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MAXIMUM SAIL POWER

CHAPTER 6

WHERE ART AND SCIENCE MEET - Part 4

Chapter 6 is an in-depth look at the sailmaking process from how we used to make to how they are made these days in a modern sail loft. There is a lot to cover from basic design elements like sail geometry and engineering to a look at the manufacturing process. There are four parts to Chapter 6. This is the last part that is about the various stages to making sails. I urge you to download the first three parts so that you will have a comprehensive knowledge of sail design as well as the manufacturing process which will also be covered.

The Manufacturing Process—Turning the Design Into a Sail

With the theoretical work done, the practical work now begins, i.e., the design that is sitting in a file on the sail designer's computer needs to be turned into a sail

for the customer. These days many design office computers are linked directly to the production floor, and with a click of a mouse the design can be transferred and production started. In other lofts the design is taken either to a lofting table or to the plotter, and the sail is cut.

It was not always a simple process. Let's look back to how sails used to be made and indeed how some lofts still manufacture sails. These modern manufacturing methods are good, but they are not imperative. Many sailmakers still make great sails the "old-fashioned" way.

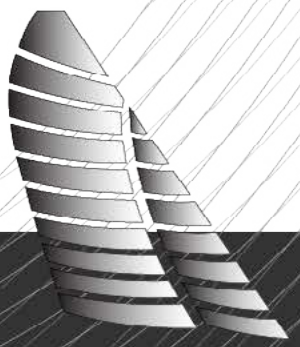
The Five Steps to Making Sails

Step 1 — First Layout

Back in the days before computers, the process began by having someone work from a hand-written design to draw an outline of the sail on the loft floor using awls to mark the corners of the sails and a string to scribe the edges. The dimensions were taken from the design and included allowances for leech hollow, luff curve, and foot round. If it was a common design the outline may have already been marked on the floor with a pen. If it was a custom job then it all had to be done from scratch. Once the outline was ready, a bolt of fabric was rolled back and forth across the string layout overlapping the fabric just enough to allow for a seam. When the fabric completely covered the area, the panels were ready for step two.

Step 2 — Broadseaming and Sewing

There are two ways to add shape to an otherwise flat surface. The first is to draw a convex or "positive" curve down the luff of the sail so that when the curve is placed up against the straight edge of a mast or headstay, the extra fabric is pushed into the sail as shape. While this sounds rudimentary, it's actually quite effective, although it does not give the sail designer much control over the overall shape. To create a more consistent shape throughout the sail, designers can also employ a technique called broadseaming, which involves adding a curve to one



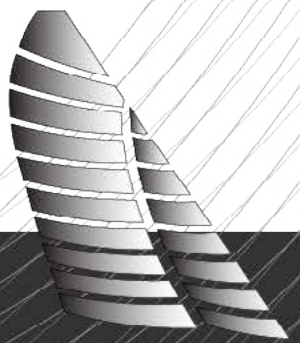
edge of each of the panels so that when the curved surface of one panel joins the straight surface of the panel below it, that surface, like the mast against the luff curve, will force shape into the sail. Think of a beach ball. You take a number of flat pieces of plastic, curve the edges and join them together. The result is a hollow sphere.

When it came time to assemble the sail the excess fabric would be cut away with a hot knife that melted and sealed the edge of the fabric. One edge of each seam would be taped with double-stick tape and stuck to the edge of the adjacent panel until the entire sail was all stuck together. It was then rolled up parallel to the seams and taken to the sewing machine pits for sewing. The sewing machines were sunk into pits so that the working surface of the machine would be level with the floor, which made it easier to sew the seams.

For big sails many lofts would use a roller, actually a series of rollers built into an oblong box, which was then tilted toward the machine. With the sail on the box it would slide easily down toward the sewing machine. Once the sail was sewn together, it was ready for second layout.

Step 3 — Second Layout

With the sail in one piece it was returned to the loft floor and laid over the string pattern to see if the sail geometry had shifted during broadseaming. Sometimes the sailmaker would need to re- mark the head, tack, or clew on the fabric. After that the sailmaker would draw the luff curve on the sail, a fairly critical part of the design process since the luff curve had to match the curve of whatever spar the sail was going to be set from. If the sail was going on a bendy mast, the curve needed to compensate for the bend while still adding shape. Likewise, a jib luff had to be cut for a particular headstay, taking into account sag. In terms of actually creating this curve the first thing the sailmaker needed to "remove" the shape from the sail since it now had an aerodynamic shape, and that shape, when laid flat, would push out at the edges and create a false edge. This he could do in one of two ways depending on the project at hand. For small sails he could "fan"



the sail. In other words he would pin the tack and clew to the floor, and while standing at the head fan the fabric in an effort to trap a pocket of air between the floor and the sail- cloth. Once he had a good pocket he would tack the head to the floor. With the body of the sail puffed up in its aerodynamic shape, he could then scribe the luff, leech and foot curves. For larger sails the best way to remove shape was by taking a fold behind the luff, i.e., laying the sail out on the floor and flaking it parallel to the luff so that the broadseam shape would be sucked up by the fold and the luff would lie flat and true. It would then be possible to lay a batten down the length of the luff, bend it to match the design offsets and draw the luff curve. The same would then be done for the leech and foot. After the excess fabric had been trimmed, the sail was ready for the next stage.

