The Shrike Build Manual

Revised 3rd December 2021

Full size Shrike

Rolling Shrike-R:

Version 1.2

Contents

A Shrike Too, an ocean cockpit version

Reasons for the Shrike project

This manual describes a lightweight sea kayak design for stitch and glue plywood construction. The design can be simply adapted to the size and shape of the intending paddler. The reasons for the project are:

1. There is enormous satisfaction in building a kayak and using it to travel our beautiful waters.
2. For a significant number of people, modern sea kayaks have become too heavy and/or too expensive. Our roto-moulded plastic double kayak weighs 44kg (97 pounds) when empty, and cost £2000. Single fibreglass new sea kayaks frequently weigh over 27 kg (60 pounds), and cost upwards of £2,500. The weight of these craft is such that many people are unable, either through limitations of strength, disabilities, injuries or age, to place them on the roof of a motor vehicle, the normal mode of transport, or to carry them up a landing beach or slipway. Weight and price are important aspects that exclude many people from fully partaking in this wonderful pastime.
3. Paddlers have differing preferences for shape, size and height of the cockpit. Commercially available kayaks may not meet these individual preferences.
4. The young people we meet have little opportunity for learning practical skills. The described construction should be within the capabilities of enthusiastic young teenagers.

Intentions of the project:

To produce a sea kayak for day trips that is:

1. Half the weight of many commercially available sea kayaks. She weighs 14.5 kg (32 pounds)
2. Elegant and beautiful, to produce pride of ownership.
3. A serious sea kayak, so that it is a craft for life, not one adapted for novices on flat water.
4. Simply constructed at low cost by an amateur with very few wood-working skills. (The prototype cost £320 in 2014, using the highest quality materials. This cost includes over £50 in delivery charges)
5. Constructed from three sheets of 3mm (1/8th inch) BSS 1088 marine plywood and epoxy resin, using "stitch & glue" construction.
6. Constructed from full-size plan drawings of all panels, available from a digital download free of charge from our website www.cnckayaks.com
7. Able to be simply adapted to cope with some variations in the size, weight, strength, preferences, and disabilities of paddlers.
8. A combination of traditional West Greenland hull design with the advantages of modern developments, e.g. bulkheads, hatches, keyhole or ocean cockpit and an optional skeg.

Dimensions

Length ……………………..5.304m (17 feet 4.8 inches)
Beam ………………………. 0.546m (21.5 inches)
Cockpit internally……… 0.827m long x 0.394m wide (32.5" x 15.5") (These dimensions can be varied to suit.)
Clearance height, keel to underside of foredeck at front of cockpit……… 0.318m (12.5") (This can be reduced to suit.)
Keel to top of rear rim of cockpit………………….. 0.229m (9") (This can be varied to suit)
Weight………………………. 14.5kg (32 pounds) for the full-size Shrike with skeg and hatches fitted.

About the design

There is nothing original in this design, but its implementation enables the deck and cockpit shapes to be radically varied with great simplicity. This simplicity is obtained by installing a one-piece compound curved foredeck and fitting simple flush plastic hatches throughout.
The hull lines are based on information gained from the books listed later in this manual. In particular, Shrike closely resembles the West Greenland Disko Bay kayak collected in 1927/8 and now at the Canadian Museum of Civilization in Ottowa. It is design 65 in Harvey Golden's superb 2006 book "Kayaks of Greenland".
These classic and beautiful lines, the result of centuries of development, produce a hull that is manoeuvrable, and suited to rough water. The Greenland hull is here combined with the best of modern sea kayak construction:

Bulkheads to increase safety by reducing the flooded volume of the cockpit more efficiently than inflatable bags.

A keyhole cockpit to ease entry and exit, particularly on beaches in rough seas.

Epoxy stitch and glue plywood construction to produce a light and strong structure with high durability.

Hatches to give access to dry stowage for equipment

Optional Ocean cockpit

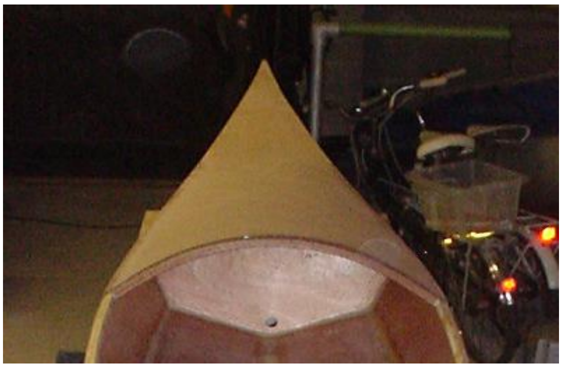
A lifting skeg to produce better tracking when the wind is off the bow.

Possible variations from the standard design

You are now able to create your Shrike to suit your weight and the weight of any equipment, your leg length, your preferred height of the front of the cockpit, the height of the decks above the water (freeboard), your preferred shape and size of the cockpit, the layout of deck hatches, and several other parameters as now described:

Choose the clearance height at the front of the cockpit

(under the foredeck beam, named the masik by the Inuit) to the owner's preference and desired knee height when paddling. This is achieved by changing the shape of the masik and the top of the foot bulkhead. Shrike has a 317mm (12.5") clearance (left hand picture below). The second Shrike, Shrike Too, has a clearance of 267mm (10.5") (right hand picture below). This creates a longer flat section of foredeck at the bow, enabling the fitting of a larger forehatch, if desired. The clearance should not be increased beyond 317mm (12.5") as this would risk splitting the plywood. Shrike was designed to accommodate a wide variety of paddlers who might wish to test paddle the kayak. A common preference is for 292mm (11.5"). Builders with access to another kayak which seems comfortable can measure the clearance and use that measurement for building the masik. The plans provide the masik shapes for a selection of clearance heights.
Bear in mind that your feet will need to fit on the bulkhead. More on this later.



Choose the length and width of the cockpit, from Keyhole to Ocean

to suit the physique and preference of the owner. A keyhole cockpit is shown in the right hand photo and an ocean cockpit is shown in the left hand photo. The length of the cockpit should only be adjusted by maintaining the position of the rear of the cockpit, and changing the length from that point forward. The position of the centre of the seat should not be changed. In such a light kayak, the position of the paddler's weight is particularly critical.
The first Shrike's keyhole cockpit has proven to be a little narrow for some paddler's comfort, so increasing the width from 393mm (15.5") to 419mm (16.5") would be a reasonable average figure. The plans will adapt to your desired width.

Vary the design to suit the weight of the paddler and the total planned maximum load.

This can be achieved in two ways. First, Low Volume (LV) or High Volume (HV) designs can be created by varying the printer instructions to produce paper plans at any scale between 90% (LV) and 110% (HV). The first Shrike LV (90%) is described under the "kayaks" tab at www.cnckayak.com. A graph of printer output % related to total planned load is in the FAQ section as the answer to the first question. Producing a design in this way scales the underwater sections, thereby creating a genuine "LV".
The second way to adapt the design is to adjust the freeboard (the height of the sides). This preserves the full 100% Shrike hull. The Shrike-R, a specialized rolling variant, was produced by lowering the freeboard 60mm.
These two methods could be combined. The plans show the lines for a range of freeboards.

Lower or raise the freeboard (height of the deck above the waterline) by 1 cm (0.4") for each 15 kg (33pounds) below or above 80 kg (176 pounds) total load.

This photo is of Shrike with a total load of 82kg (180 pounds) and standard freeboard:

Whereas this is the Shrike with a load of 91kg (200 pounds) and standard freeboard:

Choose clear finish or painted. Clear varnished finish over epoxy coating is easier to maintain than paint, but requires more care to protect the panels from marks and scratches during construction. Here's the Shrike Too with a clear finish:

Choose the position of the foot bulkhead to suit your leg length. The basic Shrike plans give 100mm (4") clearance beyond the feet of this 1.83m (6 feet) tall male. Moving this bulkhead will entail a slight adjustment of the bulkhead template in the plans. More simply, the bulkhead can stay in position, and any space filled with a foam footrest.

Choose to fit hatches or no hatches. The prototype Shrike in the photographs was designed as a light-duty day cruiser, so no fore hatch is fitted. There is a hatch in the foot bulkhead. A small fore hatch could be fitted well forward, on the flat section of deck. A larger fore hatch can be fitted if the masik is lowered, as described above. For day trips, the day compartment provides adequate stowage, and no fore hatch is necessary. The stern compartment hatch is required for access for maintenance if the optional skeg is fitted. The day hatch is the small disc immediately behind the cockpit. A day compartment is very useful for keeping small items together, especially on day trips, when these items are all that are carried.

The Shrike Too, with its lower foredeck, has sufficient room to allow a 200mm (8”) hatch in the foredeck, allowing easy access to enough storage for multiday camping trips

Skeg or no skeg. (Rope or wire adjusted lifting skeg or no skeg.) A skeg adds weight, complexity and expense, but helps to avoid strain on upper limb joints when dealing with strong winds from off the bow. We recommend a wire operated lifting skeg.

Light duty, or heavy duty to cope with rocks and beaches. Shrike was constructed to be light weight for ease of transporting, and for light duty paddling, rather than rock-hopping and landing on harsh beaches in rough conditions. However, the Shrike has taken some scrapes from submerged rocks and rough beaches, and a lick of paint is all that has been required. For extra resistance to penetration from collisions from rocks, the **inside** of the hull can be coated with glass fibre woven cloth. For extra resistance to abrasion from rocks and beach landings, the **outside** of the hull can be similarly coated. Any extra glass coating beyond the cockpit floor and coaming top will have a weight penalty, beyond the 14.5kg (32 pounds) of the prototype. The hull could be constructed from 4mm plywood, with greater puncture resistance than the 3mm we have used, but again with a weight penalty. The decks should stay at 3mm to enable the extensive double curvature required. If this option is taken, the design requires two sheets of 4mm and one sheet of 3mm plywood, instead of three sheets of 3mm.

Costs

Build a Shrike not to save money, but to obtain a lightweight kayak fitted to your needs, while gaining immense satisfaction from constructing and paddling your own sea kayak.
In 2013 the prototype Shrike, in the photos, the cost about £320, including over £50 of delivery charges. We already had various materials, such as trash timber and plywood for temporary forms, softwood for sheer clamps (inner gunwales), superglue, disposable brushes, webbing tape and line for deck outfitting, a workbench, a full complement of hand and power tools, disposable gloves, etc. Costs, in pounds Sterling were:

Three 2440mm x 1220mm (8ft x 4ft) sheets of 3mm thick Robbins Elite BSS 1088 marine plywood	£130
4 kg epoxy resin and hardener (Probably 6kg are required if panels are coated with glass cloth.)	£69
50m of 50mm wide woven fibreglass tape	£17
West filler and fairing powders	£10

Rollers and brushes	£10
Glass cloth for cockpit floor and cockpit coaming top surface	£3
Paint	£6
Minicell foam for seat and backrest	£20
Hatches	£25
Skeg slider (also known as a glide box) and wire, tube and brass compression fitting from Kari-Tek.	£30
	Total = £320

Estimated time to build

Professional wood-workers could probably complete the construction in a week, plus painting or varnishing. Enthusiasts with little or no previous experience could spend a very happy winter of spare time, lovingly creating their kayak, and taking 100 hours to complete the kayak. The enthusiast can produce as fine a finished result as the professional. It will just take a lot more time; especially thinking time.

Essential reading

It is advisable to read this entire Build Manual, including the Builders' Tips and Frequently Asked Questions Appendices before starting to build. The Builders' Tips Appendix expands on certain points and gives further options which you may wish to consider.

Preparatory Work

"Cut the crap and just build the boat!" is a good plan, but first we need a suitable place to work, some materials, and a few tools. Here are some suggestions:

Workshop

The minimum building platform must support rigidly the two external hull forms, 1270mm apart, parallel and horizontal, at a comfortable working height:

At a minimum, the two forms could be attached rigidly to two fixed trestles. They **could** be fixed direct to a floor, as an efficient way to destroy your knees and back during the construction!
We used a pair of trestles, and laid one section of an aluminium ladder across them as a rigid base for a worktop. An 18mm plywood top, 1300mm x 600 mm would be good. Ours is unnecessarily long at 4880mm x 610mm (16 ft x 2 ft), prepared from a sheet of 18mm shuttering plywood ripped down the centre.
A trash bin at each end of the kayak saves a lot of walking
A tidy shop is a safer shop. A vacuum cleaner is good inside the hull, and for keeping the floor clean.
Good lighting is essential. Bright neon ceiling tubes are good.
A portable workbench, e.g. Black & Decker Workmate type, is good for cutting and mixing.

Tools

Steel metric measuring tape, at least 6m (18feet) long
Steel metric rulers, one 1m long, one about 300mm long
Small block plane with sharpening stone
Electric jig saw with fine wood-cutting blades or fine panel hand saw
Electric drill with drill bits and screw driver bits.
Spirit levels, one at least 600mm long, and one about 150 mm.
Utility knife (e.g. Stanley knife) with many spare blades
Adjustable sliding bevel
At least five long kayak securing straps for fitting the foredeck for gluing.
4" (100mm) gloss paint disposable rollers.

Optional tools:
Hot glue gun with wood adhesive sticks
Electric staple gun and stainless-steel staples. We used Arrow T50 10mm ($3/8^{th}$ inch) staples.
Vacuum cleaner for cleaning inside the hull

Materials Used

Three sheets of 3mm (1/8 inch) quality waterproof plywood (BSS 1088 marine is best).
Elite marine plywood from Robbins of Bristol, UK or Fyneboats, UK is excellent.
Sheer clamps: two 6 metre lengths of softwood 25 x 25 mm, or scarf shorter lengths. (see P.14 for 25 x 15 option)
3 to 6 kg of slow-curing low odour epoxy resin and hardener, the quantity depending on whether or not the hull and deck are glassed. We used 4 kg of Professional Systems Epoxy. We now use MAS low viscosity epoxy with the slow hardener. 50m of 50mm wide glass fibre tape 175 gsm
2 square metres of 300 gsm woven glass fibre cloth for the cockpit lip top, and the cockpit floor.
If desired, hulls are usually sheathed with woven glass cloth of 200gm/sq. m (6 ounces/sq.yd), but we prefer to use twill weave cloth 163 gsm as it adapts very easily to shapes, particularly at the bow and stern.
Disposable gloves - box of 100
20m of copper wire for stitching, approx. 1.2mm diameter. However, we now use CA glue with accelerator instead of wires, other than a couple at bow and stern, together with pieces of adhesive tape.
Many disposable cups for mixing, e.g. used yoghurt pots
Disposable cheap 25mm (1”) paint brushes. At least 20.
Tongue depressor mixing sticks for shaping epoxy fillets.
Thick plastic sheet is useful for preventing epoxy adhering to the workbench.
Hand wipes (We’ve used Ever-Build Multi-use Wonder Wipes in the UK)
Rags and paper towel roll
Paint or polyurethane varnish to protect epoxy from ultra-violet light
Optional: Super-glue with accelerator. Evo-Stik Mitre adhesive in the UK and E-Z bond in USA have worked for me.
We use Smart Weigh scales for measuring out the resin and hardener. These are low cost and excellent.

Epoxy for beginners

Stellar advice on epoxy and safe workshop practice is available on the CLC website, but a few thoughts from me:
Mix only small batches of epoxy. It’s heavy, and a little goes a long way.
Epoxy coat the panels using firm foam rollers, and tip off with a brush or a piece of roller held in the hand. These produce a result that is far more even and economical in epoxy than any brush. **Do not apply the resin when the temperature is increasing. This would cause bubbles to form.**
Only use acetone or other solvents to clean epoxy from tools, workbench and hull, if the brand of epoxy is compatible with that solvent. (For example, Professional Systems Epoxy is NOT compatible with acetone.)
Tongue depressors produce good fillets. Hold vertical for the smallest fillet, flatter for the largest.
Beware amine blush, which forms on some brands of set epoxy after a few hours. Try to do several stages within a few hours. E.g. coat, fillet and glass tape. MAS epoxy has not suffered from amine blush in our experience.
Work as if epoxy is not gap-filling, and use that property only when your best efforts fall a little short.
Use an epoxy system with low odour, and slow initial cure to give enough time for complex tasks.
Epoxy dust can cause allergic reaction. Use overalls & long cuff disposable gloves and a dust mask when sanding.

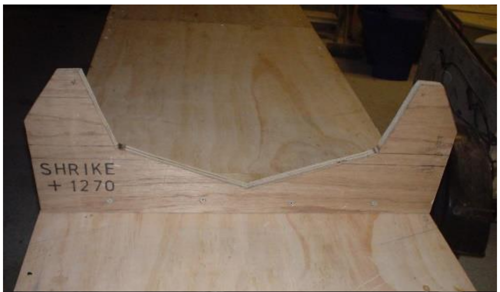
Measurements list, for later reference

All measurements for the construction are measured in millimetres from the Datum Line. This is a line drawn across the worktop, square to the long edge, and approximately 3230mm from the bow of the finished kayak.
All measurements are in mm from the Datum Line (+ means forward of Datum, - means aft of Datum)
Because the external and internal forms have a thickness, and the hull tapers, those located at +ve measurements, are placed aft of their line, and those with -ve measurements are placed forward of their line.
Aft deck beams are at -517, -700, -924 (and front of skeg box), -1133
Aft deck beams are of 12mm square cedar for lightness
Radius of curvature, R, to use a piece of string to draw a non-standard masik with beam L and height above sheer D:
R = ((L^2) + (4*(D^2))/ (8*D)   The ^ symbol means “raise to the power of”, so L^2 = L*L, where * means “multiply”.

