards.

4.2.5 With the ‘laminated scarph’ method, the first part is laminated up and the scarph end cleaned off to a slightly curved shape. The second part is laminated up with the laminates running down the scarph face on the first part.

4.2.6 With the ‘staggered butt’ method each laminate is just butted and each butt is staggered by about 50mm. The first part of the frame is made with the ends of each succeeding laminate about 50mm back from the previous one. The second part is then laminated with each succeeding laminate fitting about 50mm over the previous one.

4.2.7 Usually the best point to join the frame sections up is at the centreline at the top - but the joins can be in any reasonably straight section. We find the laminated scarph method the easiest, but all three are simple and satisfactory. With this frame however the plain scarph method is probably the easiest because the bottom ends of the frame are quite close to each other so the blocks and cramps will become very crowded with either of the other two methods.

4.2.8 Prepare some blocks of timber (softwood will do fine) about 75mm long, 50mm wide and about 35mm high. Screw these to the setting-out floor at about 150mm centres, so that the approximate centre of the block is tangential to the outline of the frame. Fit blocks for one complete side plus about 250mm over the centreline at the top to provide sufficient material for the scarph. Fit blocks to meet at the sheer corner. At the bottom make the first block run just beyond the centreline (say 30mm beyond).

4.2.9 The only real problem with making frames like this is that the cramps are quite close to the setting-out floor and it can get difficult to turn the handles and still keep the cramp square to the work. If you select small sliding cramps with cylindrical wooden handles, these should be OK, as should the small size G-cramps with a sliding T-bar handle. “Wing nut” type handles won’t be so good however. You can also get cramps that work just like a mastic gun - squeezing the handle closes the cramp. These are really excellent for laminating work of this sort - though not much good for heavy work. With most cramps you will need small squares of ply or similar to prevent the cramps marking the timber. These also help spread the pressure over the whole width of the lamination where the cramp foot is rather smaller than this. so for this frame make your cramping pieces about 25 x 25 square.

4.2.10 If you cannot get sufficient cramps, you can put pressure on the laminates by blocks and wedges on the inside. You will need two sets of blocks at each wedging position. One block will be much the same as the outer blocks and these are screwed to the floor at suitable positions around the inside of the lamination. The other block will have a convex face (of approximately the correct curvature - if anything a tighter curve than the frame so that just a small surface is presented to the laminations) to present to the inner face of the laminates. A pair of shallow folding wedges are driven between the two blocks to force the inner block on to the laminates. Folding wedges are a pair of wedges driven one over the other in opposing directions. You will need to screw a piece of ply from an inner fixed block to an outer at perhaps every other block and drive a shallow wedge between it and the lamination, in order to stop everything lifting off the floor.

4.2.11 It will be necessary to take precautions so that the frame does not become bonded to the setting-out floor and the blocks. You can wax the setting-out floor thoroughly or you can tape a sheet of clear polythene taut over it - screw the blocks on top of the

polythene. Make sure the polythene cannot get wrinkled as the wrinkles can get trapped in the laminations. The blocks can be waxed, or covered in shiny parcel tape.

4.2.12 Even if you are cramping the laminates, you should prepare some short lengths of timber or ply (called "trigs") to screw on to the top of the blocks and some shallow wedges to drive between these and the frame laminations - these will keep the laminations from slipping up as you cramp. Wax these items well, or probably better, cover with shiny parcel tape. You will also need some cramping pads (hardboard or thin ply about 20mm x 20mm) to prevent the cramp feet marking the inner lamination.

4.2.13 An alternative is to make the half frame up at double siding and then saw the lamination in half lengthwise to give both sides of the frame. This would involve a lamination about 65mm wide, which really needs double cramping and is possibly a bit ambitious to start with. If you do try this on this, or a later frame, obviously your blocks screwed to the floor will need to be appropriately higher.

4.2.14 The corner 150mm radius is usually about right for 3mm laminates, though of course only the final laminate has to pull this tight. So make up an odd piece of blocking at about 150mm radius and try a laminate into it. Laminates vary in flexibility according to their grain structure, moisture content etc. Warming the laminates with a hot-air gun will dramatically improve their flexibility. Heat the laminates as you pull them in to the curve and hold them in the curved shape until they cool. When wetted-out with WEST, they will also become more flexible. If you feel that they really are not going to pull round, then ease out the radius of the corner blocking.

