Shaping Vertically cut Sails.

Three cloth factors give shape to sails. By “shape” we mean the three-dimensional shape, the aerofoil curve, like a bird’s wing. These factors are:

- Curves at the edge of the sail, affected when the edges are tensioned. Outward curves pull cloth in to add bagginess. Shallower inward curves move outwards to flatten the edge, typically the trailing edge, aka the leech.
- Orientation of the cloth. By laying sailcloth diagonally over the boundaries of the sail the cloth is tensioned at an angle to the weave. This is called stretching on the bias. This causes the cloth to ripple, or form a “bunt”, which then fills with wind, protruding outwards.
- Broadseams. This is where the seams joining the panels of sailcloth have their overlap progressively increased to create a slight hollow. Most effective on stiffer, more stable, cloth, this is a method for *controlling* the shape, especially the draft point of the sail, and channelling the effects of the other two methods above.

Please note that edge roping can also be used to influence shape and more is said about that later.

A lot has been written, and rules laid out, for the cutting of cross-cut sails and not so much about vertical cut sails. The Sailmaker’s Apprentice by Emiliano Marino (1994) is a comprehensive source of data for the former, only slightly less so for the latter. Crosscut sails have been around since at least the late 1800’s and as sailcloth got stiffer and more consistent in production, it was an advantageous way to cut sails. One particularly important advantage of crosscut is that you can set, very accurately, the draft-point of the sail, and even vary it from the top to the bottom. The draft-point is the highest point of the sail’s camber (looking from below) and locating it just where you want it can affect the balance of the sail-plan and ultimately the handling and efficiency of the vessel. It can be applied to both quadrilateral and triangular sails. Different types of rigs have different recommended draft-points.

See illustration for the shaping of Cross-Cut sails next page:

