Chapter 12.

Sailing the Split Junk Rig, and points to watch.

This is where the payback comes, and the fun starts. This rig is easy to sail, but there are a couple of things to be aware of simply because the rig is so powerful.

As the rig is designed to be as stress free as possible, to make sail is simply a case of lifting all jambers and hauling on the halyard until the required amount of sail is raised. This is followed with a tug on each downhaul/ batten parrel and finally a light pull on the yard hauling parrel but only if less than full sail is being used. This may change as the yard peaking halyard is developed, but that will only be a one line pull. There are no other adjustments to make, apart from the sheet and you're sailing. To hand the sail we simply release the halyard and let it run, though I tend to let the halyard run over my gloved hand, probably just out of habit, or in case the tail of the halyard snarls up.

Tell tales are fitted near the luff of each jib and consist of a length of about 35 cm of dark synthetic knitting 'wool' threaded through the sail material and knotted on either side. A single tell tale is also fitted in the centre of the leech of all the 'main' panels, but is not really used since the initial sailing trips. The ones on the jibs are important and do make a huge difference to the performance if kept streaming, but that is true with all head sails.

Close hauled, the rig is brought in much further than with flat junk rigs as the jib is effectively sheeted wider than the battens, and it is possible to sail as close as 30° to the apparent wind even with the fairly blunt Westerly Longbow, though generally we sail at about 35° to the apparent wind. Once the rig angle is found then it is simply a case of sailing to the tell tales. Tacking is easy and can be slow or fast and we have never seen a hint of missing stays. The tacking angle can be below 80° if the water is flat, even in the blunt fronted Westerly, but where we usually sail the Solent chop encourages easing out to nearer 40° to the apparent wind and tacking through just under 90°. That is still better than most equivalent Bermudan hulls in the Solent and so is the windward performance. It is interesting to watch the crews on Bermudan rigged boats sit up as we go by and see them suddenly whip their crews into tweaking mode. It doesn't do them much good, but it's fun to watch.

Bearing away is simply a case of picking your heading and easing the sheet until the tell tales are streaming again. This continues as you bear away further until the rig is at 90° to the hull by which time the wind will be about 140° off the bow and we keep an eye out for windward heeling which we will discuss later. Further off the wind we just have to accept that the rig will start to stall, but even so we still seem to get some flow through the slot and some flow across the lee side of the sail, and the improved performance that goes with it. It's great to keep up with the spinnaker boats without lifting a finger or running around on deck.

There is a tenancy to over canvas the boat as it seems to just go faster. With experienced Bermudan rig sailors at the helm they keep asking for more sail even when we are above hull speed. It is rare to feel over canvassed except in the cases mentioned later. I find it tends to bring out the hooligan in the helmsman, and certainly has highlighted the fun element in sailing, just as a sports car does when driving, even though the hull is rather pedestrian. It would be interesting to see how it would perform on a sports boat hull.

As with a family saloon car, if the engine is replaced with a more powerful supercharged one then it is advisable to be gentle with the throttle, therefore it is worth also writing the inevitable 'Government Health Warning'.

Until used to the rig it is recommended that only a 2 or 3 panels are hoisted when in confined places such as a river or near moored boats while manoeuvring at low speed. Probably the best way to explain the reasoning is to give an example of what can go wrong.

On the second or third time out we motored out of a marina berth to a point in the middle of the river, turned into wind to hoist full sail with the intension of letting the bow fall off and running straight down wind and down the river. With no wey on the rudder has no effect, but with a Bermudan rigged boat there is no problem as the drag of the flapping headsail would pull the bows round and start the boat moving in the required direction, slowly build up speed and therefore rudder control. With the split junk rig the bows fell off much more slowly, and the sail remained quietly feathered into wind until the rig was at 90° to the centre line when the sheet was checked. The bows fell of a few more degrees and then the full drive of the rig hit and the boat shot forward ignoring the rudder which was hard over to bear away and promptly stalled. The natural tenancy for the boat was to round up a little which it did, but there was only about one boat length before the bows would T-bone Brtrand's lovely catamaran PHA. Fortunately the engine was still running so full astern and opposite rudder to round up and the impact was avoided, by inches!

Despite years of teaching boat handling and never having seen such acceleration before we repeated the situation, and received the same result. The look of horror on Brtrand's face was something to see! Still not satisfied, we tried again, but this time there was more room as once again Poppy accelerated out of control only to see Brtrand's rudders disappear at high speed out of the collision zone. Wise man. Older and wiser, we dropped sail and motored round until pointing down stream before slowly hoisting on the run.

There have been other indications that the full rig is too powerful to use in restricted waters, so the warning is to only use a couple of panels until you gain experience. It may be worth experimenting in open water close to a small racing buoy to see this effect.

There is another situation where it is necessary to be careful when using the high power of the rig. The aim of the design was to get the total force vector as far forward as possible, or as high a lift/ drag ratio as possible. This has been achieved to the extent that it is possible to sail with the boat heeling to windward!. True, you can do this in a Laser dinghy, but it is not normal in a 30 foot cruising boat. Again, a little story explains the situation well.

We left the Folly Inn one morning, bound for Benbridge with a nice little NW/4 blowing, and not too gusty, but much lighter as we close reached down the river. The owner of a 38 or 41 foot Moody who had been asking about the rig the evening before spotted us and dropped his lines and motored flat out after us, bound for the same destination. At the mouth of the river he was right on our transom, but as we bore away on course under full sail he had to round up and hoist his main before unrolling his Genoa. As his main was blanketing his Genoa he rounded up again to drop the main, before chasing after us again, but needless to say, there was no contest. We soon lost him in the distance astern.