4.2.15 Make the solid blocking for the sheer corner. The inner radius of this will be 150 + 36 = 186 - but see ¶4.2.14 above. Use the circular card that you marked the sheer corner radius with (¶4.1.13) to mark the radius on the block. The block can be cut from a single piece of timber with the grain running across it at about 45º, or it can be made from two pieces mitred across the corner. Fit the block into the frame corner and hold it in place with trigs and wedges.

4.2.16 Now try a few laminations round dry (no glue). In areas of tight curvature (none really on this frame) you may find that the blocks require hollowing out to better support the lamination - this will become clear if the laminations tend to pull into "hard" shapes rather than a nice fair curve. The bottom end of the laminations should run about 30mm over the centreline.

4.2.17 To start with, we suggest that you only attempt half the laminations in one go - say 6 laminates. Later on, after you have made a frame or two, you may find that you can get the whole lot round at once. So have a complete dry run and make sure that all your cramping/wedging techniques work OK and that you have all the necessary tools and other items to hand.

4.2.18 Lay the laminates in a pile. Mix up the WEST resin/hardener. Divide this into two portions. Mix #403 microfibres with one portion. Coat the upper surface of the first laminate with the plain resin/hardener (this is called "wetting out") and lay it to one side. Coat the upper face of the next laminate with the resin/#403 mix and lay it WESTed face downwards on to the first laminate. Coat the other face of this laminate with the plain resin/hardener. Coat the upper face of the third laminate with resin/#403 mix, lay it WESTed face down on the second laminate; wet out the upper face. Continue like this until all the laminates are done and piled one on top of the other.

4.2.19 Pick up the pile of laminates, lay it on its side against the blocks. Gradually cramp or wedge the laminates into the blocks, allowing them to slide on one another to take up the correct curvature. Once all the cramps/wedges are lightly tightened, tap the laminates flat down to the floor (use a block of wood and a hammer). If necessary hold them down with the ply trigs and wedges. Tighten the cramps/wedges firmly. When cramping, either work from the centre outwards, or from one end to the other, so that the laminates can be progressively tightened.

4.2.20 Clean off as much excess glue as possible - its much easier at this stage than later when it has cured.

4.2.21 Leave the frame to cure for at least 10 hours at 15°C. Before working further on the frame, check that the WEST has gone off hard.

4.2.22 Bond the remaining laminates on working as before. Allow the final laminates to cure for at least 10 hours at 15°C before removing the frame from the setting-out floor.

4.2.23 Remove the lamination from the floor and laminate up the second side in the same way.

4.2.24 Clean up both sections of the frame to 25mm sided.

4.2.25 Lay the frame sections in turn on the setting-out floor to check that they match their outline on the setting-out floor. There should have been no appreciable springback. If there has been for some reason, then some extra laminates will have to be bonded on so that the frame can be cleaned back to its proper shape.

4.2.26 Now mark and cut a plain scarph at the top centreline on one of the frame sections and plane the scarph surface flat. Lay the section on the setting-out floor pushed into the blocks so that it matches its outline on the setting-out floor. Mark and then cut the bottom end of the frame off accurately vertically on the centreline.

4.2.27 Now lay the other laminated section on the setting-out floor (not the side with blocks screwed to the setting-out floor). Lay the first section on top of it, set on packing so that it is near enough a parallel 25mm off the setting-out floor; the section can be positioned correctly by pushing it up to the blocks screwed to the setting-out floor. Mark the line of the scarph on the face of the second section. Cut the scarph on the second section and clean it up; also cut the bottom off accurately to the vertical centreline. Lay the two sections together and adjust the fit of the scarph until the complete frame matches its outline on the setting-out floor.

4.2.28 Now get out the 25mm sided material for the floor section (grain horizontal). Slide this under the arms of the laminated sections; check that they still match their outline on the setting-out floor and then draw around the inside of the laminated arms on to the floor section. Cut the floor section out to shape and fit it into the laminated arms so that the whole frame matches its outline on the setting-out floor.

4.2.29 Now bond the frame components together with WEST/#403, wetting out all bare timber thoroughly with WEST first. The frame can be held together while the WEST cures by blocks screwed to the setting-out floor, wedges and cramps.

4.2.30 Once the WEST has cured, remove the frame from the setting-out floor and clean it up to remove any excess WEST etc.. Then it is ready to be bevelled.