For a standard Shrike, R = 384mm (15.1”) on beam of 546mm (21.5") and height above sheer of 114mm (4.5”), knee clearance under cockpit side deck is 317mm (12.5”) This curve is supplied in the plans.
Centre of seat is at +250 (i.e. 300mm forward of aft cockpit bulkhead). This measurement should not be changed.
One external form is at Datum, the other is at +1270mm
My foot bulkhead is at +1255
Cockpit rear bulkhead is at -50
Day compartment bulkhead is at -345
Internal forms are at +1860, +630, and -800
LOA 5300mm (17ft 4.75"), Beam 546mm (21.5")
Bow is at approx. +3230, depending on amount of rounding.
Aft end of 40mm wide masik is at +783
Internal keyhole cockpit opening cut in the deck is 833 long, from the aft end of masik to the cockpit rear bulkhead
The front of the cockpit opening is against the masik at +783. When the 3 mm thickness of the cockpit riser at both front and rear is subtracted from the 833 mm opening, the internal length of the completed cockpit is 827 mm.
Centres of the 125mm wide cheek plates are at +265

At last, we can start construction!

Making the two external forms.



These can be fabricated from any rubbish sheet material. We used 9mm plywood from my trash bin and my friends’ workshops. From the plans, instead of cutting out the paper shapes, one can prick through the paper onto the plywood with a nail or other sharp point, so as to indicate the eleven corners. These can then be joined by drawing on the plywood with a sharp pencil and a steel ruler, and the shape cut out with the jigsaw. A 50mm square batten is then screwed to the base of each external form.

Setting up the two external forms.

Draw or snap a centre line down the surface of the build platform. Select a position and draw the Datum Line across the surface at right angles to the centre. Choose the position of the Datum Line, bearing in mind that the bow of the kayak is approximately at +3230, and the kayak has to fit into your available space. (Approximately, because you can choose the degree of rounding of the stem and stern to suit your eye.) Now draw a parallel line at +1270. Screw the two external frames to the build platform at Datum and +1270, vertical and square and on the sides of the two lines further from the mid-point of the length of the kayak.

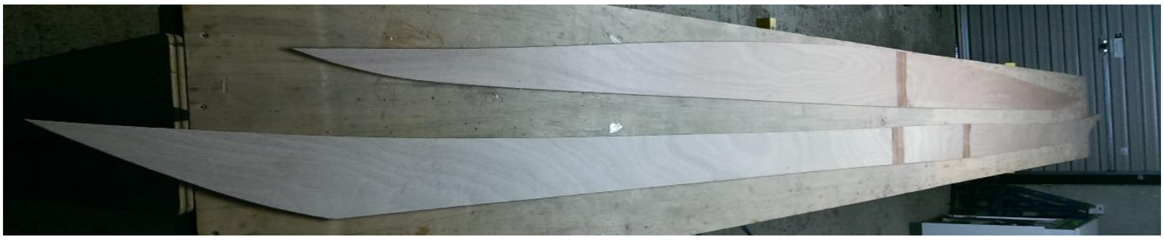
Cutting the panels

Two of the three plywood sheets are used for the four hull panels, i.e. the port and starboard bottom panels and topsides. We laid the two sheets of plywood on an aluminium ladder section on the floor, and used a Skilsaw (hand-held circular saw), to rip each sheet into 5 equal 244mm wide strips, 2440 mm long. If your kayak will be greater than 100% scale you will need to modify your cutting width.
The bottom panels are shorter than two of these strips, so they are constructed from just two full lengths of these strips of plywood. The topsides are longer, so a short length (We use 645mm) must be inserted between two full length strips to make up the length to more than 5400mm, to allow for scarf joints, if used. When cutting the plywood into strips, keep the best sheet of attractive grain for the deck. Sort the strips for colour so the topsides do not have a drastic change of colour at the joins. Match panel grain at joins where possible.
The sections can be joined with 8:1 ratio scarfs, 24mm wide, but these are difficult to create in such thin plywood, so we now only use glue and tape butted joints. These are simpler, just as strong, but may require more fairing (sanding) before varnishing or painting.

When you have dry assembled the pieces on your work surface, you must make sure the joints are touching, and stay that way while the epoxy sets. We line up the joints so that we can run one piece of tape down several joints in one go, and then lightly tap very thin nails or pins though each corner of each joint into a piece of plywood or wood beneath the joints. We place other pieces of the same thickness wood or plywood underneath the length of the panels to keep the joints level. (If your work surface is plywood or timber, just lightly nail into that.) A strip of polythene prevents the panels sticking to the baseboard.

When the epoxy has set, we cut through the tape, pull out the nails, turn the panels over, and repeat the process, but without the temporary nails. 30g of epoxy mix suffices for six joints. The next day turn the panels over and tape the other side.

When these joints are set, very carefully cut out the paper templates from the plans, and tape, staple, or spray glue these to the plywood. Draw round the templates very precisely, using a sharp pencil. Alternatively one can prick through the uncut plans with a sharp point. Long gradual curves are best marked every few centimetres, and the marks later joined up using a long flexible batten to ensure a fair curve. (We used a length of plastic conduit for electrical wires). Mark the Datum Line from the plans onto the bottom panels.
Use a jigsaw or panel saw to cut the panels just outside the perimeter line, and then use a small block plane to finish to the line. You should now have two of each of these panels. Put the pairs of panels on top of each other and ensure they're identical.



Assembling the hull panels

We now use CA adhesive with accelerator, and adhesive tape to join the hull panels, but if this your first plywood kayak construction you may wish to *"Clamp the two shorter bottom panels symmetrically on top of each other, and drill clearance holes for your copper wire (or) along the straighter side (keel) every 100mm, about 6mm in from the edge, through both panels, thus ensuring that the holes line up opposite each other for wiring. Joining these two edges will produce the keel line."*
Now the exciting bit, which you deserve after all that preparation:
Plane or sand a bevel on the top mating edges of the bottom panels at the keel and at the chines, and on the lower edge of the topsides. This will assist in keeping the joined edges from sliding off each other. A couple of passes with a block plane or 80 grit sandpaper should be enough.

Loosely wire (or adhesive tape) together the two keel straighter sides of the bottom panels, with the bevels upwards. Place the joined bottom panels into the external frames (remembering which is the bow), and start to open up the two bottom panels, like a butterfly opening its wings. If necessary, loosen some wires to ease this procedure. Align the Datum marks on the bottom panel edges with the Datum external frame. Wire the bottom panels tightly to both external forms at the outer edges (chines) and at the keel. This requires four wires on each form, with two holes in the panel and one in the frame for each wire, so 24 holes in all. Keeping these near the edges of the panels will ensure that all these holes are covered when the keel and chine joints are taped. Alternatively one can use dots of hot glue.

Now drill wiring holes along the lower, straighter, edge of the topside panels, and the stems (bows) and sterns. (or use adhesive tape, in which case loosely wire together the stems and sterns only. Spread the panels apart, and wire or tape them to the bottom panels in the external forms. Start at the stern, making a fair curved join between the bottom and topside panels, and work towards the bow, drilling and wiring or taping to the bottom panel and external frames as you go. Ensure you even out the wood at the bow and stern. In the plans we've added 6mm to the length of the topsides panels at the bow to allow trimming to shape. Do not trim the bottom panels. Remove the wires at the bow and trim carefully with the block plane to produce a graceful fair joint between the bottom and topside panels. Then replace the wires.

Now cut out from scrap plywood the three internal forms to be stationed at +1860, +630, and -800, and wire or hot glue them vertically and square at the topsides, chines and keel, as shown here.

The sheer clamps are light softwood battens, about 25 x 25 mm in section, which fit inside the gunwales to enable the decks to be fixed down, and for deck rigging to be fitted to the finished kayak. If Maroske fittings (see Builders' Tips at www.cnckayaks.com) or our 3D printed deck fittings are used, the size of the clamps can be reduced to 25 x 15 mm. Sourcing wood sufficiently long (5.4.m) to avoid any joints makes it much easier to produce fair gunwales. With a little persistence we have now found local sources of long lengths in both the U.K and the USA. If you find it difficult to source battens that long, two lengths can be scarfed together.

Kerf sawing is the technique of assisting timber to bend by sawing part way through it.
Kerf saw the sheer clamps at bow and stern to enable the upturns to be completed without undue stress:

Now dry fit the sheer clamps with many clamps (these can be bought in bulk very cheaply from eBay or Home Depot), or using temporary round head screws if the kayak is to be painted.

Saw the sheer clamps at the stem and stern so they fit together:
The sheer clamps are fitted with the 25mm edge against the plywood. Clamp a batten across the gunwales at +600 to fix the maximum beam at 546mm (21.5"). The sheer clamps run flush to the top of the plywood when aft of the cockpit, but from there forward the sheer clamps are allowed to rise up above the plywood by up to 6mm. The 900mm nearest the bow can again be left flush to the top of the plywood, as the foredeck becomes flat from that point to the bow. The protruding part of the sheer clamps is later bevelled to accept the curved edge of the deck. Note the fillet of glue in the stem. This is where you can use up any excess thickened epoxy to strengthen the bow.

Now STOP!

This is a critical point. Any imperfections in the curves of the hull at this point will be permanent once the seams are glued and taped.
Check that the stem and stern are fair and graceful.
Check that the chines make a fair curve, with no hollows or bumps. Trim out the bumps, fill up the hollows with softwood shavings, and adjust the wires.
Check similarly that the gunwales are fair curves. Take particular care at any joint in the sheer clamps. Plane the outside of the sheer clamp scarf as necessary.
Now that the hull is held to shape at multiple points, all the minor imperfections in the plans and forms may be forced into the keel, hidden under the hull.
Release the hull from the two external forms, and gently turn it upside down on some cushioning.
Check that the keel line is a fair curve. It probably is not. If not, it must be corrected.
Panels can be partly unwired to trim a panel with a plane if it is slightly too wide. If a gap needs to be filled to create a fair curve, we slice tapers of softwood from a stick with a utility knife, and push them vertically down until they jam in the gap, about 20mm apart. We then superglue them in place, and slice off the excess of the tapered pieces after the glue has set. The gaps are then filled with thickened epoxy.
<u>If, and only if, every curve is beautiful, turn the hull right way up and re-fix it to the two external forms.</u>
Glue the sheer clamps in place with slightly thickened epoxy. If the clamps are insufficient to completely pull the plywood to the sheer clamps, back them up with stainless staples. Any staples can remain.

Dot superglue and accelerator along the inside of the chine and keel joints and stem and stern about every 25mm:
When the superglue has hardened, clip and remove all the copper wires in the keel and chine seams. An alternative to the superglue is to use small dots of thickened epoxy, but this could take a day to harden before the next stage can be started.

Fit the bulkheads.

Cut out the bulkheads to the plan dimensions from the 3mm plywood using a utility knife (or jigsaw and plane), and notch the top corners to fit round the sheer clamps. We find that four passes of a utility knife blade will cut through the plywood. Make the first pass very light, so as to guide the later passes. This helps a wayward blade from slicing the top off a finger. **Adjust the height of the foot bulkhead to suit your feet size. Try standing on the drawing.**
If desired, use a hole saw on the bench to create a hole for a drain plug at the lowest point of the bulkhead. If no forehatch is to be fitted, cut a hole for a watertight access hatch in the centre of this bulkhead, to assist in drying out the forward compartment in case of leaks through, for example, the drain plug. Dry fit the bulkheads vertically and square at their positions and then superglue or wire them in place:

Aft cockpit bulkhead at -50
Day hatch bulkhead at -345
Foot bulkhead at +1255 (Do not fit this bulkhead at this stage if you are changing the foredeck height by varying the curve of the masik, or adjusting its position to suit your leg length.) The top of this bulkhead should be thickened with two strips of curved plywood to make a wider gluing area when the foredeck is fitted.

The three internal forms can now be removed. If the beam changes when an internal form is removed, replace it, clamp or screw a temporary batten across at that position, and then remove the internal form. Keep the temporary beam clamped at +600, the point of maximum beam. Now you are ready to epoxy fillet and tape the seams.

Epoxy filleting the seams.

Place neat epoxy fillets along the entire inner keel and chine seams, around the bulkheads, and up the inside of the stem and stern.
Epoxy fillets can be a ghastly mess or an elegant source of pride. Masking tape can be used if desired. We use wood mixing sticks (tongue depressors) to shape the epoxy, thickened to peanut butter consistency with West 406 colloidal silica. For narrow fillets, such as those around bulkheads, the stick is held at 90 degrees to the joint. For wider fillets, the stick is angled, or a piece of plastic sheet can be curved to serve as a shaper. We always pre-wet with unthickened resin the plywood surfaces where the fillets will be placed. The fillets must now be taped.

Taping the filleted seams

We tape the keel and chine fillets, and those around the foot bulkhead, but not those around the other two bulkheads, as they are comparatively lightly stressed. We use 50mm wide woven glass fibre 175 gm tape, with two layers along the keel.

The fresh fillets are very soft and vulnerable. If the glass tape is immediately placed on the wet fillets it is all too easy to dent the fillets with the fingers or brush. Once the fillets are dented under the tape we've been quite unable to flatten the surface. One option is to be very, very careful. Another option is to leave the fillets for a couple of hours until they are less vulnerable, but before the dreaded "amine blush" coats the surface of the epoxy. Then wet the fillets with resin and lay in the glass tape.

Another method of causing fewer disturbances to soft fillets is to pre-soak glass tape on the work bench before applying it to the epoxy fillets.

When cutting dry glass tape, make a half inch cut into the centre of each end to prevent unravelling

When wetting out glass cloth and tape, only use enough resin to make the tape clear. More will not be stronger. Epoxy resin is heavy, and it only gains full strength when glass fibres are added.

After the fillets are completed we coat the entire inner surface of the hull with resin where it has not already been coated during the filleting and taping.

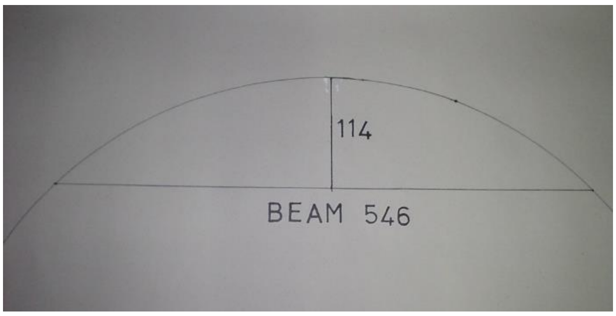
Glassing inside the cockpit

Now is the time to cover the floor of the cockpit with glass cloth. This adds to the impact resistance of this vulnerable area, and protects the floor from grit and sand on the paddler's feet. We used 300g/sq. metre woven cloth as that was easily available. 200g would be lighter, it would take up less of the heavy resin, and it could be the same material you might use if you decide to glass the outside of the hull. Pre-wet the plywood with the minimum resin, lay in the cloth, pre-cut to shape, and stipple a minimum of resin into the cloth to make it go clear. Trim the edges of the cloth near the chines with a utility knife when the resin is firm but not hard.

Fair, fill and tape the outside of the hull

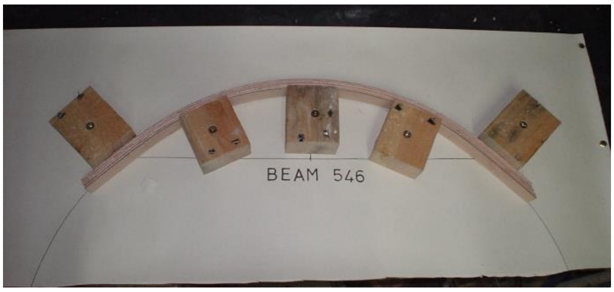
Leave the hull for a day to let all that set, release the hull from the two external forms, turn it over, and rest it on the work surface with some cushioning under the gunwales. Fill any gaps in the keel and chine seams with thickened epoxy. Ensure the stem and stern form graceful curves. Trim these with a block plane if necessary. Add thickened epoxy to the stem and stern to form a rounded cap. Let these set, and then sand a rounded edge to the stem, stern keel and chines. Now apply glass tape to the chines and keel and to the stem and stern. We put a second layer of glass tape along the main flat and vulnerable section of the keel. Snip the selvage edges of the tape to assist the curving of the tape at the stem and stern or use bias-cut strips. Turn the kayak back to upright, and place it in the external frames. One can avoid some tedious sanding of the tapes and the risk of allergy from epoxy dust by coating the entire hull inside and out with lightweight glass cloth. We use 163 gsm twill glass cloth. This drapes easily over complex shapes such as the bow and stern, and adds very little to the weight of the hull. (See Appendix A, Builders' Tips, for details of this procedure.)

Building and fitting the masik.

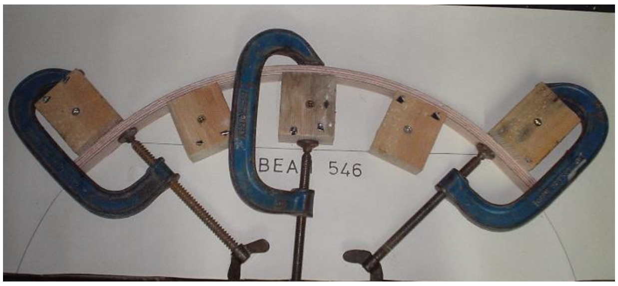


The masik is the foredeck beam at the front of the cockpit. It is the main support for the foredeck. It also sets the clearance height for the tops of your legs when paddling. Some paddlers, especially rolling enthusiasts, like a low masik. Many others would prefer a high masik. This enables the knees to be lifted, and the strain taken off tight hamstrings, the cause of many a backache when paddling. Try sitting on the floor with the legs straight out for an hour. The Shrike clearance under the masik is 315mm (12.5"). Shrike Too has a 266mm (10.5") clearance, enabling the fitting of a useful sized forehatch.