Step 4 — Finishing

At this point the sail was an aerodynamic shape built from a fabric that was appropriate for the job for which it was designed. Still, it needed to be reinforced in the corners and have edge tapes sewn around its entire border in order to withstand the rigors of wind and waves. Then the head, tack, and clew patches, and reef patches would be constructed from multiple layers of fabric cut to different sizes. The aim was to create a patch that had the required strength at the corner of the patch while tapering down toward the body of the sail. The loads in a sail diminish as they get further from the corner, and the sailmaker wants a smooth transition from the patch into the body of the sail. Triangular patches were (and are) the most common kind of patches, but patch technology has evolved, and now these once over-engineered pieces of fabric are a sophisticated part of the overall engineering process.

Once the patches were stuck down with double-stick tape and sewn onto the sail, the batten pockets would be attached to the main and the edging sewn to the sail. The edges in high-load areas would be treated accordingly, and depending on the size of the sail, there

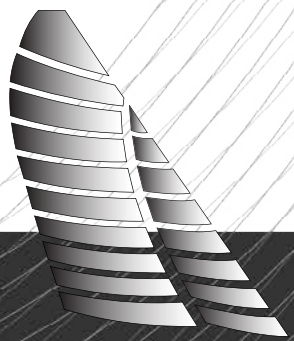
could be either one, two, or as many as three layers of edge tape sewn onto a sail, with each tape cut successively smaller to facilitate a smooth transition. A sailmaker always tries to avoid any abrupt changes in fabric strength or "hard spots" in a sail since these hard spots will later become a "hinge" or weak point as the material bends repeatedly along a single line instead of flexing smoothly across a broader area. Luff tapes, or bolt ropes, would be added if the design called for it, or regular tapes would be sewn onto the luff if the sail had hanks. Leech and foot lines would then be run inside the edge tapes, and the sail would be ready for the final stage of the sailmaking process.

Step 5 — Handwork

At this point rings would be either sewn or pressed into the corners, hanks either sewn or bent onto the luff, cleats screwed onto the sail for the leech and foot lines, the head- board, batten, and luff hardware (in the case of a mainsail) attached, and leatherwork hand-sewn around chafe areas. After this final detailing was done, the sail would be stretched out with pulleys holding the three corners and put through a final inspection. The shape that you saw when the sail was strung up was its molded shape. Once the sail was set on a rig and subjected to the winds and waves, things would change. But for the moment the sailmaker's work was done. It was time to sign the warranty card and ship the sail.

Sailmaking Today

Modern sailmaking is still a multi-step program, but computers and laser cutters have eliminated some of the early steps, making things much easier and more precise. It all comes back to the sail designer now being able to work with stable fabrics and having a database of proven designs to build upon. For example, in the old days the sail had to be returned to the floor once it was stitched together to draw the luff, leech, and foot profiles. Both this second layout process and the first layout took up an extraordinary amount of space, and sail lofts had to be large enough to allow a sail to be spread out on the floor. These days with the help of computers, the



exact shape of each individual panel can be precisely computed in advance instead of unrolling bolts of fabric on the loft floor, thereby eliminating the need for first layout. Since these panels already include the sail's precise luff, leech, and foot curves, there is no need for the second layout either. This applies to both radial and cross-cut sails. Once the sail designer has created the design, with a click of his mouse he sends it to production where the production manager is ready to turn flat panels into a three-dimensional shape. Some lofts do not have laser cutters, and in these cases the design is drawn on the fabric with a plotting machine and the panels are cut out by hand. Laser cutters save that step, but they are expensive.

The Plotter draws and marks each panel

Nesting the Design

Before the panels can be cut the production manager has to first "nest" the panels. Here the individual panels are oriented on the computer on a simulated roll of fabric, and the individual panels are arranged where their orientation takes the most advantage of the fabric's strength while minimizing waste. It's a critical step, and once all the panels are laid out, the design can be sent to the laser cutter or

plotter for the next step. In either case, once the roll of fabric has been laid out on either the laser table or the plotting table, someone inspects the fabric for flaws and blemishes, and if satisfied, the process of creating the individual panels takes place. One at a time each panel is cut and marked so that all the individual pieces can be pieced together with the panels going in their proper place. They are then taped with double-stick tape, glued together, and the assembled sail is sent to the floor for stitching. The rest of the process is as described above.

Handwork detailing on a spinnaker clew

The art of making sails is constantly evolving as newer construction techniques and manufacturing methods are developed. While computers and modern machines have made things easier, it is still a labor-intensive business. There are many steps and stages and as a result there are places where things can go wrong. It's hard to put too fine a point on this, and at the risk of constantly repeating myself, the more information you provide your sailmaker, the better it will be for your sail.

Sailors are as individual as their boats, even those who have production boats, and sailmakers are hopeless at guessing. Now that you have an idea of what goes into sail design and production, you will have a greater appreciation of how many details and variables need to be taken into account just to get a sail that looks good and fits the boat properly. Stage one is now complete — at this point you need to decide what features you want on each sail so that the finished product complements the kind of sailing you plan to do.

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