4.3 Bevelling the frame

4.3.1 To set out the bevels we need to refer to the Table of Offsets again. On this frame, the fwd face is the smaller(apart from the sheer height which is smaller on the aft face) so we mostly will be marking the bevels on the fwd face.

4.3.2 The bevels can either be marked by setting out the outline of the frame again on the smaller face, or by simply subtracting the smaller dimension from the larger and marking this distance in from the edge on the smaller face. Offset bevels are measured horizontally along their waterline and Height bevels are measured vertically along their buttock.

4.3.3 On the sheer, on the fwd face measure an offset bevel of 12mm (580 - 568) back in from the edge. On wl 600 measure a bevel of 13mm (570 - 557); on wl 400 a bevel of 12mm (531 - 519), on wl 400 a bevel of 20 (275 - 255) and on wl 200 a bevel of 12mm (462 - 450), on wl 100 a bevel of 12mm (409 - 397 and on the dwl a bevel of 12mm (329 - 317).

4.3.4 On b 300 measure a height bevel (these are measured vertically on the buttock lines) of 9mm (25 - 16); on b 200 a height bevel of 5mm (84 - 79); on b 100 3mm (117 - 114) and on the rebate 2mm (134 - 132)

4.3.5 On the deck we need to mark the height bevels. Note that these are off the aft face - across the foredeck deck the frame is usually higher on the fwd face because the sheer is rising. From the centreline through to b 300 there is 1mm of bevel. On b 400 and b 500 there is a no height bevel. At the sheer, there is 3mm bevel off the aft face. This may seem odd but it is easily explained because the offset bevel at the sheer on the fwd face of the frame is narrower than the aft face so the sheer height is nearer the centreline and has thus 'climbed' up the camber of the foredeck.

4.3.6 Join the bevel points with a batten as usual.

4.3.7 Now plane and spokeshave the edges of the frame so that they match the bevels. Try not to take any material off the existing larger face. To help prevent this, run a pencil line around the edge of the frame about 2mm away from the larger face. As you are cleaning the edge off, make sure this line remains visible until the last few strokes of the plane or spokeshave.

4.4 Cutting the notches

4.4.1 The backbone fits into a notch in the frame.

4.4.2 Mark this to the height given on the drawing (104mm). Mark the width of the notch 75mm each side of the centreline. Cut the notch out. Then bevel the base of the notch off the fwd face - the bevel will be the same amount as the rebate bevel (2mm)

4.4.3 Mark and cut the notch for the shelf. When marking this check to see if the hull/deck angle is greater than 90º or not. If it is then measure in the thickness of the shelf (15mm) first and then measure the height (50mm) down this line and square out. If the angle is 90º or less, then the height can be measured down the outside of the hull and squared in. There is a detail drawing of marking out the shelf notch on each frame drawing and this should show the appropriate method for the deck angle of the particular frame. On this frame the hull/deck angle is greater than 90º.

4.4.4 The bevel on the inner 50mm face of the notch will be the same as the sheer offset bevel (12mm off the fwd face). The bevel on the base of the notch will be the same as the sheer height bevel (3mm off the aft face) so be careful when marking out the depth of the notch to allow for taking the bevel off the aft face.

4.4.5 The other various notches are cut later on when the superstructure is built. The drain limbers can however be cut now. .

4.5 Finishing the frame

4.5.1 Sand the frame up smooth and clean off the pencil lines

4.5.2 Run a trimmer around the inside corners of the frame using an approx 5mm radius rounding off cutter (or a flat chamfering cutter if you prefer). Have a definite policy about radiusing. Finish the radius (or chamfer) a regular amount in from inside corners (where the frame meets the floor for example). Between 15mm and 20mm is about right - but stick to a single measurement throughout the boat. We call this type of radius a 'stop radius' - or a 'stop chamfer', if you are using a chamfer rather than a radius. Don't radius in way of the front coaming on the aft face. Don't radius the top of the floor - just a good sharp sand to a pencil radius is all that is needed..

4.5.3 WEST the frame so that all parts have had two coats - but the outer edges or any edge to which future components will be bonded, just one coat. WEST inside the limbers at least three coats as these will be difficult to get access to once the hull is planked. Sand the frame again smooth and matt finish.