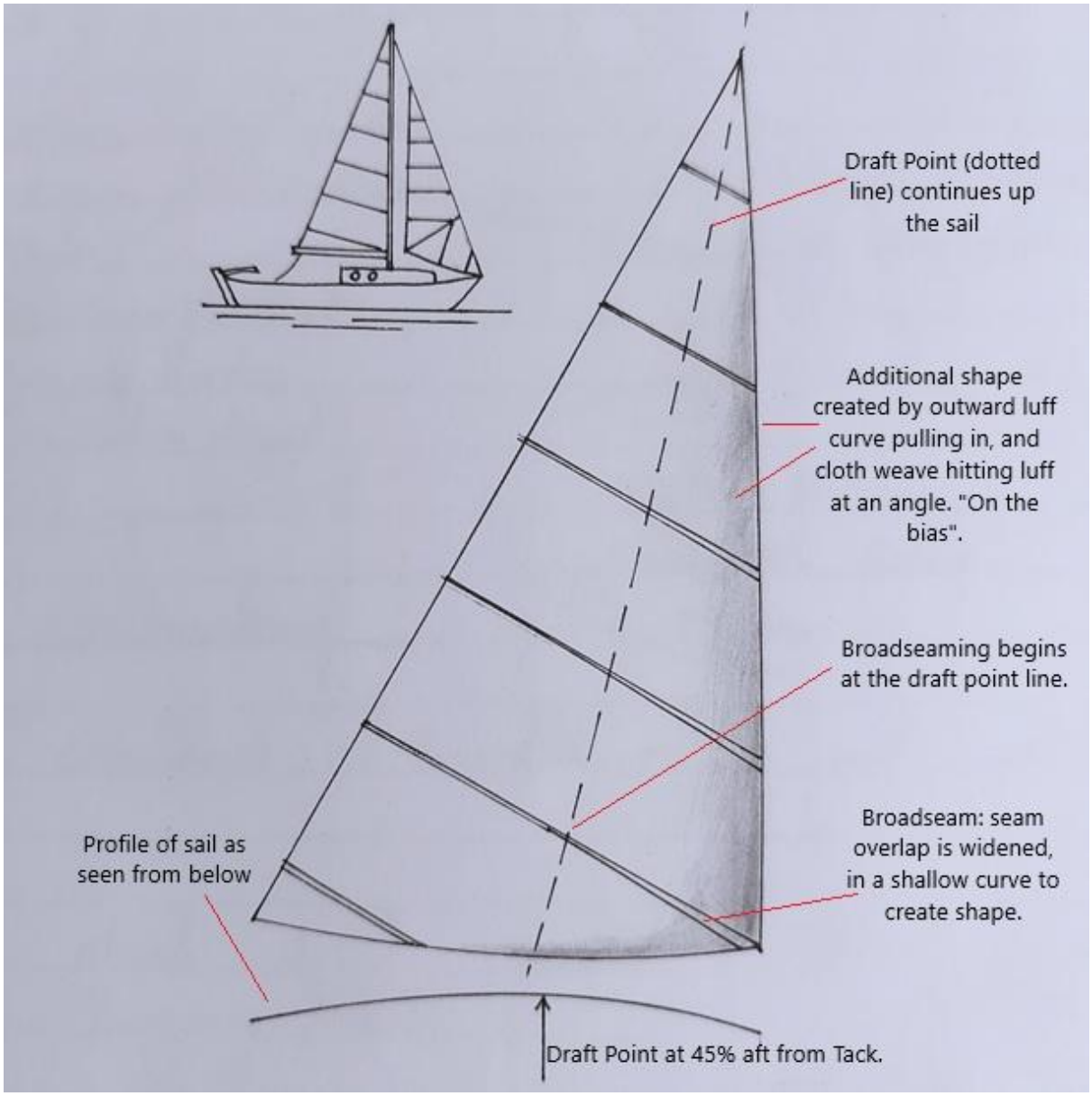

Fig 1. ©Mark Shiner 2025.

Vertical cut sails predate crosscut and are often favoured today for classic or traditional craft because they look right for the style of the boat. The vertical arrangement was originally favoured because strain forces, especially at the leech, could be taken along the length – the warp – of the woven cloth. Warp threads are straighter than the crosswise weft threads, which have a “crimp” as they travel over and under the warp. This meant that the cloth stretched, and distorted more, like a concertina, when pulled *across* the width of the roll of canvas. And so, the leech of the sail was given a continuous run of cloth from top to bottom, resisting stretch and distortion but denying the possibility to shape the sail using horizontal seams – there were none. Cross-cut sails were only possible with improvements to weaving which made cloth more stable across the weft.

The following information is taken from several sources: the author's own sailmaking experience, information in The Sailmaker's Apprentice and Steel's Elements of Sailmaking. Also contributing significantly, is an online article written by sailmaker Todd Bradshaw, online, on the Woodenboat Forum in 2015. Broadseaming theory - The WoodenBoat Forum .