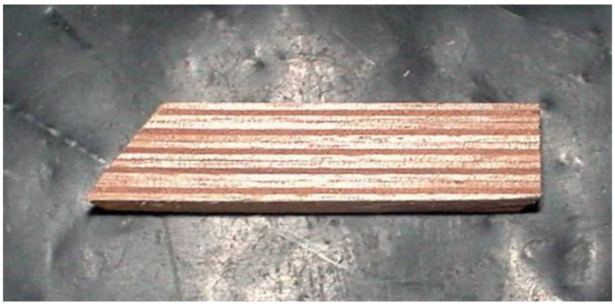
The height of the masik can be reduced by adjusting its curve, as described later. Increasing its height beyond 315mm (12.5”) risks splitting the plywood deck when it is bent round the masik. The profile of the masik is drawn in the plans for 10.5” and 12.5”. As discussed earlier, my next Shrike will have a clearance of 11.5”.



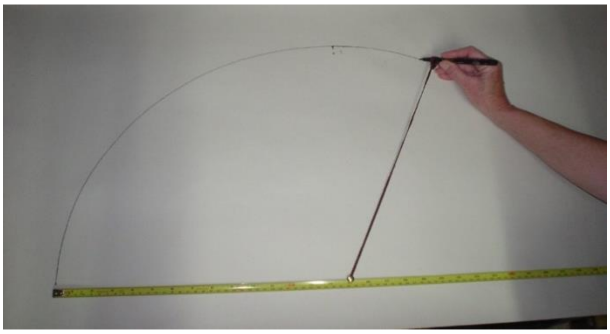
To construct the laminated masik:
Cut 5 strips of 3mm ply from your offcuts, at least 700mm long and 45mm wide, to finish down later to 40mm.
Cover a section of your workbench with thick polythene to avoid the epoxy sticking the masik to your workbench.
Cut out the full-size profile of the masik from the plans and staple or pin it to your workbench.
Screw 5 blocks of approximately 50mm thick timber to the bench, three inside the curved line, and the end two outside. Clamp the five strips temporarily over the middle three to establish the correct position of the outer two. The line from the plans shows the outside of the masik.



Now withdraw the strips, brush the inner sides of the strips with slightly thickened epoxy, replace the strips in the blocks, and clamp lightly so that glue oozes very slightly all along the masik lamination joints. We eventually used about nine clamps, but the first three are shown here:



Leave the masik to set hard, preferably for five days at room temperature, before removing it from the jig, planing the edges to a finished width of 40mm. The edge of the masik will look like this offcut:
If the masik is released after only two days, expect it to spring back about 6 to 8mm in height. There is negligible spring-back after five days.



Creating a custom masik to reduce the knee height clearance

To form a custom masik height, if the standard heights are not ideal:

The curve is part of a regular circle, to place even stress on the curved plywood.
The radius of curvature of your desired masik, R, with height above the sheer line, D, and beam of the kayak (less 6mm, the two hull plywood thicknesses) at the masik (+783), L, can be calculated from the equation:
R = ((L^2) + (4*(D^2))/(8*D) where the ^ symbol means “raise to the power of”, so L^2 = L*L, where * means “multiplied by”. Now tie a non-stretch thread round a drawing pin on some paper, and at a distance of R, roll the thread round a pencil. Draw an arc of a circle of radius R:
That is the outside profile of your modified masik. Now draw a chord of length L (beam at the masik) across the arc. Now proceed as for the construction of the standard masik.

Christopher designed Shrike Too’s deck and cockpit with his preferred options of an Ocean cockpit, a lowered foredeck, zero fastenings construction and clear finish. Description of his build is in the Shrike Too Build Options

Fitting the masik to the hull

The masik is notched into the sheer clamps with its aft edge at +783. The masik is installed square to the centre line, of course, but it is not vertical. It is fitted parallel to the sheer line at that point, by sighting across the masik at the far gunwale. We sawed and chiselled a simple 45 degree notch, 40mm wide, out of the sheer clamps. We then sawed the two ends of the masik so that they fit into the sheer clamps, just butting up to the inside edge of the plywood hull skin. We made a bad job of this, but really thick epoxy rescues the incompetent.

Glue the masik in position with temporary support from, for example, a couple of screws through the sheer clamps.

Bevelling the sheer clamps.

The decks are glued down onto the top of the sheer clamps, which must be planed to the correct angle. This angle varies throughout the length of the sheer clamps. A small sharp block plane, held at an angle, does the job.

From the stern, along the stern deck and up to the rear of the cockpit, the sheer clamps are planed horizontal, so that the flat stern deck sits straight on it. Use a steel rule across the width of the deck to check this.

From there, forwards, the angle varies to accommodate the landing angle of the tortured deck plywood. The angles at various points can be found by temporarily fitting the plywood foredeck, and measuring the angles at various points with your sliding bevel, which you can make from plywood, as shown later.

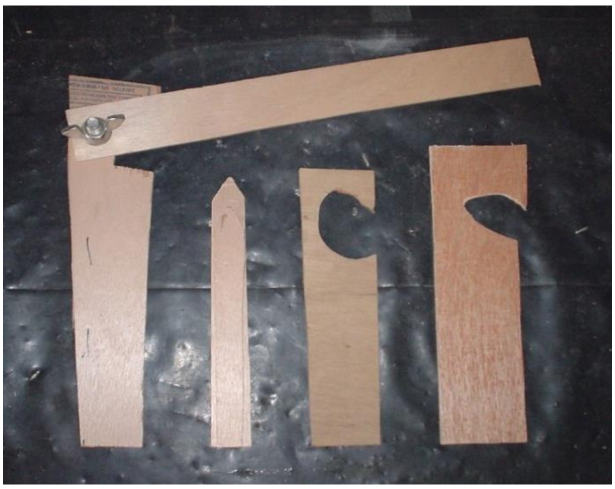
If the bevelling proves a little challenging, thickened epoxy will be your friend.

Stern deck beams

The stern deck beams are installed to suit the hatches you will fit. We fattened up the aft cockpit and day compartment bulkhead tops on the day compartment sides with cedar beams to give a larger land for gluing down the stern deck, and fitted further beams of 12mm square cedar at -517, -700, -924 (at front of skeg box),and -1133 (not shown in this photo):

We also added three fore-and-aft short beams in the day compartment area to suit the day hatch, and to strengthen this area. All the beams are notched at 45 degrees into the sheer clamps or beams, and epoxy glued into position.

Tools for fitting the decks



Before fitting the decks, it is helpful, but not essential, to make some 3mm plywood tools (left to right in the below photo) for measuring bevel angles, marking 25mm from the gunwale to guide taping, locating the edge of the topsides, and for finding the sheer clamps centre if screws are used. The bevel gauge at left has a large notch to clear the overhanging deck before it is trimmed. The next right, to mark 25mm in from the gunwale, has three layers of plywood. The top layer is 25mm back from the point of the bottom layer. The concealed middle layer is another 25mm back to allow the overhanging deck to slide into the gap between top and bottom layers. The next right transfers the position of the gunwale onto the deck to facilitate marking the deck for trimming to size by panel saw, and then block plane. The tool at far right has the same notch to clear the deck, and a beak to extend the point beyond the gunwale edge to the mid-point of the carlin (9 mm for my Shrike). This is to mark the position of any screws for attaching the deck line fittings.

Fitting the fore deck

The plans do not show the outline of the decks, as the plywood sheet can be laid over the part-built kayak, and the desired shapes transferred directly. Alternatively, use sheets of newspaper, taped together, and take a pattern from the deck area. Allow 20mm overlap on the gunwales. Cutting the panel too small would be bad news.
The foredeck is fitted before the stern deck. The full length of a plywood sheet is necessary to stretch from the centre of the masik to the bow of the kayak.

Lay the plywood sheet over the foredeck, with one short edge lying along the centre of the masik, across the kayak.
Tightly clamp the plywood at the centre of the masik in order to locate the plywood while the fitting process continues.
Use a scrap of plywood under any clamps to avoid damage to the plywood.
Bend the plywood across the masik, and clamp the plywood loosely to the ends of the masik. Bend the plywood towards the gunwales and mark a trimming line underneath the plywood so as to leave a safe margin, about 20mm, hanging over the gunwales.
Remove the plywood, cut to this line, and then replace the plywood and the clamps.
Place at least six straps around the foredeck, and gradually tighten them equally.

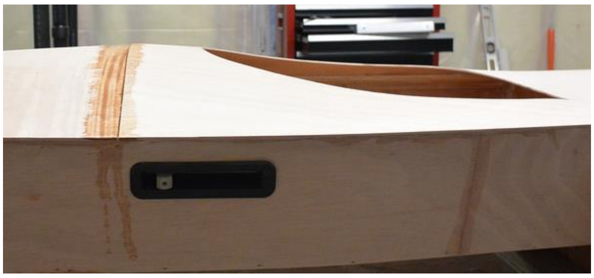
The plywood should buckle at a point about 900mm from the bow.
While doing this, check that the top of the foot bulkhead is not obstructing the bending process. Trim the top of the bulkhead if it is distorting the deck.
Before the plywood reaches the gunwales, check the size of the excess overhanging plywood. If it is more than about 10mm, it is worth trimming it a little closer, to avoid the excess plywood snapping across the gunwale as pressure is applied.
Check frequently that the plywood is lying symmetrically across the masik. The loose clamps at the ends should allow the edge of the plywood to move slightly across the masik

When the plywood reaches the gunwales, check that the plywood sits comfortably on the previously angled sheer clamps. If necessary, remove the plywood and adjust the bevel of the sheer clamps. Refit the plywood. Check that the plywood is resting closely on the masik across its entire length.
Strap a beam across the point towards the bow where the plywood buckles to ensure the buckle is even across the width of the kayak.
Mark the centre of the masik, and the centre of the plywood edge on the masik, and ensure they stay together throughout the procedure. Fit several clamps across the masik.
To show the gluing area, draw a line across the masik to mark the edge of the plywood, and mark underneath the overhanging edges of the plywood.
Slowly and evenly release the straps.
On the bench, roll a coat of epoxy resin onto the underside of the deck panel. The panel is immediately fitted. If the epoxy is allowed to harden, the panel will resist bending. Apply thickened epoxy to the top of the sheer clamps and the foot bulkhead and part of the masik, and place the panel in position, repeating the clamping and strap tightening until glue oozes all along the deck/sheer clamp joint.

Scrape off excess epoxy while it is partly set, particularly along the top of the masik. When the glue has set hard, the straps can be removed.
Turn the kayak upside down, and fillet and glass tape the joint between the top of the foot bulkhead and the underside of the foredeck.
The edges of plywood can now be trimmed back to the gunwale using a panel saw and plane, after marking the line with the third plywood tool from the left in the earlier photo.

Skeg system

As we were planning to fit a wire operated skeg, at this stage we drilled a 6mm diameter hole in the top port corners of the aft cockpit bulkhead and the day hatch bulkhead, ready to take the outer plastic tubing. We also cut the opening for the skeg slider box in the port topside panel where it would fall naturally to hand. When preparing to install the deck we epoxy resin coated the inside of these two holes and the skeg slider opening.



Here the options are wire or rope adjusted lifting skeg or no skeg. We prefer wire activation.
If a lifting skeg is chosen, it is formed from two layers of 3mm plywood laminated together while weighted down flat, and cut to the plan profile:

The actuating wire is epoxied in place, as shown in the plan:

The skeg box is cut to the plan profile from 3mm plywood, with 12mm square cedar internal framing. The outside of the box is then glass sheathed. The wire terminal compression fitting is then fitted into the top of the skeg box, ensuring that it is upright and square to avoid friction between the wire and the compression fitting. The inside of the box is given two coats of resin before assembly.

The skeg pivot is a 6mm stainless steel bolt with the thread section cut off, epoxied and glass taped into position on each side of the skeg box.

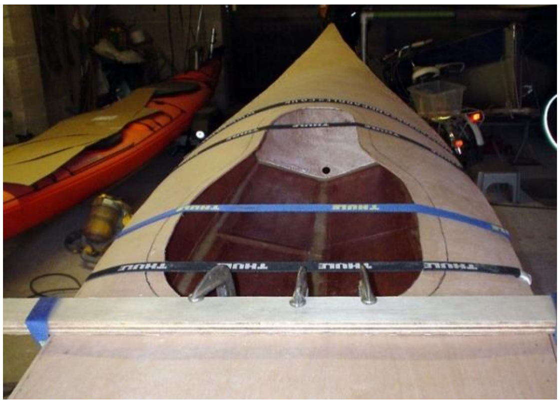
Mark the position of the front of the skeg box on the keel line at -924, and drill a 2mm hole down through the keel. Turn the kayak over and carefully mark out and jigsaw a slot aft of this 2mm hole so that the skeg box is a sliding fit into it. Turn the kayak upright, and fit the box into the slot so that its base is flush with the outside of the keel, and plumb vertical. Fillet it and glass tape it, ensuring it stays vertical and at the correct height with temporary bracing as required:

The skeg box must be able to cope with the stress from the skeg colliding with rocks or a beach. To avoid this stress causing damage to the surrounding thin hull panels, the skeg box is braced to the stern deck and beams with triangular gussets:

The skeg slider, tubing, wire and compression fitting are from Kari-Tek, UK.
We now use an alternative method of bracing the skeg box. The skeg box is cut to the plan profile from 3mm plywood, with 12mm square cedar internal framing, but we now extend the side framing pieces at least 100 mm above the top of the box. These are later notched into deck beams and trimmed to height. This braces the skeg box while maintaining maximum storage space in the stern compartment. (Shown here in a Vember):

Fitting the stern deck

The stern deck main panel uses the full length of the third plywood sheet, and stretches from the masik, aft to a short distance from the stern. Cut a panel to fit this area, with a 20mm overlap on the gunwales, as for the foredeck. Mark the centre of the short side of this panel, and preserve the previous mark on the centre of the masik. Ensure these marks coincide throughout the remaining procedure. Use a temporary stainless screw if necessary. Place weights on the length of the stern deck aft of the cockpit, to mate it flat to the sheer clamps.
At the aft cockpit bulkhead, (Datum -50mm) strap a beam across the kayak so that aft of this bulkhead the deck is flat. Place the other four straps round the hull, and gradually tighten them. The strain on the plywood overlaps is particularly great at a point just forward of the strapped beam, so trim the overlaps to about 10mm at these points. Cutting a smaller approximation to the cockpit opening in the centre of this panel will ease the bending strain required, so, from the plans, scribe a shape at least 50mm smaller than the final opening, and cut it out later on the bench.



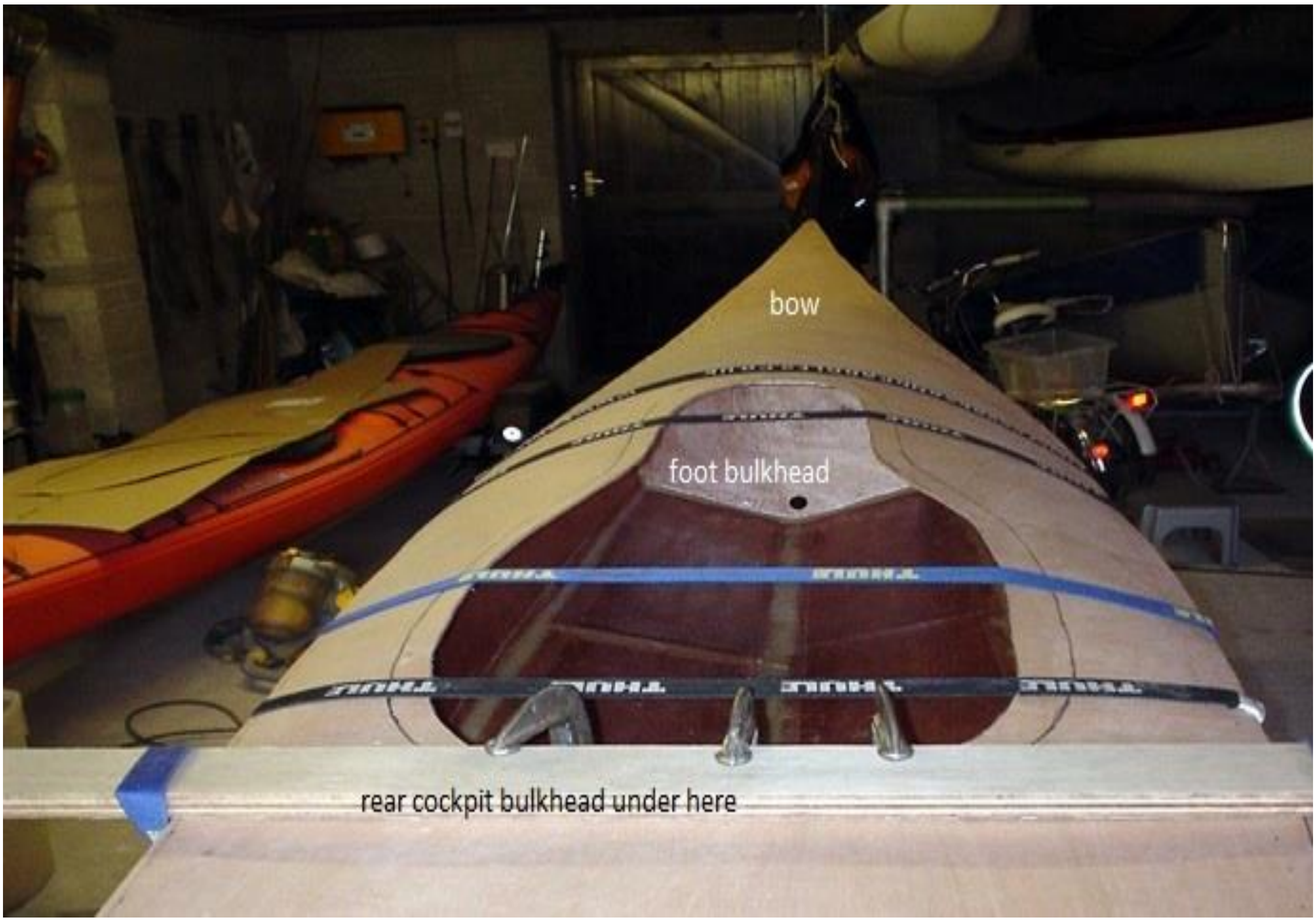
Note that the two panels do not meet all along the masik. Using a pair of dividers or compasses, scribe the shape of the foredeck edge onto the edge of the stern deck panel.
Check the angles of the carlin and note where adjustment is needed to fairly land the panel onto the sheer clamps.
The aft end of the panel tends to move during the fitting process. Locate it by fitting a plywood butt strap to the panel under the aft end, tightly between the sheer clamps. This butt strap will be used later to join the final small section of deck.
Remove the stern deck panel, plane the marked edge where it lays on the masik, and jigsaw the rough outline of the shape of the cockpit. Refit the stern deck panel, and gradually tighten the straps until the panel touches the sheer clamps along its whole length from the masik to the cross-strapped beam:
Repeat the removal and trimming procedure until you are happy with the fit. If you are clear-finishing the kayak, a few extra straps will avoid the use of any temporary screws.
Remove the panel, roll a coat of epoxy on its underside, apply thickened epoxy glue to the tops of all the stern deck beams, the masik and the sheer clamps, and glue the panel into position.

