Tech Talk *with Don Campbell*

In this issue Don discusses sails and how to make them work to point higher.

I had a most interesting trip to the Syronelle races last June, but one I will not have to do again. There was a bit of a protest by the Hamilton steelworkers union local 1005 about their treatment at the hands of US Steel that they did not appreciate so they blockaded the lift bridge on the Burlington Canal. I had missed beating the blockade by about 5 hours and so the only way out of the harbour was under the bridge and I had to take down the mast and motor to Toronto. I was able to get the mast up again at NYC and thought I had it fair and straight for the races on Saturday and Sunday. However, I did not have a long tape to be sure of the rigging measurements. All was well….. until I was racing.

It became very apparent that I was fine on starboard tack but port tack was not good. I was pointing more than 5 degrees below every other boat in the fleet on port tack and that is one big handicap in a race. Fortunately, we were fast enough to not give up too many places in the scoring and we made it to harbour in time to borrow a tape and re-set up the rig. I was ¾" long on the port upper stay and that was all it took to change pointing ability.

There are three things things to take note of in this tale. The first is that I would never have really known the difference if I had not been sailing with one-design company. The second of course is that very small increments translate into very big differences. The third is to always be prepared and I was not prepared, being without a long tape when I took the mast down. I had no choice but to take it down and had no way to check things once back up. What was shown was that there can be no better situation than to go out with a companion boat to test the ability of the boats and crews. While this is often difficult to co-ordinate, it pays big dividends if you like performance, or require the boat to be able to get you in before the storm rather than in the middle of it. The rule of thumb is that for every degree off course that you take out for 60 miles, you lose one mile upwind. If I had gone out from Hamilton harbour to go to Whitby with a north-easterly breeze, I would have been offshore an extra 5 miles and so another hour to get back in. There are advantages to being able to point well.

I am sure many of us do not check the compass course every time we tack to see what angle we tacked through. But when it is only one side of the rig that was off (I had not changed the starboard stay lengths), the tacking angle resolution tends to be halved between both tacks without determining direction when head to wind, so one never knows if you are with good rigging if the testing has been done sailing alone.

Recently Gord Laco had a comment on the Chesapeake website saying his pointing ability was improved using a high clewed 100% foresail and normal sheeting (outside the stays) and a reefed main. He felt he

had a 5 degree pointing advantage over foresails that overlapped the main (and the rest of the fleet in that race). The wind was blowing that evening over Chesapeake Bay at 30 knots.

If I analyze this situation with the resolution of theoretical centers of effort, some interesting things happen. Any higher clew will raise the combined center of effort because the center of effort of a high clewed jib is above that of a jib with a low clew. Thus, there should be more heeling moment compared to a low clewed sail, and quite often, heeling allows for more pointing ability. I have taken the time to draw out a scaled diagram of a one plane sail plan for 165, 150 and 100 LP, full luff (35 feet) foresails and used a second 100 with the clew 5 feet higher than the low clewed sail. For this analysis, I used the theoretical resolution so that the end point of the resolved Centers of Effort (CoE) were proportional to the sail areas. (To do this it is assumed that the center of the triangle is the point at which the COE operates, and that the resolved CoE is on the line joining the sail centers and that the point on that line is with the jib area closer to the main. So if the jib area is 3 and the main area is 5, then the resolved COE is 3/8 of the distance between CoEs from the center (CoE) of the main.)

For a 100 LP foresail, the higher the clew, the more overlap on the main. While this is not much of an overlap, it happens because the definition of the LP is the distance perpendicular to the luff and that has to be at 100% of J. The point of LP measurement is always on a line parallel to the luff and equidistant from it (regardless of the % factor. It just moves further from the luff for 135, 150 and 165 sails). Since the area of a triangle is ½ base x height, as long as the luff is kept constant, the sail area for any and all 100 (135, 150, 165) LP sails is constant regardless of clew height position.

First with a full main, the change from a 165 to a 150 to a 100, with the foot on the same line, indicates that the resolved CoE moves forward from a starting point with the 165 by about 3 inches for the 150 and 6 inches for the 100. The resolved CoE for the 150 is 3 inches higher and the 100 is about 6 inches higher than the resolved CoE of the 165. This happens because of the method to determine the centers of the triangles and that center rises as the foot shortens. This illustrates that the big gains from going to a 165 over a 150 is for downwind sailing where you can get much more sail area exposed to following winds. With the high cut 100, (clew 5 feet above the low clew) the resolved CoE was only 1 – 2 inches further forward from the resolved CoE of the 165 but about 15 inches above it I do not see any advantage to raising the CoE, particularly since it will increase heeling moments. Many say they can see the blind area behind the sail better if the clew is high. While this may be true, it decreases performance and can be offset with a window in the sail or a more careful look-out from the crew.

Once the main is reefed (and I used 42 inches for the reef), the resolved CoE of the 165 and reefed main compared to a full main is lower by 6 inches and it moves forward by 12 inches (because of the change in the center of the triangle of the reefed main). It is little wonder that the balance on the helm and heeling moment change. The corresponding changes for the 150 and 100 (low clew) relative to the 165 and reefed main CoE position are 2 inches ahead and 3 inches higher for the 150 and 4 inches higher and 6 inches ahead for the 100. With the high cut 100, the changes relative to the reefed main and 165 are 2 inches ahead and 12 higher. This last CoE is slightly (1 inch) higher than the CoE for full main and 165 but about 12 inches ahead of it. That means you would not notice any change in heeling moment but a real change on helm and balance around the center of lateral resistance (CLR).

Drawing lines on paper only gives a clue about what happens on the water. Things like the rake of the mast, tension on stays and shrouds, weight position in the boat and movable ballast can change all of the above for placement of the CLR and CoE. There is still skill needed in the skipper and crew to make the boat move well and point well. The only way to compare the differences you think you need to make is to go out with another class boat and do things together, one change at a time and measure the relative differences.

As we get older, some of us think it helps to write things down in a logbook of some sort because it is easier to go back to written material and repeat that from year to year rather than try to remember every last detail: your choice based on your memory by next year and your experience!

Don Campbell