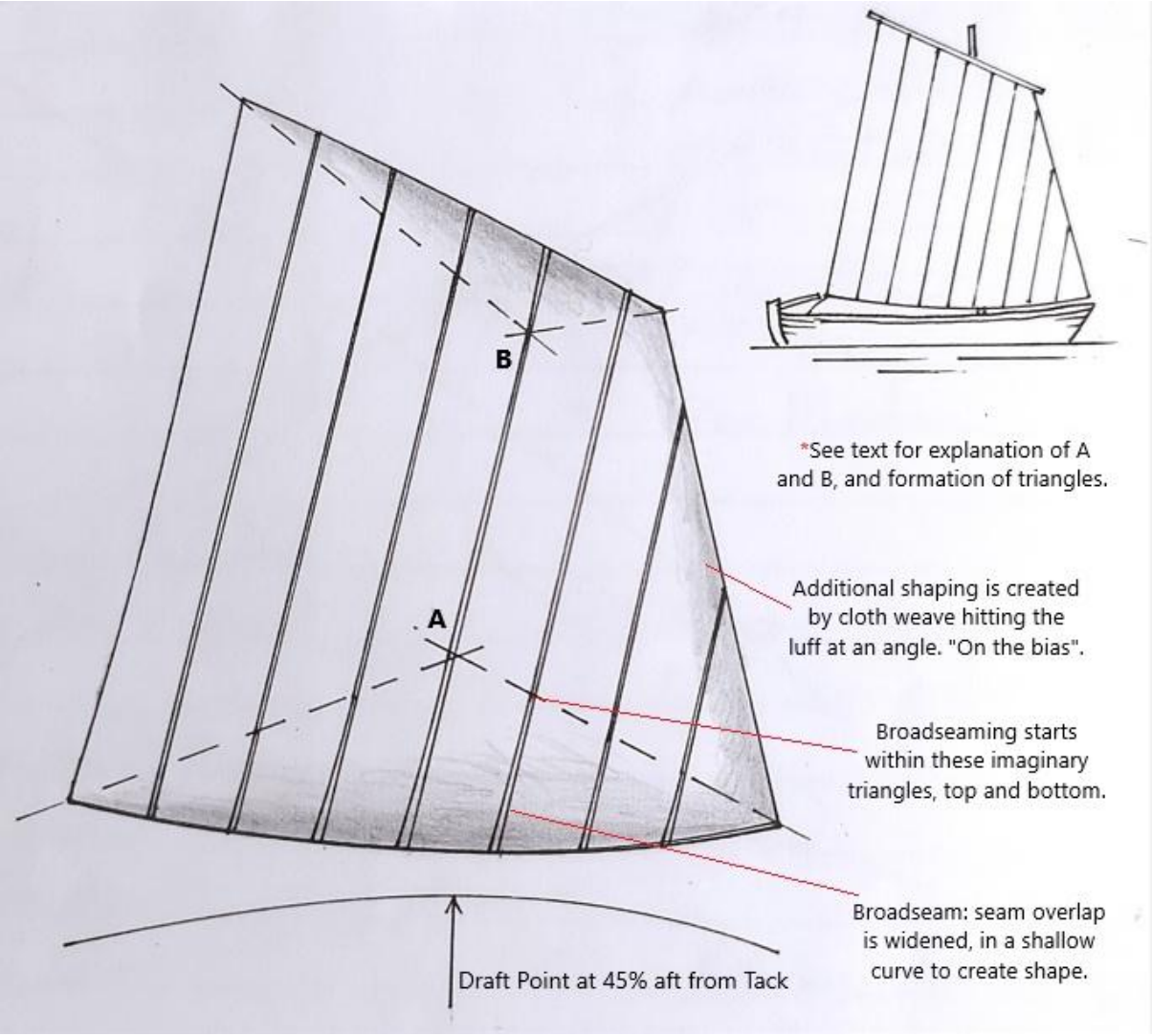

Fig 2. ©Mark Shiner. 2025.

Some quantifiable measures and suggested figures are given later in this document but first we can consider the general factors in shaping vertical cut sails.

Quadrilateral sails, like the one above, are attached to the rig in various ways. If lashed to a mast (Gaff or sprit) a small amount of outward, convex, luff curve can be added. However, if the luff is stretched unsupported in space, as with a standing or dipping lug, the treatment is different. The same applies to the head of the sail if lashed to a gaff or stretched unsupported by a sprit.

The vertical placement of the cloths will, on the one hand, limit our opportunities to define a draft-point on the sail, unlike the cross-cut. However, we still have a luff that is enhanced by cloths crossing it on the bias, creating a bunt in the cloth, which we can inflate.

Some broadseaming is possible and desirable and there are some clear guidelines here for where to place them. It should be remembered, however, that many experienced sailmakers will judge these things more by eye, using any rules or numbers as a starting point and making further adjustments based on experience.

If you are unfamiliar with the rigs of four-sided sails, please have a look at:

Gaff rig, Sprit rig, Dipping Lug, Standing Lug, Balanced lug. The following will make a lot more sense.

Edge Curves in vertical four-sided sails.

Head:

If unsupported, as with a sprit sail, the edge should be straight. Shaping here is best created by light broadseaming as described below.