The final small deck panel can now be fitted to the stern in the same manner, gluing to the sheer clamps and the butt strap.
When the glue has set, the stern deck panels can be trimmed to the gunwales.

Put a light radius on the edges of the gunwales with a block plane and 80 grit sandpaper. The sheer clamps have a large gluing area for the decks and we no longer reinforce this joint with glass tape or cloth. However, if you prefer, apply resin and 50mm glass tape over the hull/deck joints, or cover the entire hull and deck with lightweight glass cloth.

Cockpit coaming and thigh braces.

The internal width of the cockpit can be adjusted to suit the physique of the paddler. Try other cockpits to see which width will suit you. The internal length of the cockpit can be decreased if desired, perhaps to Ocean Cockpit dimensions. (See Shrike Too for construction details for an Ocean Cockpit) The size, shape, and position of the thigh braces in the cockpit are vitally important for the secure handling of any sea kayak. The braces on the Shrike cockpit rim suit me, but they are unlikely to suit you. We suggest you try out other kayaks, and sit in the hull, supported on soft cushioning, in order to design your personalized cockpit rim. See the Builders Tips section for further discussion of thigh braces. We have now extended the braces on our keyhole cockpit kayaks so that we can only just fit each leg in the gap between them when entering the cockpit when wearing a drysuit. The gap between the plywood braces on my Shrike is now 140 mm, and only 115 mm between the shaped foam padding. From the plans, or to your own preferences, draw the inner profile of the cockpit lip centrally on the deck, and cut accurately to this shape. We do this with a utility knife or a jigsaw with a downward cutting laminate blade. The front edge of the cockpit opening is at the aft edge of the masik, and the aft end of the opening is against the cockpit aft bulkhead, making the opening length 833mm. The photo shows a Shrike under construction, where the hole has been roughly cut to ease the bending of the plywood before the stern deck is glued. This is helpful if the masik is highly curved with, for example, 315 mm (12.5 inches) knee clearance.



The cockpit coaming upstand is now created by bending the 3mm plywood around the inside of the cockpit opening.

Cut 30mm wide strips of the plywood of sufficient combined length to form the perimeter of the opening. The strips should have the face veneer grain across the strips to assist in bending. The long straighter sides of the upstand can be created from these strips, superglued (using spray accelerator, an excellent invention) into position. The upstand is set vertically, and flush to the underside of the deck plywood. At certain points the upstand will extend a little below the deck, and these areas will be filled later from behind the upstand.

At the sharp bends, the plywood is sliced almost through from the outside at intervals of 10mm. It takes 4 passes of a utility knife to cut through the plywood. After just 3 passes, the plywood bends easily round the curves. It matters not if the plywood breaks into shorter sections. Fit them all in position with super-glue and accelerator.

The plywood upstand serves merely as a former for the next stages, the strengthening of the upstand with epoxy and glass tape.

Coat the outside of the upstand with resin, and place a neat fillet of thickened epoxy around the perimeter joint. Then epoxy a strip of 50mm glass tape all around the outside of the upstand across the upstand/deck fillet.

Next, epoxy a length of glass tape around the vertical inside of the upstand. Snip the outside selvage edges of fibreglass tape on internal bends as at front inside of cockpit coaming. Trim the excess width of tape when the resin is part set.

Now that the upstand is strengthened, the top edge can be reduced to your chosen height, and gently planed to produce a slight concave curve when viewed from the side, with the eye at hull level. Without shaping, the top edge may be almost straight, an inelegant profile. The concavity need only be very slight, as shown here with a plastic batten to indicate the curve.

The 6mm thick coaming top lip is now formed from either two layers of 3mm plywood or from 6mm plywood, if available. The top lip should be cut out with the profile shown in the plans, but with the thigh brace bulges removed, as these are solely for drawing the final cockpit hole in the deck. Allow at least 10mm extra on the inside, to allow for variations in construction of the 3mm upstand.

Lay the rough cut lip in position on the upstand, draw round underneath and inside, and now cut to this line. Glue and clamp the lip on to the upstand, using weights, beams and clamps until glue oozes slightly all around the joint. Alternatively, super-glue the lip onto the rim. This avoids a lot of clamping and weighting. Clean off the excess glue before it has set. When this has set, turn the kayak upside down, and fillet and glass tape the joint between the upstand and the lip. When this has set, turn the kayak upright. Round the outside edge of the lip with sandpaper.

The inner edge of the lip can be profiled with a router, or with 80 grit super-glued to a length of 100 mm diameter drain pipe:

The top of the cockpit lip and the inside of the upstand can now be coated in resin and glass cloth for abrasion resistance and strength. As this involves double curvature, the woven glass cloth should be bias-cut (45 degrees to the strands), using a rotary cutter.

Bias cut glass cloth should initially be cut well oversize, as it is dimensionally unstable. (Use masking tape where the cloth is to be cut, and use a craft knife or rotary cutter to slice through the centre of the tape)

Strengthening the thigh braces

The protruding wings of the thigh braces can be highly stressed, both when paddling and when lifting the kayak. They can be strengthened as follows:

1. Epoxy a 3mm plywood plate, with the same shape as the wings, under each wing, extending under the side decks to the sheer clamps, so as to strengthen the wings.
2. Further strengthen the wings by covering both sides with glass cloth, and add a large epoxy fillet between the top of the wings and the cockpit rim upstand. Someone will eventually pick up the kayak by just holding a wing, so they need to be strong enough to withstand that abuse.
3. Use contact adhesive to secure shaped hard Minicell foam under each wing to create a hook effect for the inner thighs.

Alistair from Cornwall cut a radial pattern part way through the wings, bent them down to fit his legs, used super-glue and weights to preserve the shape, and the coated both sides with glass cloth:

Installing the hatches

The prototype Shrike was designed as a light-duty day cruiser, so no fore hatch is fitted, and the forward compartment is filled with an inflated buoyancy bag. There is a hatch in the foot bulkhead. A very small foredeck hatch could be fitted well forward, on the flat section of deck. For day trips, the day compartment provides adequate stowage, and no fore hatch is necessary. However, experience on camping trips shows that the hatch in the foot bulkhead is suitable for stowage of items such as tents, and this has the great advantage that a foredeck without hatches is leak-proof, as well as being elegant and strong. If you can't reach an item, then, with the kayak on the beach, lift the bow and the item drops towards the hatch. Sometimes the simplest solution is the best! The stern compartment hatch is required for access for maintenance if the optional skeg is fitted. The day hatch is the small disc immediately behind the cockpit. A day compartment is very useful for keeping small items together, especially on day trips, when these items are all that are carried.

The hatch openings are now cut into the stern deck. We cut a small hole in the approximate centre of each intended hatch opening, and, with a short steel rule, established the position of the deck beams, and hence the line to jigsaw the accurate holes for the hatches. We used the inside of the hatch rims as templates to draw the lines. Install the hatches with stainless steel bolts on a bed of polyurethane a or similar adhesive.

As the stern deck immediately aft of the cockpit can be heavily loaded if a paddler sits on this area, we glued a short extra transverse beam just forward of the day hatch opening, clamping temporarily through the opening. The deck and cockpit rim can now be rolled with a coat of epoxy resin.

Coating

The entire hull and deck should now be lightly rubbed down with sandpaper. The visible edges of the glass tape can now be sanded away, so they become invisible when epoxy coated. Carefully knock back any epoxy runs when set, using 80 grit in an orbital sander. The dust should now be removed, and another coat of resin rolled over the entire hull and deck. Use firm foam rollers to coat the panels. A roller gives a far more even, thin, run-free coat. Avoid the use of brushes where possible, to avoid runs. Follow the rolling with tipping off with long strokes with a piece of the roller, held to stop it from rotating. This removes air bubbles.

This epoxy coating of the plywood should now be protected from ultra-violet light with layers of varnish or paint. We painted the prototype Shrike as we had spoiled the plywood surface with pen and pencil marks during the prototyping process. In future we will aim to clear finish the kayaks with varnish, as this should show less the inevitable scratches sustained while using the craft.

One advantage of paint is that any unfair sections and joints can be faired in with West 410 lightweight fairing compound before painting.

Any amine blush must be washed off the epoxy coating with soapy water, and the surface lightly sanded, before any gluing, glassing, varnish or paint.

If you are now opting to cover the entire panels with glass fibre cloth there will be a small weight penalty, but you may choose to accept this for the benefit of greater abrasion resistance of the hull, and the reduction in epoxy dust creation in comparison with sanding the edges of the tape..

One must attempt to create a dust free environment for varnishing and painting. We used fly spray in the shed the night before painting, after vacuuming the floor.

We used black gloss oil paint, on the basis that it was one tenth of the price of marine gloss. We applied two coats with a West foam roller, tipping off immediately with a wide soft good quality paint brush.
We painted the cockpit floor with the dregs of a can of grey International Interdeck non-slip deck paint.

Installing the skeg system

Install the slider box into the hole in the port topside panel with polyurethane adhesive. The next day, install the plastic outer tube into the fitting on top of the skeg box so that it just reaches the inside of the box. Slightly tighten the nut. Thread the plastic tube through the holes in the bulkheads and cut it to length so that it just reaches into the end of the slider push-fit connection. Now remove the plastic tube from the fitting on top of the skeg box. Thread the end of the skeg wire up through the skeg box and into the end of the disconnected plastic tube. Thread the wire all the way through to the slide box and through the tube until it emerges from the end of the tube outside the hull. Reconnect the plastic tube to the fitting on top of the skeg box, and carefully tighten the nut. Pull the wire so that the skeg is fully retracted. Push the actuating button forward until there is just enough space to place a finger in front of the button. Tighten the grub screw with a 2.5mm Allen key (hex wrench in the USA) to fix the wire in position. Cut the wire to length with cable cutters, after coating that section of the wire with 5 minute epoxy or superglue to prevent any strands unravelling.

Outfitting with hatches, seat, backrest and deck lines

Secure the hatches into the deck and the drain plug (and hatch, if fitted) into the foot bulkhead with polyurethane adhesive.
A foam seat can be purchased (e.g. from Fyne Boats) or one can be carved from a Minicell foam block, as can a backrest: **<u>Keep the seat base as low as possible.</u>** The foam can be reduced to 2mm thickness in the two dips.

The Builders' Tips Appendix describes a variety of alternative deck fittings to hold deck lines, including our 3D printed fittings. The cheapest and simplest fittings can be made from 85mm lengths of 25mm wide polypropylene webbing tape, folded into loops. The deck loops can be fixed to the sheer clamps with 19mm (3/4") pan head M4 (no.8) stainless screws through 20mm M4 penny washers, as seen here:

Now go paddling. You've earned it.

Appendix A: Builders' Tips

Getting started

1. Get the paper plans, epoxy resin, and plywood.
2. Cut round the shapes on the paper plans, appropriate to your selected variations.
3. Tape the paper shapes to the plywood.
4. Draw round the shapes and cut the plywood to the lines.
5. Stitch the plywood pieces together with copper wire to form the hull.
6. Dot superglue between the copper stitches, and then remove the stitches.
7. Apply thickened epoxy resin to the inside of the joints.
8. Apply fiberglass tape and epoxy resin to reinforce the joints.
9. Use these techniques to build the deck and cockpit.
10. Coat the entire kayak, inside and out, with epoxy resin.

Keyhole Cockpit Design

Careful inspection of a well-designed glass-fibre kayak like the NDK Romany reveals that the side decks by the front of the keyhole shaped cockpit are shaped so as to act as thigh braces. The Shrike family decks in this region are steeply sloping upwards from the gunwales to the cockpit rim. If the keyhole cockpit option is chosen, then when attempting to brace, roll or just paddle in waves, the knees can slide inwards into the cockpit, and the kayak will not be controllable. The remedy is to narrow the opening at the front of the cockpit to the minimum that will enable your chosen size of shoe to pass through the hole when getting in and out of the cockpit. This will then provide sufficient width under the side decks to glue hard foam thigh braces. On the prototype Shrike we made the front of the cockpit opening too wide, and had to create wooden thigh braces glued to the inside of the coaming. This was a time-consuming and unnecessary task.

To improve the bracing we would now:

1. Create the wings for the thigh braces in the cut-out of the deck plywood rather than in the cockpit top rim. This enables simpler strengthening of the wings.

2. Cut the wings in the deck cut-out so that the gap between the wings is 150mm rather than the 200mm we used on the prototype. This would better suit my normal paddling posture.
3. Epoxy glue a 3mm plywood plate, with the same shape as the wings, under each wing, extending under the side decks, so as to strengthen the wings.
4. Further strengthen the wings by covering both sides with glass cloth, and add a large epoxy fillet between the top of the wings and the cockpit rim upstand. Someone will eventually pick up the kayak by just holding a wing, so they need to be strong enough to withstand that abuse.
5. Use contact adhesive to secure shaped hard Minicell foam under each wing to create a hook effect for the inner thighs. The above picture from Morris Ho illustrates this.

Made to measure spray decks (skirts)

If your Shrike's cockpit is of a non-standard shape or size, Reed Chillcheater will make a spray deck to your pattern, and deliver world-wide. The Aquatherm fabric is light, flexible, and does not absorb water. We use these decks on the Shrikes, other than in very cold conditions, when we use thick neoprene decks and Tuiliqs. The Reed deck in the photo is fitted with the optional bale hole for pumping out bilge water without removing the deck.

Size of sheer clamps and deck fittings

On the prototype Shrike we sized the width and depth of the sheer clamp timber to be sufficient to provide a gluing surface for the deck. However, we also intended to screw simple deck line fittings through the deck and into the sheer clamp. We used 20mm stainless washers, as described in the Build Manual. During sea trials and carrying out contact tows or just being rafted up to another kayak we discovered that these washers could rub against the accompanying kayak, causing damage. We changed to 16mm washers, but this was not sufficient to avoid the damage, and we ultimately used some small solid stainless cup washers. This process could have been made simpler by using slightly wider sheer clamps to bring the deck fittings a little further inboard. We now use 1" square timber (25mmx25mm). If Maroske fittings or our 3D printed deck fittings are used (see Builders' Tips below), the size of the clamps can be reduced to 25 x 15 mm.

Super Glue

Super Glue, aka cyanoacrylate adhesive (CA), is a wonder material for this project, especially used with the accelerator spray. We use it for assembling the hull panels to enable removal of the temporary copper wires and, for example, fitting the cockpit upstand and rim prior to epoxy filleting and taping. However, the glue when set is very hard. If large drops are used in, for example, the keel joint, when the hull is turned over you will be faced with hard blobs of glue on soft plywood. It is very tricky to sand away the glue without over-sanding the plywood. Make your life easier by only using the minimum amount of Super Glue.

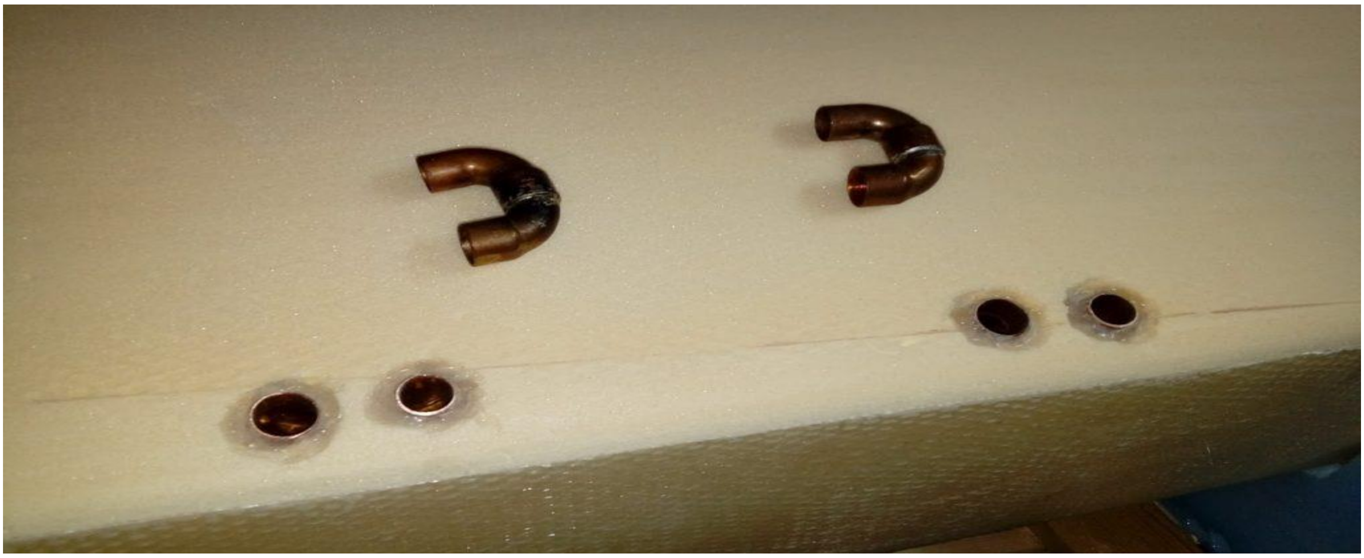
Hot Glue Guns

If aiming to clear-finish the hull, rather than use paint, you may wish to minimize the number of holes in the plywood for the temporary wires. In that case one can use a hot glue gun to position the external and internal forms. Just use a few small blobs of glue. When you need to remove the forms, a sharp tap will break the adhesion. Make sure the glue sticks are suitable for joining timber.