Passing Ryde we had the wind on the port quarter 140° from the bow, and were overhauling a trio of 38 foot Beneteau sailing school boats, and we were worried that they might broach in front of us as they were showing signs of rounding up in the gusts.

It was at this point that we realised that they were heeling an average of about 10° to starboard, down wind, while we were heeling about 10° to port, up wind. In a gust their heel would increase and they would round up a little, and our heel also increased to about 15° to post. Suddenly we were struck with a much stronger gust, and my wife who was sitting in the cockpit with her back to the wind and steering with her hand lightly on the tiller found herself leaning back as the boat heeled towards her and her arm wasn't long enough to push the tiller up hill and hold the course. I was on the other side so simply took the tiller and pulled it up and we held the course, but the Beneteaus all rounded up.

We were obviously over-pressed in the gusts so we quickly dropped a couple of panels and continued with the mast upright and with no loss of speed. We were obviously heeling to windward because the total force vector from the rig was to windward clearly indicating the high lift/ drag ratio. An alternative to reducing sail may be to pull the rig in about 10° from squared off, and in that way pulling the total thrust vector round to dead ahead so that a gust would not heel the boat.

The moral of this story, as with the previous one is that it is necessary to be aware just how powerful the rig is and be aware of the direction of the total force direction with respect to the sail.

Is it conceivable that the Split Junk rig can beat a Bermudan rigged similar hull to windward? The key to close hauled performance is in achieving a high lift/ drag ratio. Without going into detail it is possible for the rectangular shape of the junk could have a better average lift over the total area than the triangular with its inefficiencies near the tapered top of the sail. Equally the drag of the unstayed rig is less than the stayed Bermudan, but more importantly the lower induced drag from the better sail profile can produce a much lower overall drag.

With good total lift and less drag then there is no reason why the rig should not have a better lift/ drag ratio and therefore a better windward performance. It is no longer necessary to touch your forelock to the Bermudan rigged boat as he moves ahead.

Appendix 1.
'Some Thoughts'

These 'Thoughts' were previously published in the Amateur Yacht Research Society, number 11, January 2003 and the Junk Rig Association Newsletter, number 40, January 2003.

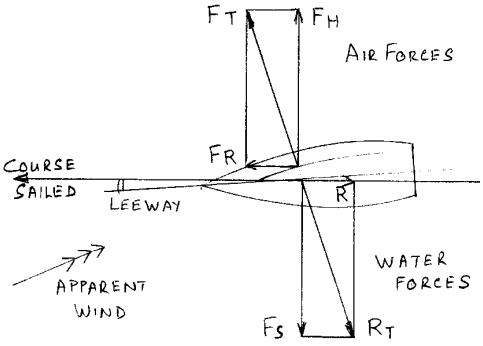
Background Thoughts.

The following notes were written in an effort to analyse available information as it applies to the windward performance of the westernised version of the Full Battened Chinese Lug Rig. They should be viewed as a personal interpretation as required for a particular set of problems. The diagrams below are either based on the diagrams of others or on best assumptions based on their results. The author is keen to receive criticism of these thoughts in an effort to open a debate and expand the pool of knowledge.

Basic Thoughts.

Since the first Single Handed Trans-Atlantic Race significant effort has been made to improve the performance of the Chinese Lug rig, yet it is still seen as being over complicated and to have poor windward ability. Unfortunately comparisons are usually made with highly tuned Bermudan rigs as used on America's Cup boats which have large well-trained crews and extensive sail wardrobes. No effort is taken of more realistic comparisons with family cruisers, where an elderly roller Genoa with a poorly set sheeting position will also produce poor windward performance, and which will be even less efficient as the wind frees. Until a boat with a fully battened lugsail produces a remarkable performance in some much-publicised popular event interest will stay low, leaving just a few enlightened enthusiasts to enjoy the many benefits.

The quest is to produce an easily handled rig for a lightly crewed cruising boat which will have equal or better performance than a cruising Bermudan sloop on all points of sailing. Inevitably this means concentrating on the windward performance.



Basic Hydrodynamic Theory.

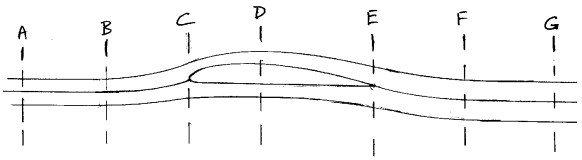
Figure 1 is a simplified diagram of the forces involved in the close-hauled situation. F_T is the total aerodynamic force produced by the wind in the rig, and can be resolved into F_R along the track sailed, which drives the boat forward, and F_H perpendicular to the track sailed, which causes the boat to heal and make leeway. R_T is the total hydrodynamic force which is equal and opposite to F_T, which can be resolved into F_S which resists leeway, and is equal and opposite to F_H, and R which is along the track sailed and is equal and opposite to F_R.

As the wind gets stronger it pays to reef to reduce the heeling force F_H to keep the boat moving at its best speed. As reefing reduces the total air force F_T it also reduces F_R, the driving force. This implies that simply increasing the total force F_T will not necessarily increase the boat speed, and as the wind gets stronger an increase in F_T will actually slow the boat below its best speed.

The simple answer to improving speed to windward must be to increase F_R without significantly increasing F_H, which is the same as swinging the vector F_T forward towards the bow of the boat. The question is how to find a simple solution to this simple problem.

Basic Aerodynamic Theory.

It may be helpful to look at the aerodynamic forces involved to find an answer to the 'simple' problem. Figure 2 shows the airflow around a simple flat-bottomed airfoil of the Clark Y type, and Figure 3 shows the forces involved. Admittedly thick airfoils are somewhat different to sails, but this diagram should make the situation easier to grasp.