4.5.4 Lay the frame back on the setting-out floor so that it matches its outline and transfer the centreline and dwl back on to the frame (marked lightly in pencil; you can stick a piece of masking tape top and bottom and pencil on this if preferred).

4.5.5 Label the frame, label the aft face and store the frame until required. Store the frame carefully so that it does not become twisted.

4.5.6 We have discussed the making and finishing of this frame in detail; from now on we shall discuss principally matters peculiar to each frame, rather than repeating the same detail frame by frame.

SECTION 5 - FRAME –1375

5.1 Making & finishing the frame.

5.1.1 This frame is in the coachroof and these frames are really rather easier to make than the one-piece ring frame under the foredeck. The laminated parts are in three sections - two hull/deck sections and a single roof section.

5.1.2 This is also the mast frame so it has bigger scantlings that the other frames - 30 sided instead of 25 & 42 moulded instead of 36. You will need deeper blocks on the setting-out floor to laminate to and you will also need larger cramping pieces so that the cramping pressure is applied evenly over the lamination. Remember that you will need to make your laminates wider for this frame - say 35mm to allow 5mm for cleaning up. If from the first laminated frame you found that 5mm was more than sufficient cleaning up allowance, then you can adjust downwards to a lesser amount.

5.1.3 Mark out the complete frame on the setting-out floor, using always the larger offsets as before. Join the marks with a batten. Mark the corner radii at the sheer edge and the roof edge. Screw blocks to the floor as before. allow for extra length inboard on the deck section and downwards on the roof section, so that you have plenty of material in the final laminations for cutting and fitting the sections together.

5.1.4 Laminate up the two hull/deck sections generally as you did for the first frame. Laminate up the roof section in one piece.

5.1.5 Clean the laminated sections up and side off to 30mm.

5.1.6 Check the sections against their outline on the floor. Cut the bottoms of the hull sections off to a vertical join on the centreline.

5.1.7 The ends of the coachroof section are tenoned into the tops of the hull/deck sections. The mortise & tenon dimensions are not too vital - say 22 long x 20 deep x 10 wide. If you prefer you can half joint the sections together rather than mortise & tenon.

5.1.8 Lay the roof section on the floor and mark the line of the sidedeck on it each side. Set-out and cut the tenons.

5.1.9 Lay the hull/deck sections accurately on their outline on the floor and set the roof section on top, again accurately on its outline. You can sit it on small blocks so that it is parallel to the floor with the tenons resting in the hull/deck sections. Mark the mortise positions. Remove the hull/deck sections from the floor and chop out the mortises. leave the inner ends long for the moment.

5.1.10 Assemble the three sections together on the setting-out floor and check that they accurately match the outline on the setting-out floor. Make any adjustments as necessary.

5.1.11 Mark the underside of the coachroof section at the centreline (in way of the mast post).

5.1.12 Mark and make the 30 thick floor in the same way as you did for the previous frame (laying it under the hull/deck sections to mark its shape etc.).

5.1.13 Get the material out for the mast post. Lay this on the setting-out floor and mark the top and bottom ends (let the bottom end run down to the rebate height). Also mark the slot depths (top of floor and underside of coachroof beam). Mark these as accurately as possible so that the post is a tight fit under the beam and down on to the floor in order to take the mast compression loads.

5.1.14 Mark & cut the slots top and bottom of the post. To cut a slot like this, drill through each bottom corner with, say, a 10 spade bit. Bandsaw down the slot to the holes keeping as accurately as possible. Cut across the base of the slot with a jig saw (you may need an extra-long blade for this - these are available for most jig saws). If your jig saw won't tackle 50mm material, then mark out and drill a series of holes across the base (keeping them just far enough apart so that the drill doesn't wander into a previous hole). Finally chop the material out with a good sharp paring chisel. Chop from both sides so that the timber doesn't splinter out. Clean the slots out so that they are a slide fit over the floor and beam.

5.1.15 Assemble the whole frame, floor and post on the setting-out floor to make sure it fits together correctly and matches its outline on the setting-out floor. Because of the mast post size, you will need to set the other components on 10mm spacers on the setting-out floor, so the whole thing sits level and flat. Make any adjustments necessary. Screw extra blocks to the setting-out floor so that the components can be held together firmly and held in place correctly when the assembly is bonded together. If by mistake the mast post has ended up a sloppy fit between the beam and the floor, correct this by bonding a solid timber slip on top of the floor in way of the post.