Deck line fittings

The standard low-cost and simple deck line fitting is to use short lengths of folded tape screwed into the sheer clamps, as described in the Build Manual. There are other options:
We use the 3D printed fittings whose printer files are included in the plans download:

Another simple and low-cost solution from Alec Naneti in Romania uses two copper plumbing bends:



Another option is to create Maroske fittings.

We like the visual simplicity and elegance of Maroske deck fittings, but they are anything but simple to construct. Google “Maroske fittings”. It can be a struggle to pull the PVC tube out after the epoxy has set. To make it easy to extract the tube We first put the wire inside the PVC tube, then wrap the PVC tube with PTFE tape, and then insert the PVC tube into the fibre-glass sleeve. This entire assembly is then threaded through the deck. We use fiberglass tape over and under the sleeve to spread the load, and then thickened epoxy smoothed over the entire assembly. The PTFE tape makes the PVC tubes easy to extract after removing the wire. We use a bottle cleaning brush to remove any remnants of PTFE that stick to the epoxy.
One way of producing lightweight Maroske fittings is to bond in a semi-circle of 3 mm plywood. This minimises the use of the heavy epoxy, and also produces an even curve, thereby facilitating the eventual withdrawal of the inner tube.
When positioning the fittings near the cockpit, bear in mind the need for foot-room. Those in the below photo are a little too close for comfort.

Key to open screw-in hatches

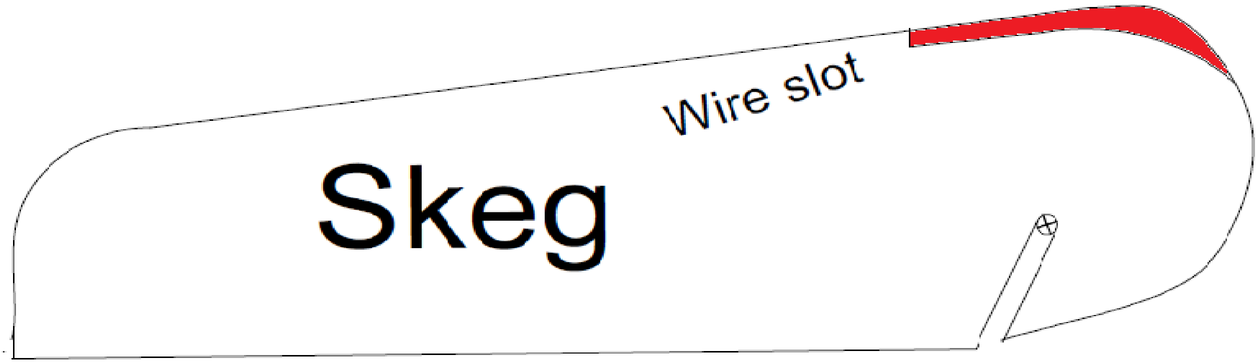
Screw-in hatches are simple to install, and they don’t interfere with the elegance of the kayak. However, they can be difficult to undo, particularly if subject to temperature changes. This is only exacerbated by having cold wet hands. We made a simple HDPE (bread or chopping board) key. One side opens the large hatches, and the other side opens the day hatch. We use both hands on the key, pushing and pulling, for maximum leverage. There are a couple of holes for a lanyard to attach it in the cockpit. (No, not inside a compartment…….)

Low-profile skeg box system

The skeg system shown in the Shrike plans works well with full-sized Shrikes and also with Shrike LVs where the plans are all scaled down, including the size of the skeg box and skeg. However, if only the height of the decks is reduced, as in the Shrike-R, there may be insufficient space between the top of the keel and the underside of the stern deck to accommodate the system. The deck may foul the compression fitting on top of the skeg box.

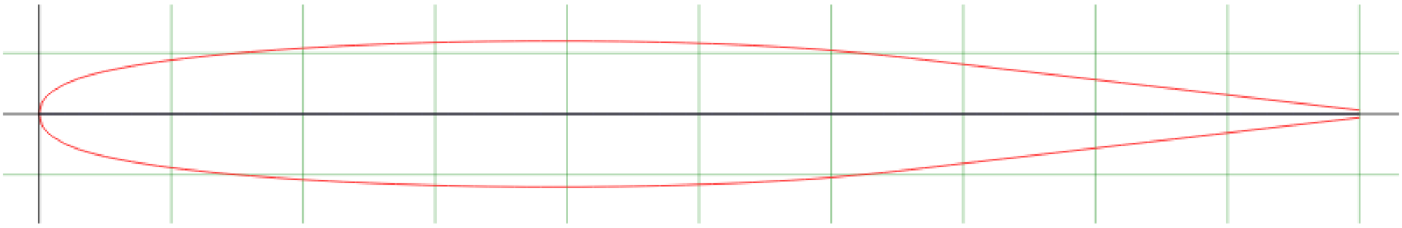
This can be avoided by installing the compression fitting in the front of the skeg box as shown in the photo below. The following instructions should be read in conjunction with the accompanying photos, and the appropriate section of the Build Manual in the download.

1. Print the paper plans for the skeg box and skeg at 90%, thereby reducing the deck clearance height by about 13mm.
2. Increase the width of the inside of the box to 15mm by using 15 x 12mm cedar internal framing. The overall dimensions of the 90% box are 346 x 122mm.
3. Make a 9mm thick skeg blade from three layers of 3mm plywood, instead of the standard two-layer 6mm thick blade. Before gluing the three layers together, the top curve of the middle layer is profiled to accept the 3mm stainless wire cable in a groove, where it is later epoxy bonded. Cut the inner layer of plywood to accept the wire by reducing the radius of the curved end to a circle centred on the pivot point, and meeting the bottom of the straight slot for the wire, as shown in the area coloured red, which should be removed:



After the three layers are bonded together, taking care to remove excess glue, shape the groove with a round file to accept and guide the free wire over the range shown in the photos, and epoxy glue the wire into just the straight section of the groove:

4. Round the leading edge of the blade and taper the trailing edge in accordance with the NACA 0012 profile, (Thickness 12% of width), a good shape for optimizing lift at normal kayak speeds: (C.A Marchaj, “Sailing theory and practice”, 1964, pp 281 – 284 & airfoiltools.com)



Give the skeg and box a coat of epoxy, sanded hard, and then a second coat, to ensure smooth contact surfaces.

5. Fit the compression fitting horizontally, with its centre line 95mm above the bottom of the box.
6. When the outer 6mm O.D/ 4mm I.D plastic tube is inserted into the compression fitting, the plastic outer tube should extend into the skeg box by 25mm. With the compression fitting we used, this gave a measurement of 60mm from the outside of the compression fitting to the end of the tube. A pen mark or piece of tape 60mm from the end of the tube helps to position the tube correctly.
7. Fit nylon spacer washers as necessary on the pivot, and complete the box.

The box, when slotted through the keel, will require a height clearance of 119mm from the top of the keel to the underside of the stern deck. A skeg system to this design operates very smoothly, but disadvantages of this design are that the compression fitting and tube are more vulnerable to damage from stowed equipment in the stern compartment, and the available storage volume is reduced.

Bow and Stern protector

You may have noticed in some of the pictures of Christopher's Shrike-Too and Shrike-R that there are small black objects on the bow and stern. These are protective rubber pieces formed from SuGru, a self-mouldable rubber compound. Inuit kayaks often had similar shaped end protectors but they were probably made from wood or bone, making these an authentic method of modifying your Shrike. SuGru is very simple to mould in place using just one's fingers and it's great for making "bumpers" to protect both your kayak and those things you decide to ram!

Weighing Epoxy.

We use the excellent Smart Weigh digital scales to weigh the epoxy resin and hardener. The scales have an accuracy of 0.1g and a maximum capacity of 1 kg. They are equipped with a "tare" button, which re-sets the scale to zero after the container is placed on the scale. This is a great feature. The scales cost £6 in the U.K on EBay.
In the USA, eBay has the scales for $18 including shipping. Try "Smart Weigh SWS100" and Amazon.com has them for $10 – try "Smart Weigh SWS1kg"
One disadvantage of the scales is that they have a 60 second time-out, which can be inconvenient.

The importance of sheer clamps.

Some kit manufacturers omit sheer clamps, and rely on taping the seams between hull and deck. We strongly advise against this when building with the 3mm plywood. The sheer clamps produce fair smooth curves and enable a very strong joint. We've spent too much time mending these joints on $3000 glass fibre kayaks where glass tape has been the sole method of joining the hull and deck.

Tethering Barton-style hatch covers

Peter M. from Cornwall, UK, used ½" 6g A4 s/s pan head screws and suitable washers to attach a nylon R-type cable clamp to the central moulding on the underside of the hatch cover. Knotted shock cord (3mm) joins the cover to another R-clamp inside of the hatch fitted to one of the bolts holding the hatch cover rim in place. This means that when the hatch cover turns, the central R-clamp turns freely and the shock cord is not wound up.

Replacing the copper stitches with adhesive tape

Adhesive tape can replace nearly all the copper wires, except a pair at each of the bow and stern. Gorilla tape is too sticky, and liable to damage the plywood. We used Scotch Tough Duct Tape.
This tape has reinforcing strands across the roll, and the tape should be aligned so that the strands cross the joint. We then used CA glue and accelerator, with a couple of copper wires at the stem and stern. This tape did not damage the plywood, though we only left it on for a few hours, removing it once the CA glue had set.

Raising the exterior forms.

In the early stages of construction it can be awkward to access the keel line of the hull between the exterior forms, particularly when attempting to adjust the copper stitches or adhesive tape at this point. This access can be eased by raising the forms by fixing them to deeper timbers.

Finishing the edges of fiberglass cloth.

Occasionally a clean finished edge is required on an area of glass cloth. This can be when, for example, just the floor of the cockpit is glassed for abrasion resistance, or when a tapered extra keel strip is added. An elegant solution is to use dark coloured masking tape around the perimeter of the area, and laminate the glass over the desired area, overlapping slightly onto the coloured masking tape. After a few hours, when the cloth is set, but not hard, cut at the inner edge of the masking tape with a craft knife, and remove the surplus cloth and tape. The next day seal the cut line with resin.

Black Keel strip

When the hull is left with a clear finish, it is difficult to spot when the keel has been scratched from contact with the beach or rocks. Water can then pass through the scratch and soak the plywood. With the black painted hull on the prototype Shrike, any scratch though to the underlying epoxy is obvious, and one can put a dab of paint on the scratch, thereby sealing it from further water ingress. This issue with a clear finish can be avoided by applying a coat of black pigmented epoxy (10% epoxy pigment) in a strip down the most vulnerable part of the keel, entirely below the water-line. If you taper the ends it can even look elegant. Good quality masking tape is worth the extra expense for this task. We use the blue 3M 50mm (2 inch) wide tape.

Feathering the edges of the glass fibre tapes

Feathering the edges of fibreglass can be time-consuming and not very interesting work, but one is rewarded by the fact that the edges become invisible when the next coat of epoxy is applied. There are several ways in which this task has been approached, including:
1. A random orbital sander with 220 grit abrasive paper can remove the edges quickly, but great care is needed to avoid sanding through the top veneer of the adjacent plywood.
2. Scrape the edges of the tape with a craft knife blade or razor blade held in a leather-gloved hand, and finish off the feathered edge by hand, using 80 grit abrasive paper.

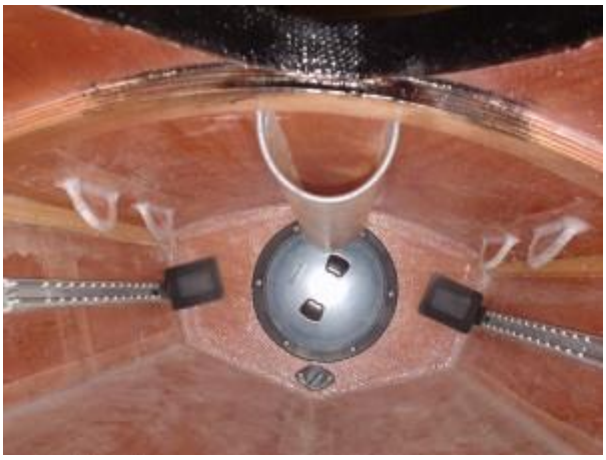
Any such method will produce quantities of potentially allergenic epoxy dust, so adequate protective methods should be used.

Covering the entire hull and deck with glass cloth

Covering the entire hull and deck with lightweight glass cloth avoids tedious scraping and sanding the edges of glass tape, and reduces exposure to the allergenic epoxy dust. We use 163 gsm (4.8 oz./sq.yd) twill weave glass cloth from East Coast Fibreglass Supplies in the U.K. Twill is remarkably easy to drape into shape over curved surfaces. It is woven with the fibres in pairs, rather than singly.

We lay one piece over the bare plywood hull and gently smooth the cloth into place with a large soft brush. The epoxy resin is then poured over one side of the top of the hull, one cup at a time, and rapidly spread with a squeegee (a piece of flexible plastic like a large thick credit card), until the cloth goes completely transparent, at which point **all** excess resin is scraped off so that the cloth has a matt finish, with no shiny patches. The second side is then treated similarly. Having a helper to mix fresh batches of resin is helpful, particularly if the temperature is high. We use low viscosity MAS epoxy with the slow hardener option

Knee tube for a manual pump



It seems a shame to spoil the lines of a beautiful kayak by having an ugly plastic pump on the deck, however sensible and practical that may be. One can install a knee tube under the deck. The knee tube construction is very basic. We use a length of 100mm diameter sewer plastic pipe as a mould, and laminate two layers of whatever glass cloth we have handy round the pipe, using either polyester or epoxy resin. We cut it to length and width when set, and glue some split plastic flat wire sheathing round the ends to protect feet, etc. We now angle the front of the tube for maximum foot clearance. We install the tube with the kayak upside down, using a few blobs of 5 minute epoxy, and later put a fillet of thickened resin down each side. We then install a piece of elastic shock cord across the mouth to stop the pump falling out. Note that you may have to shorten your pump. By removing an end cap this is usually possible. On some pumps we also temporarily remove the handle to shorten the rod.
Reed Chillcheater will supply spray skirts (decks) with bale tubes to enable access to the pump without removing the skirt, if you consider this necessary.

Thickening epoxy resin when used as a coating.

Occasionally one needs to place a coat of epoxy resin on a sloping surface, or on an exterior corner. One example is filling the weave on an existing keel strip, where the angular keel line makes the resin flow away from the apex of the upside down hull, which is exactly where one wants the thickest resin. Another example is filling the weave on parts of the cockpit rim and upstand. On all these we use 10% black pigmented epoxy resin with just sufficient West 406 Colloidal Silica filler powder added to make a "paint" that will still brush out smoothly, but will not run and sag as much as pure resin. This gives a very hard and shiny finish. We first mix the resin and catalyst very thoroughly, then add the pigment with much stirring, and then gradually add the powder until we obtain the desired consistency.

Installing a commercial hatch system

Instructions from Damian, in Plymouth, U.K:

Buy a large oval hatch rim. I found that the 42/30 Kayaksport hatch fitted my standard Shrike perfectly.