In Figure 2, between A and B, the air approaches the airfoil with the streamlines straight and parallel. From B to C the presence of the foil is first sensed by the air, which produces upwash (of which more later). At the stagnation point C the flow splits and the air going over the top accelerates over the curved leading edge and the pressure drops. The flow which goes below the foil slows and the pressure increases. After E the flow is deflected but by F will return to its original direction but with energy removed.

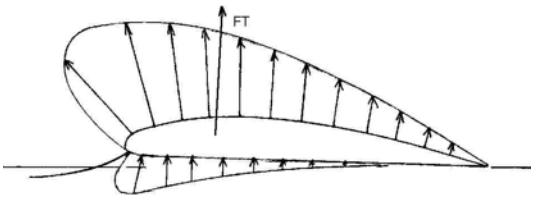
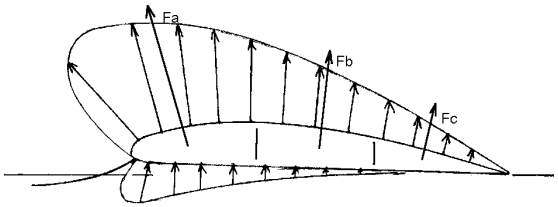


Figure 3 shows the pressure pattern affecting the foil. As pressure can only exert a force perpendicular to a surface, the force vectors will always act at right angles to the curved surface of the foil. The total force produced is the vector sum of all the vectors for each unit of area, and is the total force F_T referred to earlier. Rather than add all the force vectors it is interesting to divide the foil in thirds and add the vectors for each third separately. Although not accurately drawn, Figure 4 shows that it is the sum of the vectors from the first third of the foil, Fa, which produces the desirable forward directed force. This shows that it is the first third of the foil that is the most important for sailing to windward.



Figures 2, 3 and 4 show the impressive performance of a thick asymmetrical airfoil, and suggest that a wing sail should perform well. Unfortunately a single ply sail cannot have a thick leading edge, with the stagnation forced round to the lower side by the upwash and the air accelerating over the leading edge, which produces excellent windward drive. With a sharp edged sail the leading edge must exactly point into the airflow as it strikes the sail or a separation bubble will develop which will greatly impair the pressure development. Therefore the best a single ply sail can do is produce a force vector at right angles to the upwashed stream.

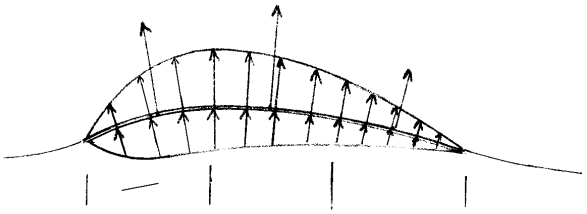


Figure 5

Figure 5 is an effort to show that the single ply sail can still produce useful 'forward' thrust provided

that the first third of the foil is well cambered and that the sail starts to curve as early as possible to develop the suction at the front of the sail where the vectors will point furthest forward. (In chapter 17 of his book High Performance Sailing, Frank Bethwaite gives very clear descriptions of the flow and pressure distribution around sails, and makes essential reading for students of sailing performance.)

The Effect of Upwash.

In Figure 2, between B and C the airflow starts to curve up as it approaches the foil. With a sharp edged sail it is important that the air meets the sail exactly in line or separation bubbles form. The more upwash the higher the sail can point to the relative airstream A to B, and as VMG to windward is the cosine of the angle between the true wind and the track multiplied by the boat speed then any increase in the upwash will improve VMG. The air approaching the sail cannot anticipate the sail, but can only react to the pressure pattern produced by the sail. The airflow can only be upwashed by the low pressure above and in front of the leading edge of the sail. Therefore achieving good suction at the leading edge is doubly important as it not only helps boat speed, but by promoting larger upwash also helps by reducing the tacking angle. If the first third of the sail is flat (as on many existing junk rigs) and the low pressure is not formed until a third of the chord from the leading edge the low pressure will have no significant effect on the approaching air and there will be no significant upwash, and therefore a large tacking angle.

All this infers that the solution to the ‘simple’ problem referred to earlier is to build a good camber into the first third of a sail, and encourage the airflow to follow the curve.

Practical Examples.

So how does this ‘simple’ answer fit existing practical Junk rig experience?

Despite achieving significant improvements in performance on his boat Felix, Bunny Smith pointed out that his Junk rig still under performed to windward. He illustrated this in Junk Rig Association (JRA) newsletter No.26, page 22, para. 8, with a sketched polar diagram. In para.18 he stated that when designing the Felix sail he decided on the basis of his airflow observations, sailing experience and aerodynamic knowledge that all sail area ahead of, in way of, and for one foot aft of the mast should be ignored in deciding the lead of the CE over the CLR. This infers that the forward area of the sail was having no significant effect. He actually moved the mast 3 feet forward (11.5% LOA), and raked it forward. Apparently this corrected all the handling problems and the boat then became perfectly balanced. This ties in with his diagram in JRA newsletter No.20, page 16, where he shows a large separation bubble covering the first third of the lee side of the sail. It’s interesting that Joddy Chapman also found leading edge separation bubbles were predominant in his Junk rig experiments.

In stark contrast Frank Bethwaite, in his book High Performance Sailing, in Fig. 17.28 shows a modern wingmast with turbulent flow immediately reattaching, eliminating the separation bubble and establishing attached turbulent flow right from the front of the curved sail. At the end of para.17.10 he states that when they started to get the wing masts to work the boats all developed lee helm. They had to move the centreboard forward a foot or more (> 7% LOA) to balance the powerful suction close behind the mast (at the luff of the sail). This is the exact opposite to Bunny Smith’s experience.