If laced to a spar, as with a gaff or yard, there is a tendency for the spar to bend downwards at the ends, pulling the middle of the head outwards, flattening it. An outward, convex curve may therefore be added. 1” (25mm) around 45% of the spar’s length measured from the throat, where the head meets the luff at the leading edge.

This is done by finding the 45% point along the straight edge measurement of the head, measuring out by the required amount and placing a flexible batten from one end , past the measurement point, to the other end, creating a long, fair curve. Use this method for the other curves described here.

Consider more curve if the spar is profiled to be thicker in the middle. You could add this amount to the guidelines above.

Leech:

If a traditional leech without any roach and battens is required, then place an inward, concave curve with its maximum point midway up the leech. The depth should be 1” (25mm) per 6 feet (2m) of leech length.

Foot:

The foot of a traditional sail, is often loose-footed (not lashed to a boom) or even boomless. In this case, there is a pronounced curve with its deepest point around 45% back from the tack. This can help to define the draft point to some extent. Most canvas on boats up to around 23 feet (7m) cannot support a foot curve deeper than 4” (100mm)

without it flapping. There is no real need to go deeper anyway unless your vessel is very large. Foot curve is, to a large extent, for appearances as a straight foot looks slightly odd.

Luff:

Unsupported luffs need a lot of tension and can flap about, especially if given an outward curve as is usual on other sails. On smaller boats under 16” (5m) a straight luff is recommended. On larger vessels it may be necessary to scoop the luff inward slightly, which is somewhat counterintuitive for many sailmakers. Todd Bradshaw recommends an inward curve depth of 1” (25mm) for every 10 feet (3m) of luff length. In any case the luff should be well reinforced with luff tape or edge roping to enable significant downhaul pressures.

On supported luffs, for example lashed to a mast, a standard approach of considering camber ratio – often around 10% - and gathering that by rounding out the luff correspondingly; an outward, convex curve.

Cloth Orientation.

In the two pictures above, it will be seen that at the luff the cloth crosses the line at an angle in both cases. This allows stretch and the formation of a ripple, or bunt, that can fill with wind. At the leech, the vertical cut sail carries an uninterrupted run of cloth, stretching against the resilient warp threads. The bias angle is less at the head and foot of the vertical cut sail and it is here that some shape can be created using broadseams.

Broadseams.

A Broadseam is simply that, a broadening of the seam width by pulling two panels together, overlapping progressively more as you go towards the edge of the sail. Although the seam is broad, you are really reducing the edge length a small amount; gathering it a little to create a tailored, curved belly at the foot and head of your vertically cut sail. Broadseams have three important aspects; where they begin at their narrowest point, how wide they eventually become and whether they are straight or curved. If curved, we also think about how full or shallow that curve might be.

The first consideration is the position of the narrowest point, or beginning of the broadseam. In fig 2, this is determined by where the seams happen to cross the imaginary lines of the triangles at the foot and head. These triangles run, respectively, between *clew - point A - tack* and *peak - point B - throat*.

Placing points A and B are therefore the first consideration.

Point A: this is placed at the height where you want the main belly of the sail to be apparent. This is one of those areas where judgement and experience is helpful. Look at other boats, search images on the internet, decide what looks right. Remember that the

belly of the sail is part of the leverage moment that tips the boat so you don't want it too high. Start at 1/3 of the way up the sail and work around that. Certainly it would never me over half way up. Once you have decided the height of A, imagine a horizontal line at this height, parallel with the foot and plot A at 45% along this line from the luff. Mark out your triangle by joining A to tack and clew. In the loft, use string or chalk or just a straight edge, making a small mark on the seams.

Do not confuse point A with the Centre of Effort of the sail, used in sail-plan design; they are two different things.

To plot point B, run a line from A, up the sail parallel with the cloth seams. B will be along this line somewhere. (Fig 2 has points A and B lying on a seam, that is not always the case at all.) Run it to the head then come back down approximately 1/9 of the leech length. 1/9 is also 11% of the leech length. Once again, this is a start point; does it look right to focus a billow at the head here? Join B to throat and peak.