1. *Make an approximately 4cm-wide oval ring out of 2 layers of 3mm ply so that the bottom lip of the hatch rim just locates inside it. (You do this in the same way as you manufacture the cockpit rim for a Shrike.)*
2. *Decide where you want the hatch to go on the front deck. Then draw the outside edge of the plywood ring onto the deck.* ***(NB: when you sit the ring on your curved deck, the left and right sides will be dangling a few inches above the deck. Trace round the ring keeping it horizontal, and your pencil vertical to get the right shape on your deck.)*** *Draw a line approximately 4cm outside the rim outline and cut it out, e.g with a jig-saw. (NB – I am saying 4cm here, but it's your choice: whatever distance you choose will determine the angle of the recess from the deck down to the hatch rim. You'll probably want to have different angles at different points on the rim to make it look nice – that's fine.)*
3. *Put the plywood oval ring into the hole in your deck. On a standard Shrike, the edges of a large hatch rim should be sitting on the port and starboard sheer clamps. (If not, you'll need to support it while you do the remainder of the work.) Use sandpaper/files/plane/etc. to make sure everything is neat and symmetrical and that you're happy with the angle of the slope down from the deck to the hatch rim. Then use superglue and accelerant to stick the plywood ring in position on the sheer clamps.*
4. *Cut out lots of pieces of plywood to fill the gap between the oval ring and the deck. This gap will start at zero by the sheer-clamps and get bigger as the deck rises. I used about 20 pieces in total. Shape them with a plane and sandpaper. Don't worry if it looks a bit rough-and ready: you'll fill gaps with epoxy and sand them smooth later. Bevel the edges of these pieces so they butt up against the deck and the cockpit rim.*
5. *Use super glue and accelerant to fix the gap-fillers in place.*
6. *Apply an epoxy fillet around the underside of the top joint (i.e. where the gap-fillers meet the deck) and fill any gaps between the gap-fillers.* ***NB: if you have any big holes, then cover them with masking tape from above, turn the boat upside down and fill them with thickened epoxy from underneath. Remove the tape when the epoxy has gone off and sand it smooth.***
7. *Put a layer of fibre-glass over this fillet – either glass tape (cutting the edges to allow it to go round corners) or cut glass cloth to shape.*
8. *Put a fillet on top of the bottom joint (i.e. where the gap-fillers meet the plywood ring) and use thickened epoxy to fill in any remaining gaps.*
9. *Once this fillet has hardened, smooth off the underside of this joint with sandpaper and then apply fibreglass to it – either glass tape or glass cloth.*
10. *Finally, sand the top surface of both top joints smooth and cover both in glass – either tape or cloth. I used 160 gram 'twill' cloth which will lay flat over curving surfaces, so I was able to easily cover both joints with one piece. At this point, make sure you've painted any exposed plywood with epoxy.*
11. *When the epoxy has just gone off, cut the corners off the glass with a Stanley (craft) knife, apply more layers of epoxy (to bury the fibreglass weave) and then sand it smooth and flush with the surrounding deck. Then finish it however you prefer – varnish, epoxy or paint.*
12. *Fit your hatch rim to the plywood ring using adhesive. I used a silicone sealant, and then drilled/bolted it in place.*
13. *Buy a cover to fit your hatch rim. Tie it on to your deck-lines (so it doesn't fly away if it comes off while you're driving.) Fit it. Job done.*

Recessed hatch with drain hole from Christian in Luxembourg

1. measure and cut the recess bottom (the ply-plate that receives the rim)
2. define and cut a bigger top ply-plate
3. cut a piece of styro-foam (same size as in 2.)
4. stack 1. + 3. + 2. (use double sided tape to hold everything in place)
5. trim a smooth conical shape with a file
6. now wrap and glue the recess side parts with CA (I use aero ply 0.8mm). Only glue the recess bottom plate! Trim/sand everything
7. remove 3. +2.
8. Drill holes and use epoxy glue to secure the ends of the plastic pipe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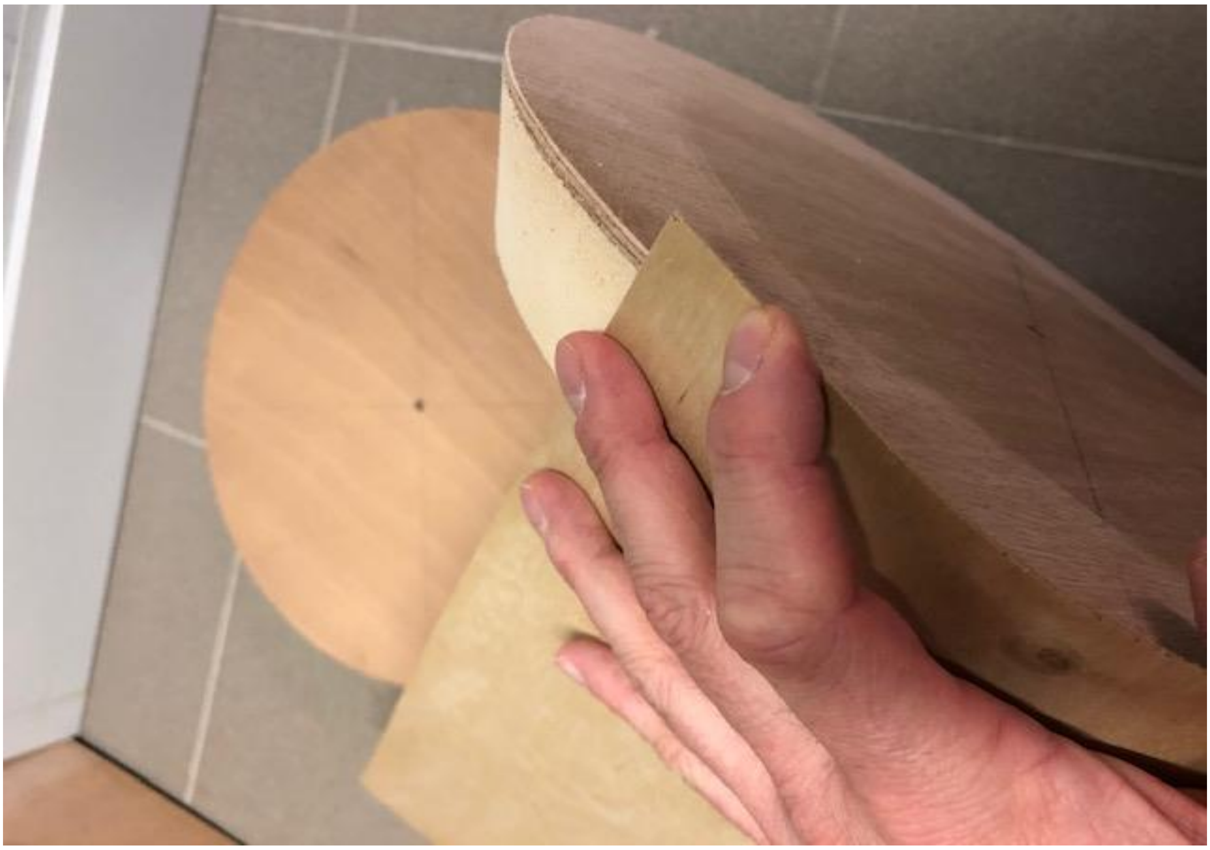
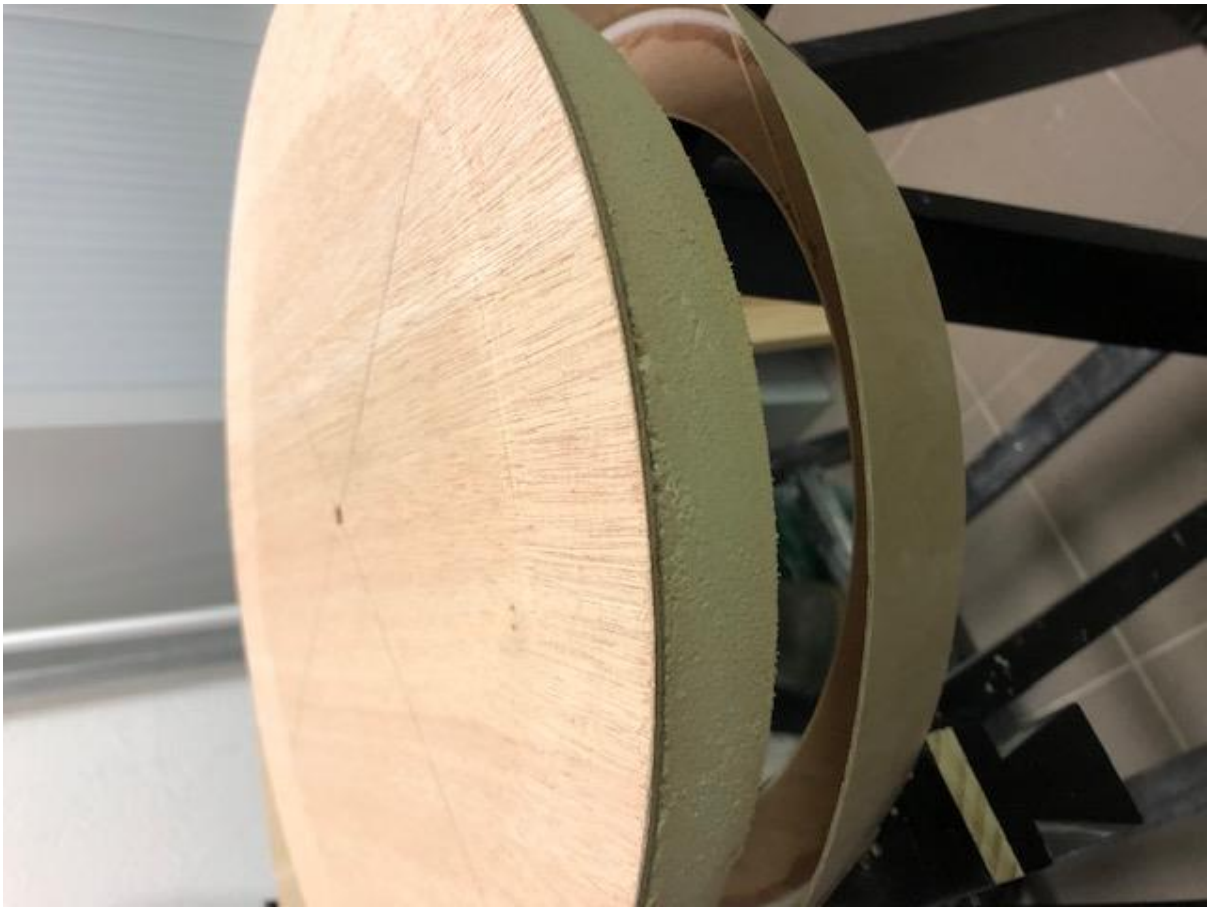
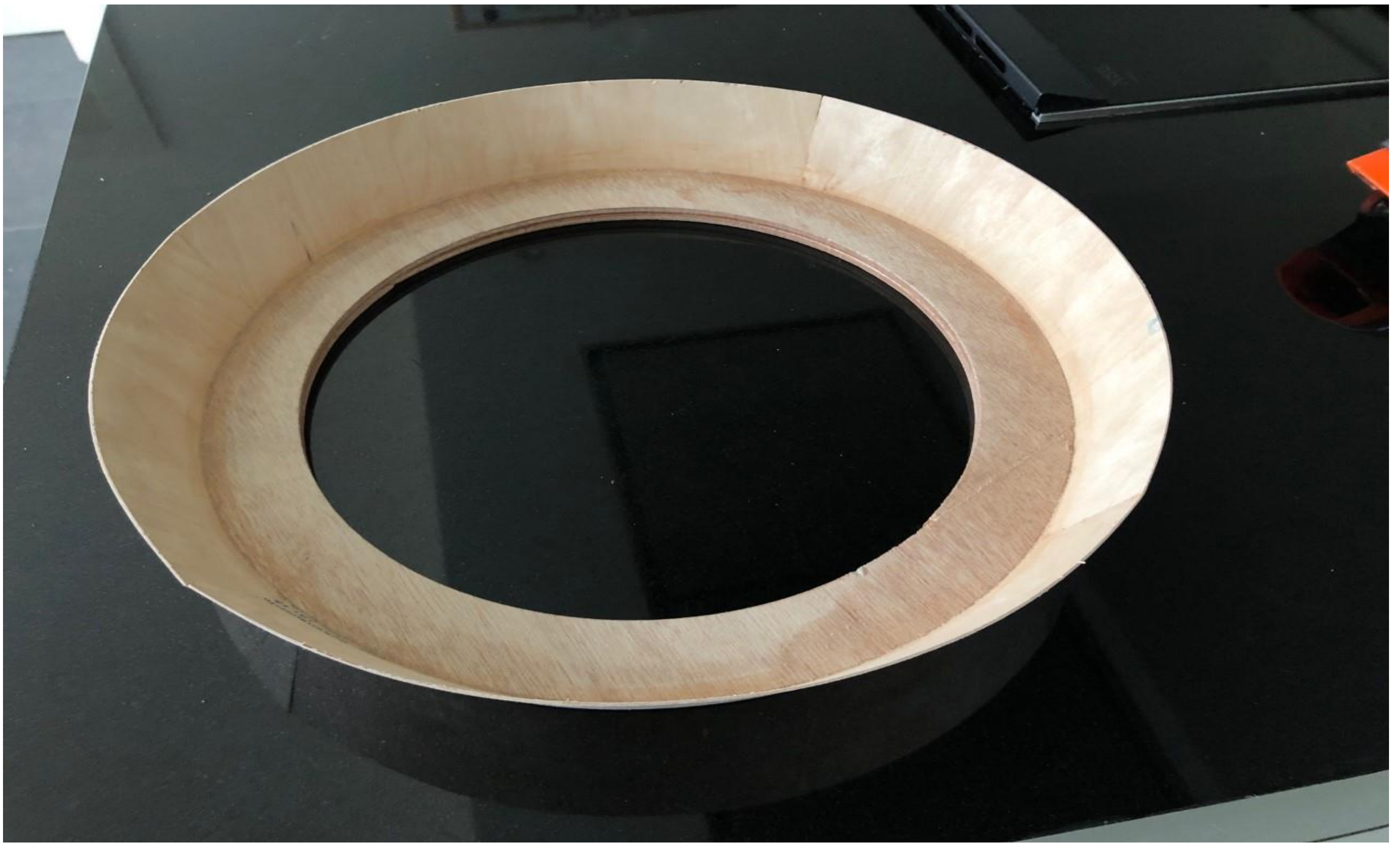
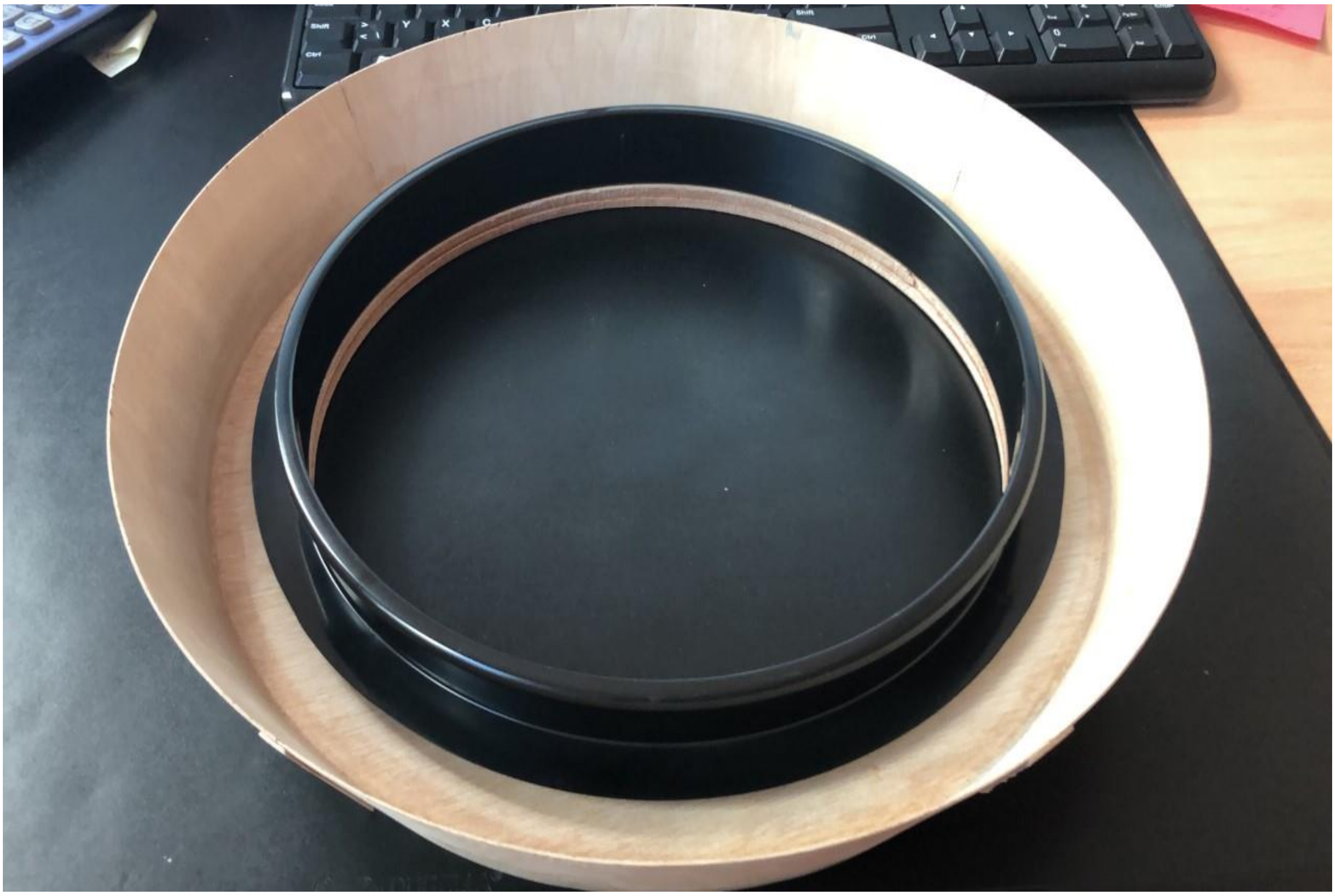
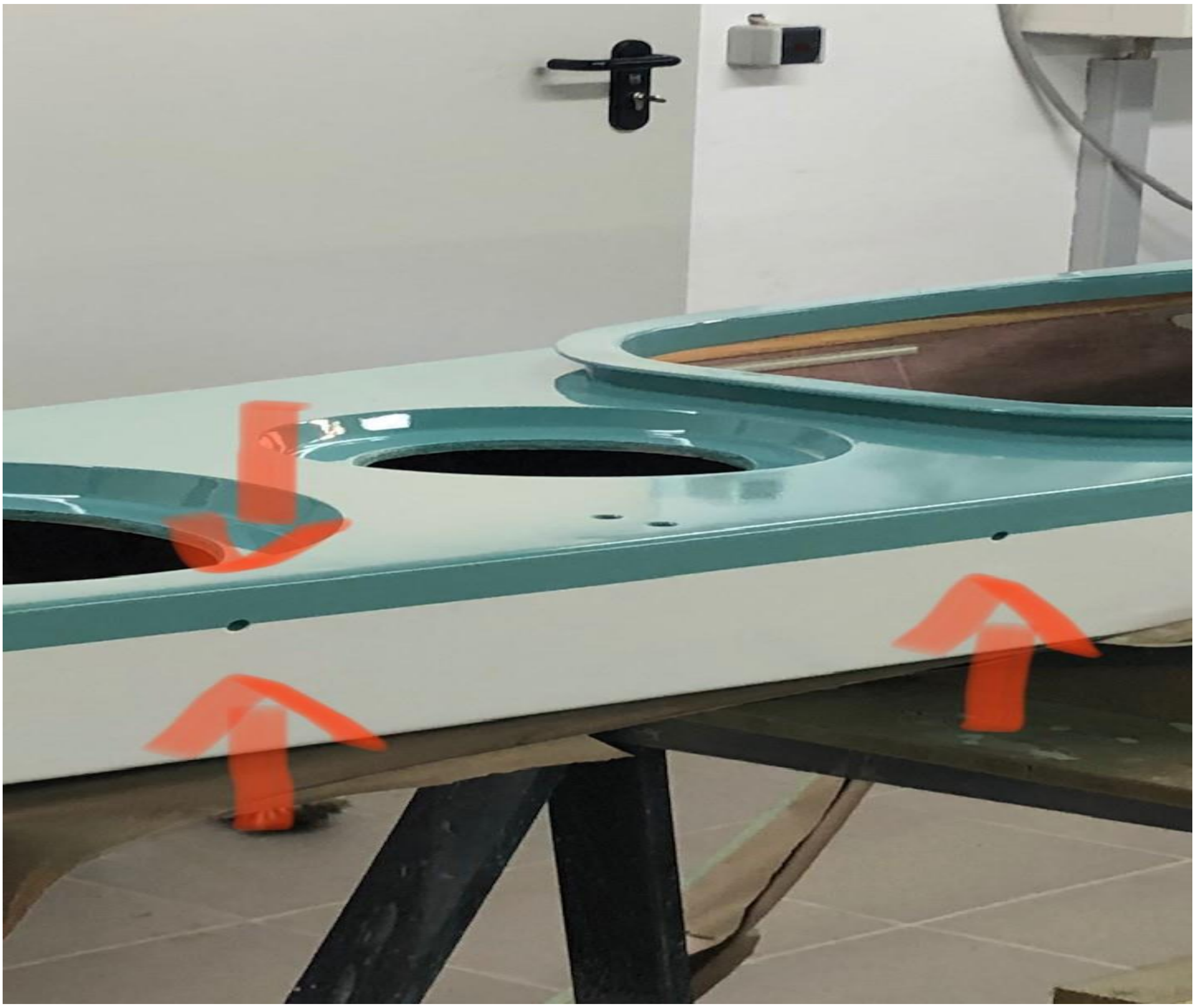