5.1.16 Bond the frame assembly together, wetting out all bonding surfaces first as usual. Leave for the WEST to go off hard then remove from the floor and clean up, Cut the excess material off the inside deck ends.

5.1.17 Mark the bevels as described for the previous frame and then bevel the outside edges as before.

5.1.18 Cut the shelf notches and bevel them as usual.

5.1.11 Cut the backbone notch and bevel the base. Cut the limbers.

5.1.12 Sand the frame smooth; radius (or chamfer) the inner corners and pencil radius the floor edges. WEST the frame two coats - but just one coat on the outer edges. Mark the centreline and the dwl. Label the frame, label the aft face and store the frame until required.

SECTION 6 - FRAME –2035

6.1 Making & finishing the frame.

6.1.1 This is back to the "standard" scantlings - 25 sided x 36 moulded. Start to check the Table of Offsets very carefully now as soon the bevels may start to change to different faces.

6.1.2 It is made, assembled and finished just like Frame –1375 (but no mast post).

6.1.3 Bevel the frame edges as usual. Cut and bevel the shelf and backbone notches. Cut the limbers.

6.1.4 Sand the frame smooth; radius (or chamfer) the inner corners - but not across the floor (just rub the sharp edges off) because the sole will sit down directly on to the floor tops. WEST the frame two coats - but just one coat on the outer edges. WEST the limbers three coats.

6.1.5 Mark the centreline and the dwl. Label the frame, label the aft face and store the frame until required

SECTION 7 - FRAME –2695

7.1 Making & finishing the frame.

7.1.1 This frame contains the aft main bulkhead which forms the aft end of the coachroof and the front of the cockpit. Note that we have turned around in the boat and we are now standing fwd looking aft - looking at the fwd faces of the frames instead of the aft faces. This is because the bevels will mostly have changed by now so that the aft face is mostly the smaller - and by convention we usually like to draw the frames looking at the larger face, unless there is some specific detail we want to show on the smaller face. When drawing the frame out check the Table of Offsets very carefully to see which are the larger and smaller faces.

7.1.2 The frame is recessed down to 16mm siding in way of the 9mm bulkhead.

7.1.3 A 60 x 20 beam (beam ‘A’ on the drawing) runs across the frame to take the bottom edge of the bulkhead and also to carry the cockpit seat and bridgedeck top ply. The beam is tenoned into the frame hull components. The detail on the drawing shows the profile shape of the beam.

7.1.4 The bulkhead can be 9mm ply (with the grain vertical). Make a vertical join on the centreline. This can be a simple butt join WEST bonded. It will be further supported and covered later on by the companionway trim.

7.1.5 If the exterior of the coachroof is to be clear finished, it would be preferable to make the bulkhead from 6mm ply with 3mm Khaya veneers laminated on the outside to make up the 9mm thickness. The reason for this is that the coachroof coamings and trim are all solid mahogany and once exposed to sunlight, solid timbers fade differently to ply so after about 12 months the two will look very different in colouration. We can get over

this by laminating on the 3mm Khaya (Khaya is African Mahogany - the same species that we specify for the coamings etc.), which will then retain much the same colouration over the years as the solid timber

7.1.6 To veneer the bulkhead, select nice looking veneer pieces from the khaya stock veneers (for the laminated frames). Usually you can select veneers that are cut one after the other so they will look 'matched'. Saw the veneers to a chosen width - usually best to be between 150 & 200mm. If you are using a fine toothed circular saw (preferably tungsten carbide tipped) then the sawn edges will butt closely without any further fitting.

7.1.7 As usual, have a dry run before applying any WEST. You may find it useful to drive a few staples near the edges to stop the veneers sliding about on the ply. So make both play and veneers a bit oversize to allow for stapled areas to be cut off.

7.1.8 Lay the ply on a flat surface. It's probably easier to veneer the two sections of ply separately and make the centreline join afterwards. Select the first two or three veneers and lay them on the ply. Check that the edges fit well. The tape the joins tightly together with masking tape. Mark the last veneer edge on the ply (so you know the area of ply to WEST). Turn the veneers over and wet out both their bonding surface and the ply bonding surface; sufficient WEST will get down the veneer joins. Then spread WEST/#403 (thin mayonnaise consistency) evenly over the ply. Lay the veneers in place. Smooth over the veneers (a tile grouting spatula or similar is ideal for this) to expel any air or excess WEST. Smooth down the length of the veneers, not across them or else you may pull the joins apart. Cover with a piece of polythene and then a piece of 12mm ply. Weight the ply down over the veneers, making the weights as evenly spread as possible. Clean off excess WEST, especially from the edge where the next batch of veneers is to go. Allow to cure as usual. Repeat the process with the next batch of veneers.