With the separation bubble over the flat first third of the sail the Junk rig under-performs to windward whereas the wingmast with attached turbulent flow over the first third of the cambered sail actually helps the dinghy plane to windward!

There are many other examples of the importance of the flow over the first third of the lee side of a properly cambered sail. Without a tight luff the jib of a Bermudan rig looses its designed cambered sail shape and flow, and its windward performance deteriorates. A partly reefed roller genoa also has very poor sail shape and performance to windward is much worse than if using a smaller hanked on sails. An old stretched genoa, with the camber blown aft will not point nor foot well to windward.

Without good suction near the luff of the Junk sail there is less upwash than with the Bermudan rig and therefore a wider tacking angle.

An Apparent Conclusion.

The above would suggest that until a method is found to build a properly cambered leading edge and achieve flow to the lee side over the first third of the sail then the Junk rig will not perform well enough to windward to sway the sceptics. Conversely, if this can be achieved then when combined with its other virtues, the Junk rig could embarrass quite a few people and achieve a large following.

An Examination of the Present State of Art.

All the above suggest that a flat, uncambered sail will not perform well to windward. The early Hasler/ McLeod rig performance agrees with this, with poor drive and large tacking angle due to lack of upwash.

All the newer, better performing Junk sails employ camber, either from flexible battens, hinged battens or stiff battens with broad seam built into the sail. Unfortunately the achieved camber does not always extend forward to the luff. There is now some news of experiments with pre-bent battens with double skinned sails, which could prove to be very interesting.

Flexible battens have the known disadvantage of bending more as the wind gets stronger, which is far from ideal. The forward section of the batten, in front of the mast, also tends to bend the wrong way and show no potential to easily produce the desirable camber and attached flow suggested above as required for good windward performance.

Hinged battens have the advantage that the camber is constant over the full wind speed range. Unfortunately the first 30% of the batten has to be stiff to prevent the batten hinging the wrong way which does not encourage the development of high suction forward to get the forward directed force and strong upwash desired.

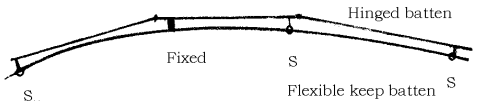
Stiff battens with panels shaped by rounding or broad seam, as illustrated by Arne Kverneland in JRA newsletter 30, page 21, does seem to show some advantages, and some weaknesses. This set-up does not produce an ideal smooth airfoil surface but does have camber right to the leading edge at the middle of each panel when on starboard tack. The photographs on pages 21 and 24 show this, but the photo on page 23 shows the port tack case with the mast and the Hong Kong parrels distorting the airfoil shape. Arne claims that the rig tacks through 90 degrees and gives good balance. It would be interesting to fit instruments to see if the performance on starboard

tack is significantly better than on port. It would appear probable that it is, and if this could be achieved on both tacks then the performance may be very interesting, particularly if the broad seam at the luff could be carefully tailored.

In JRA newsletter no. 31, page 14, Arne also stated that using hinged battens 'gave some increased weather helm.' This would suggest that the centre of pressure was positioned quite far aft in the sail, and not in the first third. Referring to his straight battens/ cambered sail in JRA newsletter no.30, page 24, he wrote that 'he had to pull the sail a bit aft to avoid lee helm' which would suggest that the first third of the sail was producing good drive. (This would tie in with the better performance achieved with Frank Bethwaite's experience with the wing mast.)

Of the 4 types mentioned above, stiff flat, flexible, hinged and stiff with shaped panels, the latter seems to be the only one able to produce camber in the forward third of the sail at the present state of the art. It may be that best performance will eventually be achieved by combining types, such as hinged battens with broad seam shaped panels over the first third of the sail, or between the straight sections of the battens, as in figure 6. Alternatively, fitting the sail to very flexible 'keep' battens attached by spacers to structural hinged battens may achieve a desirable smooth camber in the sail, even into the first third of the sail. In figure 7 the battens are joined with a fixed spacer at F, and sliding spacers at S.

Figure 6



Considering the amount of shaping required with Bermudan sails, and even with rigs like the Standing Lug it is asking a lot to expect a flat cut sail to perform well in a Junk rig, even on bent or hinged battens.

A Sideways Thought.

The above mention superior performance of wing masts would suggest that the thick forward section of the Swing Wing Rig, with the mast enclosed by the sail, has huge potential. It is a pity development did not continue as it would appear that a simple fundamental design error may have marred an otherwise very good rig.

Some Thoughts on a Different Vein.

At the moment there are a number of different outline sail-plans being used. Some are based on the early Hasler/ McLeod designs, others on the Felix form, and some on Vincent Reddish's observations. Rather than follow existing forms it may be worth considering some of the reasons behind the various features in an effort to obtain a better modern day solution. Features worth examining could include 1) batten angle, 2) yard angle, 3) sail outline, and 4) sail balance.

1) Batten angle. Although many think of the air flowing from luff to leech as being horizontal it must be remembered that in producing lift the high pressure air will blow up the windward side of a sail and the low pressure air on the leeward side will blow downward, and producing a vortex behind the sail. The lower the aspect ratio the more pronounced this 'span wise' flow will be. Bunny Smith was keen to promote turbulent flow on the lee side of the sail by 'tripping' the air over the battens. It may, however, be more important to accurately align the battens with the airflow on the windward side to provide a free uninterrupted journey across

and up the sail, and not to 'trip' and lower the pressure of the high pressure air. Streamers or smoke may show the ideal batten slope on the windward side of a well cambered sail.