Building a three-part sectional Shrike

The usual procedure for producing a 3-part kayak is to through-bolt the sections together, and to rely on soft washers to prevent leaks around the bolts. Damian from Plymouth, UK has designed a system that avoids leakage around the bolts by fitting the nuts into self-contained recesses, and by using threaded studs on plates which can be epoxy bonded to the face of the bulkhead. Threaded studs with plates are available as a ”footbrace mounting kit” from Chesapeake Light Craft, SeaLect and other retailers:

How does the kayak perform on the water? From Damian: *My design for bolting the sections together requires 4 square holes below the water-line to access the nuts/bolts. I was worried that this would cause drag, so tried to gauge this by testing it out with my regular group of paddling buddies – either I'm imagining things or the boat is now a bit quicker. There is no possibility of leaks as the compartments remain fully sealed, even when not bolted together. I've taken it out in big, slamming seas, and it's all held together fine. (Off the water, the boat can now be stored in the corner of a room and fits inside my little hatchback car!)*

Three-Piece Kayak Construction from Simon

This method is an evolution from the method described by Damian. It employs the same concept in keeping all the bolts external so as to avoid waterproofing issues. This method is rather more complicated to build, but gives a very neat and streamlined finish.

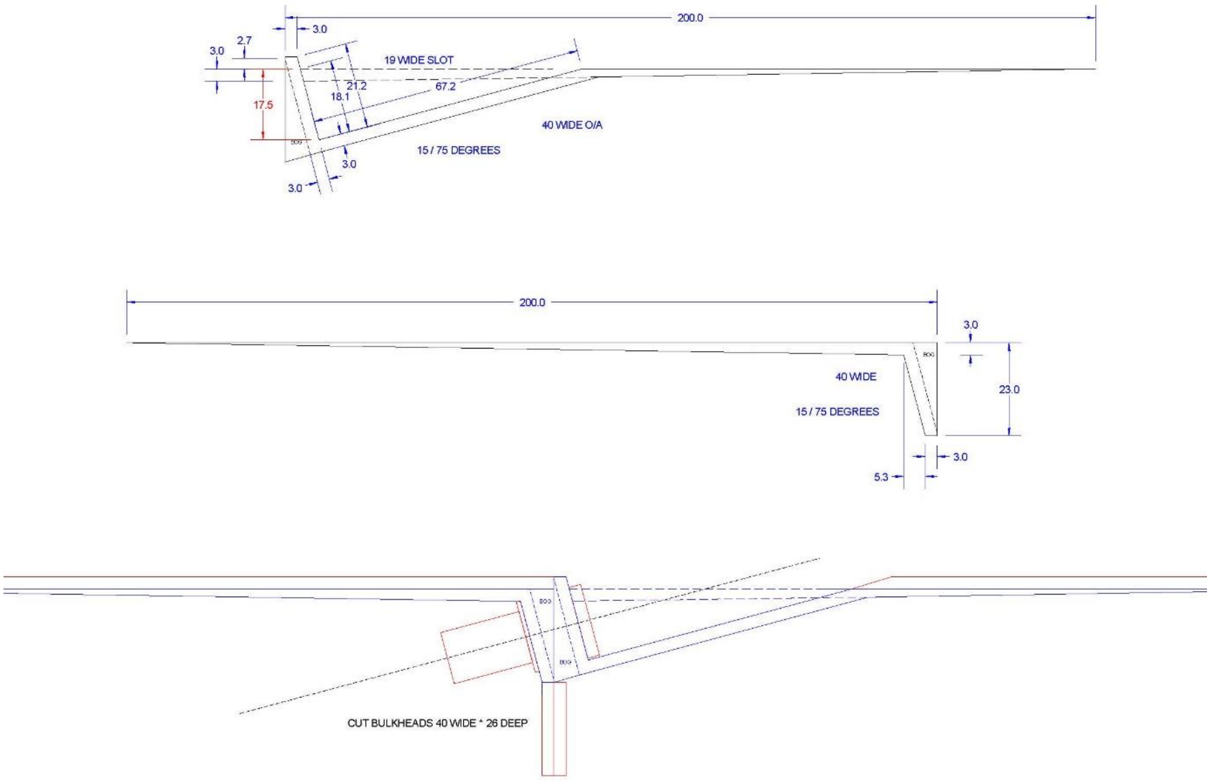
You will need:-

- 10 No 30mm*8mm stainless steel flange head bolts with an Allen key socket (18mm diameter flange head)
- 10 No 60mm*8mm mild steel flange head bolts with an Allen key socket (temporary)
- 10 No M8 stainless steel penny washers
- 10 No 25mm*8mm connector nuts
- A long Allen key head screwdriver to fit the above – this must have a round end so that it works at a slight skew angle.

Making the Fabrications

This is the hardest part of the job and there is quite a lot of work involved, so I suggest you make up all the fabrications before starting to build the boat.



Longitudinal sections through the fabrications

The drawings and photos show what is required. The fabrications which support the nuts are easiest to build and I made up a large board with a 15-degree end piece, all covered in polythene and peel ply. I then laid up all the pieces in one large piece and then saw cut them to 40mm width. With all the fabrications use peel ply on both surfaces to achieve a good bond to the hull; but sand them too.

Fabrications cleaned up and ready to go. I used a mixture of glass and carbon

The keel fabrications need to sit into the angled chine of the boat. Make them individually with an angled base to fit the chine angle at each bulkhead location.

The recessed bolt fabrications are made with a male mould on a flat board and these are best done separately.

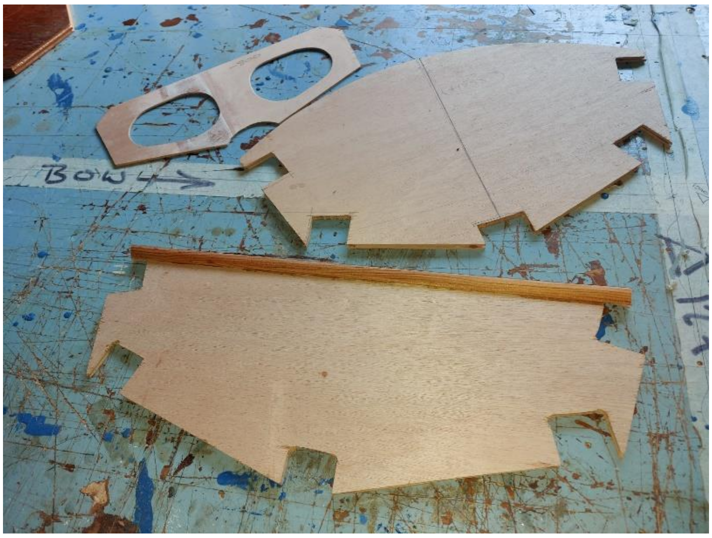
Popping the completed work off the mould is impossible unless the greatest care has been taken in forming the recesses. I tried and failed.. and then resorted to the following method, which I recommend you follow. This is to make a very thin glassfibre mould which becomes part of the finished fabrication.

Start with a 19mm thick * 50mm planed timber board and chamfer one long edge to a neat semicircle. Cover it with polythene and lay up one layer of 200g/m2 glass cloth over the curved edge. You are making a long 'U' section in glassfibre. Make a lot more of this than you think you will need. Using a chop saw set at 75 / 15 degrees, without removing the timber, cut this into a series of triangular pieces 67mm*21mm. This uses up a surprising length of timber and there will be some trial and error involved in making 10 identical pieces to the correct dimensions. Release the pieces from their timber formers and bond the ends to a small piece of flat 200g glassfibre sheet (which you have laid up previously) to make a fully-sealed end piece. You now have a thin glass fibre former, over which you can lay up the main bulk of glass or carbon. Now re-insert the timber formers (to stop it crushing) with the polythene separation layer (to break the bond) and fix them down to the prepared board.

The lay-up of such a thickness of glass or carbon over such a small complex shape is very difficult to achieve. It is best to use multiple layers of a 200g twill, rather than fewer layers of a heavier cloth. A vacuum pump is strongly recommended, both to achieve a high-strength job, but more importantly to bend the fibres over the tight corners of the mould. I recommend making up a trial piece first to find out all the pitfalls.

<u>Work to the Kayak</u>

Make up double bulkheads in 3mm ply, spaced about 2mm apart with thin slivers of wood (match sticks or a sliced-up mixing stick) held in place with CA glue. Keep these small.   Now cut out 40mm*25mm slots in the twin bulkheads to coincide with the bolt locations. The uppermost bolts need to be as close to the deck as possible and these holes should be right up against the shear clamp timbers; the next set is in the lower hull panel, just below the chine, the final bolt is at the keel.



double bulkheads made up with cutouts at bolt locations

To achieve the best bond to the hull we want to bond to clean plywood, so stop the epoxy fillets and glass tape of the chines about 250mm either side of the bulkheads to keep this zone resin-free. Bond the double bulkheads to the hull with small epoxy fillets.

Offer up the recessed bolt fabrications and drill a few 12mm holes through the hull to mark their locations. Bond the fabrications to the plywood hull (sand both faces first) with resin and silica filler. Align the lip of the recessed bolt fabrication do that it lines up with the far face of the first bulkhead, then align the angle fabrication so that its tip lines up with the face of the second bulkhead. – we want these to be as close together as possible (about 2mm) whilst still being able to run a saw between the two bulkheads. Fillet and tape both edges of each fabrication, extending the tape about 75mm up the bulkhead.

fabrications bonded to hull with edges glass-taped

When the resin has hardened, turn the boat over and form the slots in the plywood hull with a sharp chisel. drill a small pilot hole for the bolt using just the tip of an 18mm drill bit aligned carefully within the slot. (The 18mm drill bit ensures the hole is exactly centred in the slot). Now you will need a very long drill bit 4mm or 5mm diameter. Drill through the pilot hole all the way through both fabrications taking great care to keep the drill bit exactly centred and aligned at the 15-degree angle of the slot. This is critical so take care here. Working from inside the boat progressively drill out this hole to 8mm diameter.

You will use 25mm*8mm flange head bolts to bolt the boat together, but you will need some identical bolts 60mm long as temporary bolts to line up the captive nuts. Push the 60mm bolt a distance of 20mm through the hole, leaving the rest of the bolt exposed in the slot; the head of the bolt should be just touching the three sides of the slot if you have lined up the hole perfectly. Thread on the penny washer and connector nut. You might need to trim one edge off the penny washer. Bond the connector nuts and washers in place with a very small amount of filler mix. When the resin has set remove the temporary 60mm bolts and test fit the stainless bolts. If it all lines up nicely then add some more filler to the connector nut to stop them rotating. Also plug the open end of the nuts with glass tape and filler.

Over-length bolt just touching the three sides of the slot to maintain correct alignment when bonding in the captive nut with an initial small blob of epoxy.

Before fitting the deck use a hacksaw blade between the twin bulkheads to start the cut in the hull. Do not cut the boat in half until the deck is in place, otherwise you might get a distorted boat; but you do need to locate where the cut needs to be. You might need to glue a temporary mend piece across the cut if this distorts the shear line.

Now fit the deck and then saw the boat in half with a hacksaw blade!

Loads and Strength

The ends of the boat each have about 80kg of buoyancy. If you imagine the bow section fully submerged then there will be an 80kg shear force at each bulkhead; or more correctly a force of 0.8kN. If we have 4 bolts at the bulkhead then each will see a shear load of 0.2kN (20kg).

The centre of buoyancy of each end is about 650mm from the bulkhead. So, a bending moment of 0.8*0.65=0.52kNm occurs at the bulkhead. If we have 2 bolts at the shear line and 2 bolts just below the chine, they will be about 150mm apart vertically. The tension in each bolt will be 0.52kNm/(2 bolts*0.15m) = 1.73kN. (Or 173kg). I have been very conservative here because I actually use 5 bolts, with the lower bolt at the keel with a larger lever arm – but I am just trying to keep the sums simple.

The submerged compartment cannot exert any greater loads than this under static conditions but we should multiply this up by a load factor to account for the dynamic load case of a moving wave or the swamped boat crashing into the beach. This is impossible to calculate exactly so we have to make a judgement.

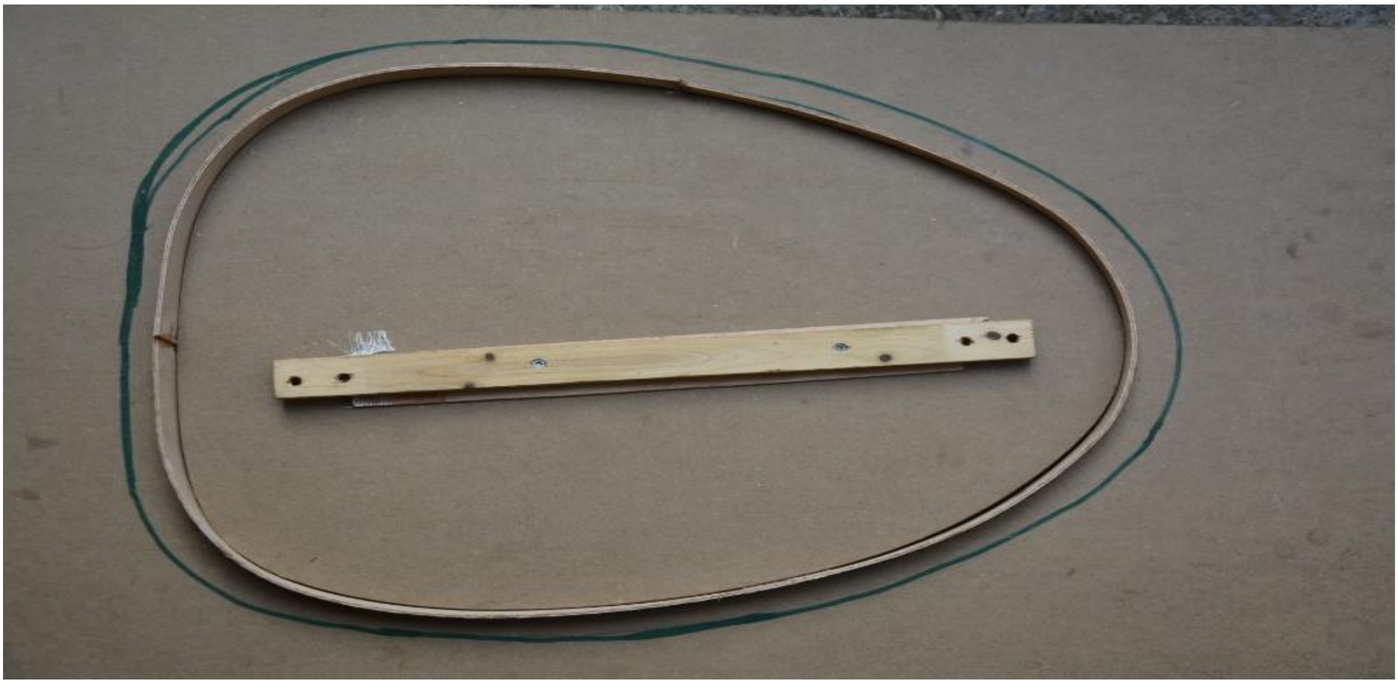
An 8mm stainless steel bolt has a yield strength of 9.2kN. (Almost 1 ton) We will be very conservative and design all our components with a load factor of 5 so as to match the strength of the bolt.