At head and foot, start your broadseams at the points where the triangles cross the seams.

The ultimate width of the broadseams, where the seams meet the sail's edge are 1.6% of the length of the broadseam. In other words, take the length of the broadseam and multiply by 1.6%. Bradshaw expresses this as ½" (12.5mm) for every 30" (762mm) of broadseam length. However, this figure is for 36" wide sailcloth, which was standard for a time. On wider panels, the width would be reduced so that the same amount of tightening at the seams is divided across the same width of foot or head.

For example with 18" (457mm) panels, you halve the broadseam width OR just broadseam alternate panels. For 54" (1.4m) panels, you would double it. So, for example, for a 10 foot (3m) foot, you have the same total edge reduction – which is what broadseams really do – regardless of the panel width and number of panels.

For vertically cut sails, the broadening should trace a shallow curve rather than be a straight dart-like feature. Take a flexible batten from the start point to the marked widest point on the edge and allow the seam to curve slightly, towards the leech.

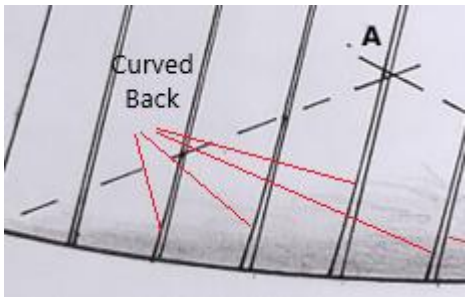

Fig.3. ©Mark Shiner

The upper triangle distributes the broadseams and avoids too much shape around the throat, which does not really disperse itself across the sail very well.

This section on Broadseams has been written for certain sailcloth, namely, modern canvas substitutes such as Clipper Canvas. This is a fairly soft Dacron which has some flexibility and “give” to it. With organic canvas, very little broadseaming is necessary.

Roping.

For centuries sewing a bolt rope was essential to limit the stretch on a sail at a point before the canvas or seams parted. As the rope was actually more stretchy than the canvas that means ropers (the lords of the sail loft in terms of experience and skill) had to gather “slack cloth” into the rope, both into the grooves in the rope – which had a much ruder name before the Victorians – and by just bunching up small amounts of cloth within their stitching. **Remember**, this is soft flax or cotton canvas we are talking about here. David Steel (1794) write that for the luff and head of a sail you should gather 3 inches of slack cloth per yard of rope; 2 inches at the foot and for the leech, rope it plain – which means don’t really gather any.

Gathering slack cloth had another effect, which sailmakers consciously utilised, it added shape. Tailors gather the top edge of a shirt sleeve tube before they attach it to the body, that curls it over for a better fit. Gathering at the luff, for example, adds a little curl and starts the bluff entry of our aerofoil. Again, cotton or flax.

So, what does this mean for roping modern Dacron sails?

For traditional vessels, with a matt finish Dacron like Clipper Canvas by Haywards, roping is a great finishing touch. For heavy ocean-going square riggers, it is still, in my view, a source of strength and reinforcement although many smaller tallships go with out it. As all the materials, cloth and rope are polyester, there is no great difference between them in terms of stretch. That makes the roper’s life easier!

However, it is important to remember the echo of what Steel wrote and firstly, rope a leech with minimum thread tension so that the cloth does not dig into the rope grooves, causing a curl; that’s bad. Neither does roping need to be a consistent gathering along a given side. Here are some suggestions:

Heads of 4 sided sails: rope into the grooves near the throat, reducing thread tightness towards the peak and more or less “plain” aft of the draft point for flatness,

Luff: sew quite deep into grooves, especially at tack and head.

Foot: less tread tightness than the luff, and tightest near the tack, again easing off towards the clew, as for the head.

Leech: “rope it plain” attach the rope well, but avoid pulling cloth down into the rope grooves in order to maintain flatness.