2) Yard angle. It seems to be generally accepted that the longer the luff the better the potential performance. This has produced long yards angled as near to the vertical as possible, like a Gunter rig. Modern airfoil design is paying more attention to efficiency by pushing the tip vortex as far out and aft as possible. A shorter less acutely angled spar may be more effective if fitted to a sail with a longer luff, by sweeping the actual tip further aft and encourage the vortex to flow from the extreme tip. A less acutely angled spar may even produce an efficient leading edge vortex as developed with the Crab Claw rig. As Tony Marchaj has pointed out, nature seems to like swept tip foils, so possibly evolution should be worth copying.
3) Sail outline. It would appear that all sail outlines are being drawn with a straight luff, with the sail needing adjustable luff parrels or Hong Kong parrels. Vincent Reddish reminded us that the original Chinese method of making the sail was to make the framework of boltropes and battens, and fastening the material to the tensioned framework. If this is done the tension in the angled leech boltropes will push the battens forward and will have to be balanced by the tension in angled luff boltropes pushing the battens back. This will produce a convex shaped luff, and if this shape is built into the sail then the requirements for luff and Hong Kong parrels may be reduced or eliminated. On the subject of Hong Kong parrels, which are required in current designs to keep the boltrope/ batten structure in shape when slack cambered sail panels are attached, the Chinese fitted the parrels at the luff. There does not seem to be any reason why they could not be fitted further aft or even towards the leech to cause less interference and allow better sail camber at the luff, or even eliminate them with better design.
4) Sail balance. Since Bunny Smith found it desirable to pull the sail as far back as possible with the flexible battens of the Felix rig it is notable that all rigs have been pulled back for windward work. If camber can be induced in the first third of the sail then it may be desirable to place as much of the sail as possible forward of the mast to achieve as much beneficial forward thrust as possible. Such increased balance in the rig could produce many desirable side effects, as mentioned later, as well as softer tacking and jibing. The mast could also be stepped further aft in the hull, which could have structural advantages.

<u>Some resulting thoughts.</u>

All these thoughts lead towards a different sail shape based the most promising features, which would appear to be –

5. Stiff battens, with broad seam to produce camber right to the luff.
6. Maximum clear cambered area in front of the mast to maximise the desired forward thrust.
7. A convex luff to balance the convex leech forces and simplify the rig.
8. A long luff with a moderately angled yard to push the vortex as high and as far aft as possible.

As the mast will spoil the sail camber on port tack, it would seem logical to split the sail around the mast and end up with a 'jib' and a 'mainsail' on the one set of battens, like a junk rigged Swing Wing or Aerorig. This would appear as in Figure 8 and may have the following advantages –

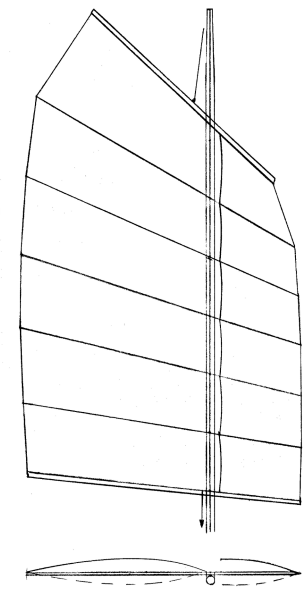


Figure 8, not to scale.

9. With the convexed luff balancing the convex leech, simple fixed batten parrels and downhaul tension aligned with the straight ‘mainsail’ luff there should be no need for either luff parrels or Hong Kong parrels.
10. The downhaul tension should control the twist as on a simple balanced lug so it should be possible to use a simple 2-part sheet on the boom.
11. With so much balance it should not be necessary to move the rig fore and aft to balance the boat on and off the wind.
12. The ‘mainsail’ may require less camber as the ‘jib’ shape and setting will be the most important to produce windward drive. Also the chord of the ‘mainsail’ would be reduced compared to a single sail case so there would be significantly less broad seam required achieving the sail camber.
13. The interaction between the two ‘sails’ may encourage faster flow over the lee side of the ‘jib’ and encourage enhanced upwash and better drive.

There could also be some disadvantages –

14. The shaping of the broad seam of the ‘jib’ panels would be critical to the windward performance.
15. Reefing may not be as easy as with a conventional junk as the bottom batten after each reef would have to be tensioned by a downhaul at both luff and leech, however modern single line reefing may help to achieve a good set.

The obvious name for this rig would be the Split Junk, or SJ for short.

Looking back through old copies of the JRA Newsletter to No. 24, page 31, there is a very similar diagram in an article by Paul McKay, different only in that he had not placed the slot between the sails at the mast position. It’s a pity he could not have been encouraged to follow his line of thinking all those years ago.

Appendix 2.

Sailmaking, and tips.

They say that you learn by your mistakes. If that is the case I must be an expert sail maker by now, as I have made so many mistakes along the way when building the sail for Poppy.

When I came to the conclusion that a Split Junk might give improved windward performance I realised the only way to find out was to try it. The final decision was to build it for a 31 foot Westerly Longbow which became available and which needed a new rig.

The sail area was planned to be the same as that of the mainsail and genoa combined, which is 540 sq.ft. (50 sq.m). One sail maker I regularly use quoted £3000 of the top of his head for a flat sail to that area, without knowing of the complexity of my design. Another was interested in the design features, but would have charged on an ad-hoc basis. Then I visited the 2005 Southampton Boat Show and approached all the sail makers at the show. On average it took only 2 to 3 minutes for them to show their disinterest in making anything other than a computer designed triangle. Then I came to two very interesting stands almost side by side. The first was the Solent Sewing Machines and there I found a row of machines being demonstrated. David Tyler had told me that he uses a Sailright Ultrafeed LSZ-1 and I could quickly see why. They do not hire out the machines nor keep second hand ones as they can sell them for near new prices on e-bay. This then made sense of paying some £500+ on a new machine and selling for over £400+ some 6 months later.