The captive nuts and the bolts are held in a glass or carbon fibre fabrication, which is laid up off the boat and then bonded to the inner face of the plywood hull. The bond area of the fabrication is 40mm*200mm so the bond stress is 920N /(200mm*40mm) = 0.11N/mm2. This is tiny compared to the bond of the epoxy to timber, which is in the region of 3N/mm2, so this detail is robust.

Calculations for the fabrications are much more complex so I will not reproduce them here. In glass fibre they need to be 5mm thick and this can reduce to 3mm if using carbon. The thickness is greatest at the nut/bolt and tapers along the length of the fabrication.

An alternative methpod of making an ocean cockpit from Chris JK

I am trying an alternative method for constructing the cockpit. Here it is an ocean cockpit and it might be a bit more challenging for a keyhole. I have used two lengths of ply and got round the bends with the help of a heat gun and screws.



How to determine your ideal masik position and height for an ocean cockpit

Christopher favours ocean cockpits, and these necessitate some changes to the position and height of the masik. Here's how he calculates these changes:

"The only area that matters "upstairs" is where you end up sitting and where that places your knees. I focused first on identifying where I would be sitting. This is a fixed point from the measurements list, and it should not be changed. I placed the hull (just after fitting the sheer clamps) on the ground resting on cushions and very gently sat inside it. By doing this I was able to identify where I wanted the masik, or deck beam; an inch behind my knee caps. Unlike the first Shrike, I defined the position of the deck beam based upon my body rather than the size of the plywood. It would be possible to do it both ways by using two deck beams, one for the plywood joint and the other for the knee beam (masik) but I decided it would be simpler to slide the plywood aft to the position of the masik beam leaving a small triangle at the bow rather than attempt to construct and align two curved deck beams. The other critical measurements are the deck height and cockpit length, and they are related. You need to decide upon one and the other is derived from it. I chose a cockpit length of 19inches as this was similar to my other kayaks and allowed me to share spray skirts between them. I then used my body to decide how high the deck would to be to curve to allow my knees to get under the deck at the front of the cockpit while my butt was sitting on the back of the cockpit rim (which remember will be slightly raised above the deck). This sounds complicated but it isn't really. I sat on a plank straddling the stern deck and I rested another across where the masik was going. I was then able to adjust it and approximate how much clearance I needed above the gunwales (70mm)."

Adjusting the top of the foot bulkhead when the masik curve has been lowered.

If you decide to reduce the curvature of the masik to lower the front of the cockpit you will also need to reduce the height of the foot bulkhead.

The simplest way to do this is to place the foot bulkhead plywood against the masik and trace the same curve onto the top of the foot bulkhead. Different plywood will bend in different ways, so if you wish to be more precise you can create the curve at the top of the top of the foot bulkhead using the same equation used to create a bespoke masik, with a new beam (L) and new height (D) above the gunwales. The beam (L) is easy to measure at the foot bulkhead, but the height (D) is more complicated: Without the foot bulkhead in position, fit the foredeck plywood in its final place without any glue, but with enough straps to make the plywood buckle in its final position about 900 mm from the bow. Then measure the vertical distance (E) from the top of the keel to the underside of the deck plywood at the foot bulkhead position, inside the hull. We use a flexible steel tape measure with a lock to do this. The body of the tape is usually marked with its width, so you can jam the tape in position and thus obtain an accurate measurement. (E)

Now remove the deck, place a straight edge across the hull at the foot bulkhead position, and measure the vertical distance (F) from the keel to the underside of the straight edge. Subtract this distance from the previous measurement, and you have the height (H = E - F) to put into the equation.

Whichever method you use, fit the foot bulkhead temporarily in place with hot glue or drops of CA glue, fit the deck with straps, and mark with a pencil any places where the foot bulkhead top is too high. Take off the deck, adjust the top of the foot bulkhead with a plane, and repeat until you are satisfied. Then add the strips to make the top of the foot bulkhead thicker so as to make a stronger joint, as shown in the Build Manual.

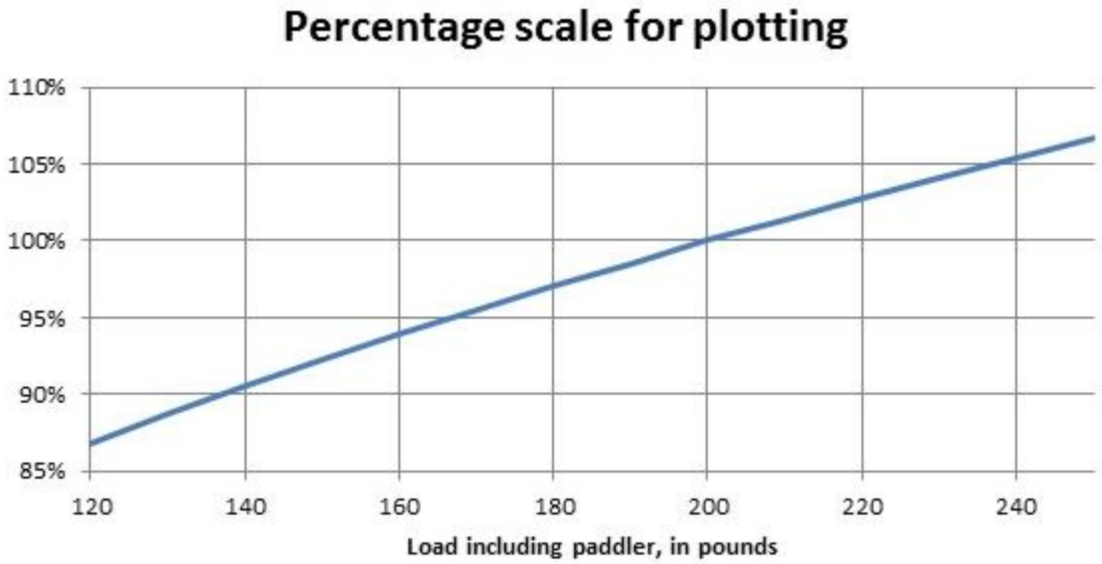
Appendix B: Frequently asked questions

How do I decide which model and variations to choose?

Do you want (a) a day tripping or expedition kayak, or (b) a specialist rolling kayak? If (a) then, then select (c) keyhole cockpit – this is a standard Shrike or (d) ocean cockpit – this is a Shrike Too If (b) the specialist rolling kayak is Shrike-R Now that you have selected your basic model, Shrike, Shrike-Too or Shrike-R, decide whether you wish to vary the scale of the kayak to suit your bodyweight, as determined by the graph below under “Will the Shrike work for my weight?” Finally, select your desired height for leg clearance at the front of the cockpit, between the keel and bottom of the cockpit rim. Experience in other kayaks will guide you in this.

Will the Shrike work for my weight?

As described in the free downloadable Build Manual, the height of the gunwales can be varied to suit differing paddler and equipment loads. However, the scale of the plans can also be changed during printing, so that every dimension of the kayak is adjusted by the same percentage. Below is the graph we use to relate the printer/plotter percentage scale to various loads of paddler plus equipment, in pounds.



Because of the length limitations in the pdf specification, the pdf is downloaded at 50% scale, so percentages taken from the above graph must be doubled. For example, a load of 137 pounds (62.1 kg) suggests a 90% plot, doubled to 180% if the pdf is downloaded at 50%. The resulting “LV” version for a 137 pound (62.1 kg) total load would have a beam of 19.3” (491 mm), and a length of 15ft 8 inches (4773 mm). Feel free to experiment with your planned design. Bear in mind when scaling the design that all linear dimensions must be changed to the same scale. That includes all the measurements relative to the datum line, such as paddler seat centre, position of temporary forms(exterior and interior), and position of bulkheads

If I increase the height of the topsides to cope with higher loads, will that change the cutting layout on the plywood?

To construct the standard hull we cut two full sheets of ply each into five equal width strips (1220mm divided by 5, less saw cuts). The topsides, in particular, are a close fit for width on these strips, because of the rise of the gunwale towards the bow and stern. If you increase the topsides height you may need to nest the curves of the bottom panel chines into the gunwale shapes of the topsides when devising a cutting plan for the plywood. This may require you to devise an alternative layout and cutting procedure for the full sheets. Cut round the paper templates and lay them on the full sheets before cutting into them.

Why do you not fit the sheer clamps to the topside panels before assembly? This seems simpler, and is recommended by most kit suppliers.

With the steep rise and double curvature of the gunwale near the bow of Shrike, and the required kerf sawing (of unknown extent – it varies with the timber) to enable this without stress to the timber, we decided not to use the usual simpler method of prior fitting. If the topsides plus sheer clamps are stressed excessively into position, this can distort the desired final shape of the gunwales, and unnecessarily stress the whole structure.

How do I know that my plans are printed accurately?

The plans include two lines, each 500 mm long, one along and one across the print-outs. These lengths should be checked with a steel rule to ensure accuracy. Our comfort level is plus or minus 0.5 mm.

How do I make sure my Skeg box does not leak?

Two builders have reported water leaks from the top corners of the standard plywood skeg box. The plywood and inner solid wood framing of the box have simple joints at these points, so there is potential for leaks. We recommend special care to ensure the skeg box is water-tight. Do not use excessive clamping pressure which would exclude all epoxy adhesive from the joints. Apply glass fibre tape and resin over the outside perimeter of the box. Spoon a small amount of warm thin resin into the upside down box while it is on the bench, before the hole is drilled for the skeg wire fitting, and tip the box so as to run the resin into the joints. Leave the box upside down until the resin is set. Taking extra care at this stage is less trouble than attempting to cure such a leak after the kayak has been completed and launched. Filling the box with water is a good test.

Does the Shrike need the skeg?

Whether or not a skeg is necessary very much depends on the area you paddle, what are the wind and sea conditions in which you paddle, and your own physical state. For example, Nick has a chronically damaged right shoulder. He can't afford to edge and sweep for long periods to counteract weather-cocking. The worst conditions for weather-cocking are flat sea and strong winds from the quarter. If you always aim to paddle in light winds, and you are fit and strong, then you may never need to deploy a skeg in a well-balanced kayak. If you are in doubt, you can build a Shrike without a skeg, but with a stern hatch and the stiffening structure for a skeg. You could then retro-fit a skeg if you decide one is desirable, although this is more awkward than fitting one during the initial construction. In the end though, we have not yet paddled a sea kayak that, ultimately, and in certain conditions, did not benefit from the deployment of a skeg.

Can I omit sheer clamps, and rely on glass tape inside and outside the deck to hull joint?

We strongly advise against this when building with the 3mm plywood. The sheer clamps produce fair smooth curves and enable a very strong joint. We've spent too much time mending these joints on $3000 glass fibre kayaks where glass tape has been the sole method of joining the hull and deck.

I read via the Origins page on your website that hard chine kayaks like Shrike balance quite differently from kayaks with a flatter hull. During the time I'm building a Shrike, are there any exercises I can do to train for this type of balance?

In addition to maintaining your flexibility and core strength, just follow the Inuit practice. Build or buy a simple "kayak balance stool", and build up the time you can maintain your balance, perhaps while watching a DVD. Searching the internet for "kayak balance stool" will bring up simple directions for building one from scrap timber, or there are commercial suppliers.

Can I use cheaper plywood?

The recommended BSS 1088 3mm okoume plywood is usually of superb quality. It is consistent in that we have experienced no voids in the inner ply, and it bends evenly without splitting. We have experimented with cheaper plywood, with conspicuous lack of success. It is possible that poorer quality plywood would take the bends in the hull panels, but not the contorted shape of the foredeck, particularly if a high foredeck is constructed. Low building cost is one of the aims of the project, so we would like to hear of any successful use of cheaper plywood. Top quality BSS1088 okoume marine ply is such a joy to use.

What brand deck hatches do you use?

In the U.K, SeaWorld hatches have proven to be 100% watertight, as claimed. Solent Marine and Seascrew are suppliers in the U.K

How do you repair a hole in a compartment?

Let's suppose you were rock-hopping, and holed the Shrike's hull. You did, of course, have a buoyancy bag filling most of the compartment, enabling you to get home…… The challenge in repairing a hole in a bow, stern or day compartment is that there is no easy access to the inside to facilitate a simple patch repair, unless it is close to a hatch. In an emergency, just cover the hole in repair tape, but, when back in the workshop, here's how we do it: 1. Remove the damaged area by sawing round it with a jigsaw, or a hacksaw blade held in a rag. Make any corners well rounded, to reduce stress concentration. 2. Prepare a patch of 3mm marine ply (left over from your construction) to be the same shape as the hole, but about 25mm (1”) larger all round its perimeter. Drill a hole of about 3mm diameter in the approximate centre of the plywood. 3. Coat both sides and the edge of the patch and the hole with epoxy resin, and let it set. 4. Lightly sand one side of the patch, and draw a conspicuous pencil line on this side about 1.5” (40mm) in from the perimeter, and all round it. Sand the first inch or so (25mm) of the inside of the compartment around the hole. 5. Pass about a foot (300mm) of 1/8th (3mm) cord through the hole in the patch, and put a bulky knot at the end of the cord on the unsanded (inner) side, of the patch. Tie a one inch diameter loop in the cord on the outer side of the patch, and leave the excess cord intact. 6. Check that you can now “post” the patch through the hole in the hull, and pull it back by hand until it is firmly pulled into the correct position and orientation inside the compartment, as shown by an even view of the pencil line around the hole. The patch can be manipulated into position with one hand, while putting tension on the cord with the other. A temporary knob hot-glued into the centre of the outside of the patch can aid this procedure. Don’t lose the patch inside the compartment! Tie a large tool to the other end of the cord to make sure. Remove the patch and cord. 7. After the rehearsal, generously coat the outer inch or so of the perimeter of the sanded outer face of the patch with epoxy resin thickened to peanut butter consistency. The resin must hold its shape when the patch is vertical. 8. Delicately feed the patch through the hole, and pull the patch into its correct position and orientation. Slide a large screwdriver or piece of timber through the outer cord loop. Rotate the screwdriver to twist and thereby shorten the cord until the patch is pulled snugly against the inside of the hull, and an ooze of epoxy is visible. Maintain outward tension on the cord with one hand while rotating the screwdriver with the other. (This is known as a Spanish Windlass technique.) Tape the screwdriver to the outside of the hull when the desired tension is achieved, remove any excess epoxy, and leave the epoxy to set. 9. Remove the Spanish windlass system, cutting the cord and allowing the inner knot to fall into the compartment. 10. If the kayak has a painted finish, fill the resultant void with epoxy thickened with lightweight fairing compound, then sand and paint. If the kayak is clear finished, take a rubbed pencil tracing of the hole on paper, and prepare a repair patch to this shape from 3mm plywood. Fix the outer patch by using superglue with accelerator to hold it in position, and then finish with thickened epoxy in the visible joint. Sand and coat the area with epoxy resin until satisfied with the finish. This procedure will take much care to produce a satisfactory result, and one option for such a repair in a conspicuous position is to convert to a painted hull, and/or deck.

I don’t have enough clamps, what can I use instead?

If you are using the screw-less approach to fitting the carlines you need a lot of clamps. If you don’t already have enough you can make some simple alternatives using plastic plumbing pipes cut lengthways. The longer the tube section the greater the force they apply. Here is a video that demonstrates this approach.

Can I get the AutoCAD DWG or DXF files?

The Shrike templates were drawn using AutoCAD®. The original CAD (DWG and DXF) files are now included in the plan and template download file that you can receive using the download page. We encourage you to alter, enhance, experiment and improve upon every aspect of our work. If you want to make money making kits and selling them, or constructing kayaks derived from this work you are free to do so.

Why the name Shrike?

We could say that a shrike is a bird with a pointed beak, just as the Shrike kayak has a pointed bow. However, the truth is that Nick first came across Shrike as the name of an extreme rock climb on Clogwyn d’ur Arddu, a cliff on the north face of Yr Wyddfa, the highest peak in Wales. A photo of this climb appeared in the rock-climbing guide to the cliff (1960’s ??). The climber in the photo, Hugh Banner (RIP), was shown in a wonderfully dramatic position on a very steep wall. The name, Shrike, had just the right tone to emphasize the dramatic nature of the route. Fifty years later, when Nick saw the finished kayak with its flowing lines accentuated by black paint, he knew it had to be called Shrike.

Why the name CNC Kayaks?

We like to play with words. CNC is, of course, widely used as an abbreviation for “Computer Numerically Controlled”, which describes the method by which computers take over from humans in much of industry. However, a main tenet of the Shrike project is that the design should evolve organically from the way the very thin plywood actually wrapped around the craft during the prototyping, rather than be constrained by the limitations built into the controlling software. Have you ever wondered why some stitch and glue kit kayaks look boxy and slab-sided? We only used computers to receive the manual measurements of the completed kayak, and output these measurements to plans. So, CNC is used tongue-in-cheek, knowing that it is likely to be misinterpreted. The truth is that **C**hristopher & **N**ick **C**rowhurst is the reason for the label.