7.1.9 When the whole of the ply section is veneered, sand the surface off smooth (use a belt sander or preferably an oscillating sander but not a disc sander)

7.1.10 Laminate up the two hull frame sections as usual.

7.1.11 Make the floor as usual.

7.1.12 Make the beam 'A'. We show the rebate for the bulkhead ply bevelled off on the base - so that the bottom edge of the ply will also be bevelled off to suit - but this is not entirely necessary and can be omitted if you prefer, with just a simple square rebate. Fit the ends of the beam tenoned into the laminated hull sections; make the tenons about 30 long x 20 deep x 12 wide. Keep the tenons towards the bottom of the beam below the rebate for the ply. Cut the housing for the bulkhead in the top of the hull sections.

7.1.13 Assemble the frame hull sections, beam & floor on the setting-out floor so that they match the outline on the setting-out floor. Then bond these components together.

7.1.14 Lay the ply for the bulkhead over the grid on the setting-out floor and transfer the vertical centreline and the appropriate buttocks from the setting-out floor on to the ply. Mark these very lightly on the ply as heavy marks will be difficult to sand out later on, especially if the frame is to be clear finished. Mark the bulkhead out as usual, cut to shape and fit it to its outline on the setting-out floor.

7.1.15 Bond the bulkhead to the frame and beam 'A', making sure as usual that the whole assembly matches its outline on the setting-out floor.

7.1.16 Laminate up the coachroof beam and clean up to 16 sided. Make the deck beams and the coachroof side stiffeners - all can be solid timber and are 16 sided.

7.1.17 Fit the beam and the solid stiffeners to the bulkhead. Because they are all bonded to the bulkhead there is no need for tenon joints - just simple butts and mitres as shown on the drawing. Bond these components to the ply.

7.1.18 Clean up the whole frame and bevel the edges. Check the Table of Offsets very carefully to see which are the larger and smaller faces. Cut and bevel the shelf and backbone notches. As usual, the limbers are best left until after the backbone is fitted later on.

7.1.19 Cut the 48mm wide slot through the bottom of the frame for the centrecase. Then join the frame together again temporarily with a length of ply screwed each side across the slot. Sandwich a piece of polythene between the frame and the temporary strips of ply so that the ply cannot get bonded to the frame as building proceeds. When the ply is removed, remember to WEST fill the screw holes

7.1.20 Sand the frame smooth; radius (or chamfer) the inner corners - but not across the floor (just rub off the sharp edges). WEST the frame two coats and the outer edges one coat. Mark the centreline and the dwl. Label the frame, label the aft face and store the frame until required.

SECTION 8 - FRAME –3695

8.1 Making & finishing the frame.

8.1.1 This frame is in way of the cockpit. The sidedeck part of the frame continues inboard to butt against the outboard face of the cockpit coaming.

8.1.2 The basic cockpit structures and dimensions are shown on the frame drawing so that you have a general idea of what is happening and how the cockpit will be put together. The frame itself is however very simple - just the two hull/deck sections and the floor section.

8.1.3 Laminate the hull sections as usual and make and fit the floor section; bond the components together so that they match their outline on the setting-out floor.

8.1.4 Clean the frame up and bevel the edges. Note that some of the bevels are given on the drawing rather than in the Table of Offsets.

8.1.5 Cut and bevel the shelf & backbone notches.

8.1.6 Sand the frame smooth; radius (or chamfer) the inner corners - but not across the floor (just rub off the sharp edges). WEST the frame two coats and the outer edges one coat. Mark the centreline and the dwl.

8.1.7 Fit a temporary cross bar just under the shelf notches on the fwd face. This will hold the frame in shape until after the hull is planked. Put polythene under the temporary cross bar so that it doesn't get bonded to the frame by mistake from drips of WEST etc.

8.1.8 Label the frame, label the aft face and store the frame until required.

END