The next stand was Kayospruce, who provide sail making materials. A few quick sums and the economics of making my own sail made a lot of sense. (The one weakness which I expected to appear was that I probably would not sell the sewing machine afterwards and which has been the case, however there are covers and further sails to make so I am not unhappy). By the way, I have no commercial connection with the 2 firms mentioned here, other than as a customer. (But see note 1 below)

Armed with this information I decided not to approach any sail maker as, although I had the design firmly fixed in my head, it was not easy to specify to someone else to make for me. In practice the details evolved as my experience grew, and sometimes were different on similar panels as I experimented. Later experience proved that I was right in not using any sail maker at that time.

My kit is shown in the photograph, and some explanation may be of interest to those who may want to have a go. The main feature of the sewing machine over my wife's domestic machine is that it has a walking foot which grips the material above and below and pulls it forward between stitches. This is most powerful and will pull half a rolled up sail across the floor! I used the zigzag quite a lot, but the

straight stitch machine was a few pence cheaper (and probably would loose out on resale value) and would still do a good job. I had a light fitted, which was well worth the expense.

The red handled seam ripper was extremely useful. Although I did occasionally unpick a seam, it was used for all thread cutting. The red handle was great as, although I always tried to set it down in the same place, it sometimes got lost in the sail material and the red colour made it easy to find. I only used scissors for cutting the Venture tape, and trimming the thread to thread the needle.

I used a separate spool of thread to wind bobbins which I wound at least 4 at a time. It was a real pain to have a bobbin run out halfway down a long seam, so it paid to chop and change on a regular basis.

The green hot knife was not cheap but well worth the expense. I cut all the sail material with it which sealed the edges as I went. The bit of surplus wooden work surface on the left was the mobile cutting surface. (See note 2 below)

The panels were lofted individually directly on the material from an A4 scale drawing. A good propelling pencil with a 0.9 mm lead was the best marker I could find. I used a roller rule as all the camber calculations were drawn on the material (from a spreadsheet).

The white roll leaning on the green hot knife is 19 mm Venture Tape (basting tape). This double sided thin tape held the sections together before sewing, and makes life very simple. I used 19 mm to help make up for my lack of expertise.

The roll of tape under the cutting board is 1 inch tubular polyseter/ Terylene tape to reinforce edges and make loops to spread the load to the battens. The double thickness of the tubular tape was difficult when 3 thicknesses were used, so a thinner tape might be better, but I am happy with the strength of the tubular tape and am glad I used it.

The grey split tubes are soil pipe used to clamp to rolls of material to pass it through the arm of the machine. This was a David Tyler tip and was excellent advice. I tried one long seam without, once, and never again. The knee pads were essential as I worked on the floor, there being no other way to support the material. This meant that I worked single handed, literally, as one hand was needed to press the foot pedal leaving only one to guide the material.

I used V69 thread and number 20 needles through out. This needle size it a little large and the correct needle for V69 apparently is a number 16. The cloth I used was 6 oz sailcloth 145 cm wide, some of which was discounted as end of roll and with slight flaws. I tried to use ‘proper’ sail making techniques, laying the vertical cloths in line with the leech and using edge round and seam taper (broadseam) to shape the cambered panels. The result was a very complicated design, but I found it a very interesting exercise. There are simpler ways to make a junk sail but I would probably use the same technique again.

My sail loft was the family room measuring 5 x 4 metres, complete with furniture in the way, and a woollen carpet on the concrete floor, but I was able run the rolled up bundle through the door

into the next room. To start I did mark out a paper pattern of one of the lower panels in a longer room to let me draw in the camber shape full size. Later, using a spread sheet I was able to use a pattern of the camber edge and draw the camber directly on the material.

Note 1. It is not essential to buy a sewing machine of this quality to build a junk sail. I have repaired and altered sails over the last 40 years on my wife's standard domestic machine which has simple straight and zigzag stitches. Any reasonably sturdy zigzag machine should be up to the job when fitted with the correct needles and thread, and the tensions correctly adjusted. The main difference is that the walking foot of the Sailrite machine makes life easier as you would have to be very careful in feeding the material through the lighter domestic machine. Using basting tape to stick the cloths together before sewing is a great help here. Similarly the lighter machine may not be able to sew multiple layers of webbing and then these would have to be hand sewn.

I have read that if using a domestic sewing machine it is advisable to increase the foot pressure to as heavy as possible to help it pull the material through evenly.

If financially pressed then look for an old second hand zigzag machine. I have been able to pick up 2 in the past year for nothing, and after a careful clean out and oiling with the correct type of machine oil they have worked perfectly. If following this route, look for older machines as the modern ones tend to have lighter structure and questionable plastic bits that can become brittle with age. Look for Singer or Pfaff machines and don't worry if they are 40+ years old. Most domestic machines will only have had light use.

It is possible to build up tables so that the material is supported at work level as it runs through the machine, but I simply put the machine on the floor and used knee pads to protect my joints. It may not have been elegant, but it worked for me and required no setting up.

Note 2. When joining separate cloths always stick the cloths together with two sided sticky tape or basting tape before trying to sew them with the machine as they tend to move a little and will

produce hard spots in an otherwise smooth curved sail. Make the stitches long and the zigzags, if used, as wide as possible. Shorter stitches with holes closer together are not stronger and if the holes are extremely close together they will weaken the cloth and allow it to 'tear along here'.
Note 3. The price of hot knives seems to have become ridiculous recently. The one I bought now seems to cost £250 in the UK and $188 (£120) for the 240V model in the USA, and less for the 110V model. Shop around as there are cheaper ones to be found on Google, and much cheaper if you consider the quick heating soldering iron type when fitted with cutting blades, which I have seen at down to £20 ($30 US). For example, B & Q have some interesting ones in the UK, if you can sort out the blade. These may have a 10 second time limit on each cut in theory, but in practice seem to survive longer usage. 3 or 4 at £20 is a lot cheaper than one at £250!! However, if you know anyone with a trade name then you should get one like mine at trade price from Kayospruce, and that makes the price realistic!

I've also read that a hot knife can be any sharp tool that can be heated, which seems obvious, but then there was the suggestion that a soldering gun with a tile cutting tip works well and is often used by professional sailmakers.

The technique for getting an even cut will probably vary depending on the type of knife you are using. It is well worth practicing cutting and sewing seams with off cuts of the material before you start on your sail. Knives like mine, which heat up in a few seconds when you pull the trigger tend to get hotter as you run along the cut. This means that you start the cut moving quite slowly and get faster as the blade gets hotter. If you move too slowly or stop the material will melt and give a crooked cut and a large bead of molten plastic at the edge of the material which can cause problems. With the soldering iron type of knife where the blade is hot when you start you may have to move quickly at the start of the cut and slow down as the blade cools during a long cut. Getting a clean cut is simply a matter of practice on long scraps or off cuts.

Tips on sewing sails.

It is not that difficult to sew sails, and there are a few tips I picked up which might make life easier for someone making their first attempt.

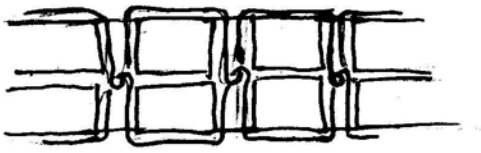


FIG. 1

Tip 1.
Every book you read says that you should adjust the tension of the thread on your sewing machine to pull the stitch into the middle of the material, as in the rough sketch Figure 1.

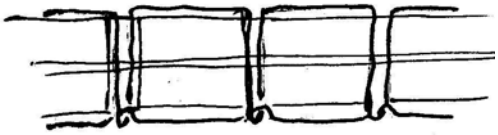


FIG. 2

With a hard material like polyester (trade names Terylene or Dacron, or a number of other names) this is not really practical, so the best that you can do is to pull the stitch tight against the bottom as in Figure 2.

This means that the stitch is more susceptible to chafe on one side, so the answer is to sew one line of a seam close to the edge and then turn the sail over and sew the other line from the other side to get best chafe protection on both sides of the seam.

Tip 2.

If not done correctly it could be difficult to align the separate cloths for a seam without wobbles, which could leave slack and tight spots in the sail. The easy way seems to be – lay the bottom cloth down. Stick the basting tape with its backing still in place close to the edge so that the inner edge aligns with where you want the edge of the adjoining cloth to be. In practice, I used a 19 mm tape and decided on a 21 mm seam so I placed the tape 2 mm from the edge, and as it is easy to eyeball the 2 mm, so it is easy to get a straight seam. Doing it this way you do not have to draw lots of pencil lines at a measured distance from the edge of the bottom cloth. Then you simply lay the top cloth to the edge of the tape, reach in under and peel off the backing tape and press the cloths together. Figure 3 and 4 are a poor effort to illustrate this., But see **tip 6.**

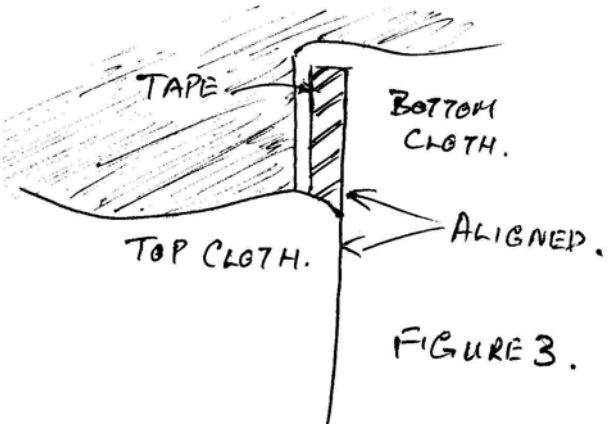


FIGURE 3.

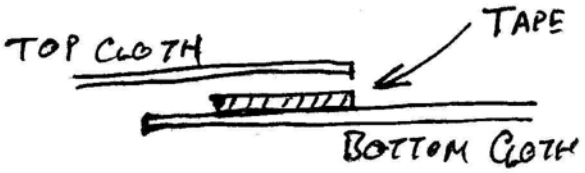


FIG. 4.

Don't forget, you only need a seam allowance on one side when joining two pieces of cloth together for an overlapping seam in a sail! (NO, I didn't make that mistake, but others have!)

Tip 3.
Some people suggest that you should sew a zigzag stitch slightly over the edge of the material to stop it fraying, but with modern 'plastic' material it is better to cut it with a hot knife which seals it at the same time as cutting it. Unfortunately it is not possible to keep the hot knife moving at the ideal speed so the edge of the cut will sometimes have a hard bead of plastic. Any stitch across the bead would be easily chafed, therefore it is better to sew with the edge of the zigzag just inside the edge bead where the bead, if raised, will protect the stitching. Figure 5 is an attempt to show a cross section of a seam. Having stuck the cloths together with the tape it is easy to sew close to the edge of the top cloth, then turn it over and sew close to the edge of the new top cloth, so you are not trying to sew near the edge of a bottom material which you may not be able to see clearly, particularly if using coloured material.

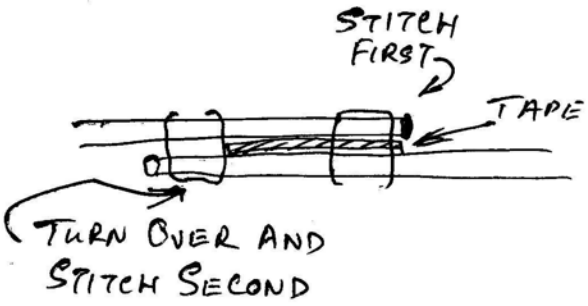
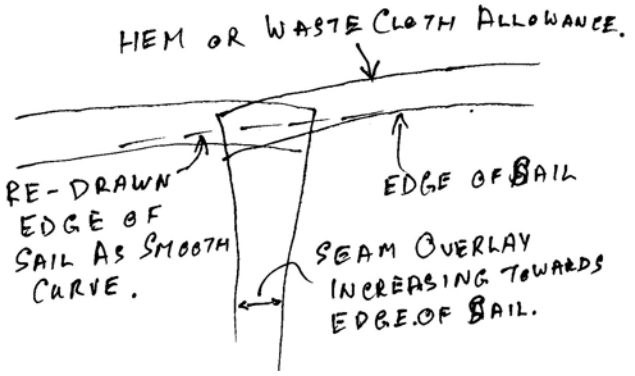


FIG. 5

Tip 4.
Broadseam.
Depending on the sail design you are making, and the type of material you have chosen you may want to use broadseam to tailor the flow in the sail. Broadseam is sometimes referred to as seam taper. Broadseam has the same effect as a dart in your clothing, but due to the unforgiving nature of hard synthetic sail material it is better to make the seam between 2 cloths get wider as it

approaches the edge of the sail. In practice it is a very quick way to make a cambered panel without wrinkles.
The key to a smooth broadseam is to broaden the seam gently and only reach the full dimension right at the marked edge of the panel. For example, if aiming for a 12 mm broad seam over a depth of 40 cm it is suggested that you only increase the seam by 3 mm (25%) of the seam by half of the distance, 20 cm, and by 6 mm (50%) at a quarter of the distance from the edge, 10 cm, and only overlap the cloths by the full 12 mm right at the edge. This may seem difficult, but in practice is quite easy as it is simply a case of sticking the basting tape down as mentioned in Tip 2 above, and only start widening the seam 40 cm from the edge (from 21mm using the figures above, to 24 mm at 20 cm from the edge, to 27 at 10 cm and 33 mm at the edge). Then you just place and stick the top cloth to the edge of the tape as before, though the material will then not lie flat because of the shaped seam. Then you simple sew as usual.

When you do this you will find that the edge of the material and the line for the edge of the sail will have dipped in a little, so you simply re-draw the edge of the sail as a continuous smooth curve and accept the dip in the hem.



When making some major alterations as an experiment I wanted some extra wide broadseam and found it convenient to use a double run of a narrower basting tape. I used 10 mm wide tape over the broadseam area, putting one strip down the edge of the material and starting the second strip off parallel and touching to give 20 mm wide straight seam and broadened the gap between as the seam was to widen out. Once I was happy with the tape placement I simply laid the cloth on top and as I stripped the backing of both the basting tapes I pressed the edge of the top cloth to the edge of the inner tape. It made an apparently difficult job very easy, quick and produced a smooth shape change.

Sailrite have some useful videos on the web which show many sailmaking techniques. Look at http://www.youtube.com/watch?v=RpDlYq6Hj0Q on the use of basting tape,
and
http://www.youtube.com/watch?v=2BvIr1mNYiE on the use of the ‘Simple Overlapping Seam’.

Tip 5.
Seamless Broadseam, or The False Broadseam.

As mentioned earlier in a sudden ‘Eureka’ moment an idea for making darts similar to smooth broadseam but without a seam occurred. To overlap the material would end up with a hard spot at the end of the overlap and not be satisfactory, but there is no reason why the dart can not be cut out of the material to the required smooth shape and effectively butt joined with the edges of the cut just touching and strengthened with a false seam or patch . The dart would probably have to be cut out with a sharp knife rather than a hot knife to get it narrow enough and smooth at the inner end to the dart.

To make the dart, mark the position with a line going the full length of the dart from the finished edge of the material. Draw in the shape of the dart symmetrically on either side of the line, achieving the full width of the required ‘broadseam’ at the edge. Cut the flared shape with a sharp

knife or scissors. Cut a patch twice the width of the basting tape you are using (say 2 X 19 mm) and about 40 mm longer than the dart plus the hem allowance. Stick two strips of basting tape on the patch just touching down the centre line. Place the patch under the sail cloth with the spare 40 mm positioned beyond the end of the dart cut and align one edge of the material with the centre line of the patch. Reach under and peel the paper strip off the basting tape and press one side of the cloth down on the patch aligning the edge of the cloth with the centre line of the patch. Repeat for the other side of the dart so that both edges of the flared dart just touch. This should have the same effect as a broadseam and now be ready for two rows of stitching on either side of the butt joint like any other seam.

Tip 6.
When joining seams with basting tape there is an easy way to do it.

Lay the first cloth down and stick the basting tape along the edge as mentioned above. Before placing the second cloth on top, un peel the backing tape for a distance of about 2 to 3 cm at the ends of the tape, or more particularly at any join in the tape, and twist and fold the end of the backing tape so that it lies flat pointing into the middle of the cloth. Then when the top cloth is aligned with the inner edge and held down with wide spread fingers it is easy to grip the exposed end of the backing paper and simply pull it out horizontally still holding the top cloth in position with your fingers. By easing each finger in turn the backing paper will slide slide out and then the finger pressure presses the cloths together, all in one easy action without the cloths moving.