

# Tuning

The principle of tuning is rather simple, but since there are so many variables it will always remain an art, rather than a science. Science, like the theory presented here, might help you develop your art of sailing more. Most sailors only know "In heavy wind have all sails as flat as possible, In light winds have a deep curvature. I will not explain what line to pull to flatten the luff, which is dependent upon what boat you are sailing, and might change some other things too. For example: if you loosen the vang to get more twist, the mast will straighten also, if it is flexible.

## Sail tuning

For optimal sail tuning you need to deflect as much air as possible aft.

How to deflect air aft: Take as much curvature as possible and make your leech directed aft, so it is parallel with the centerline.

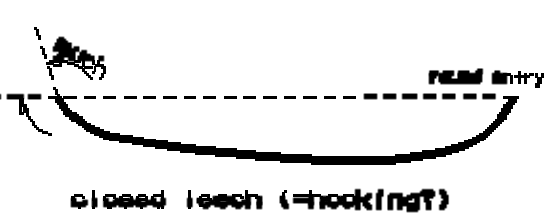
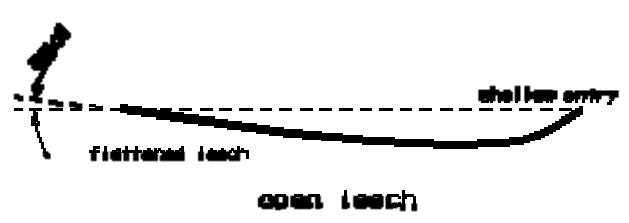
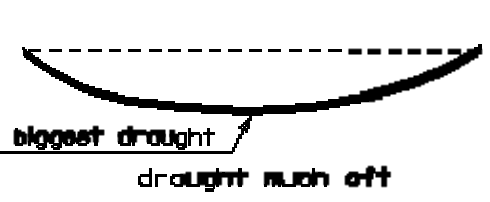
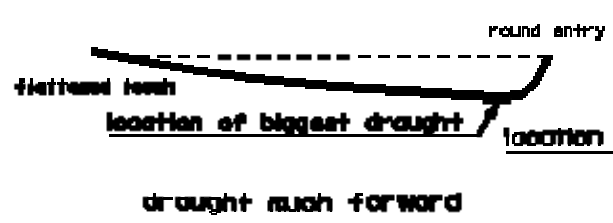
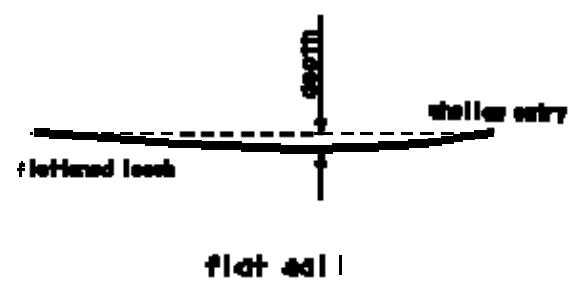
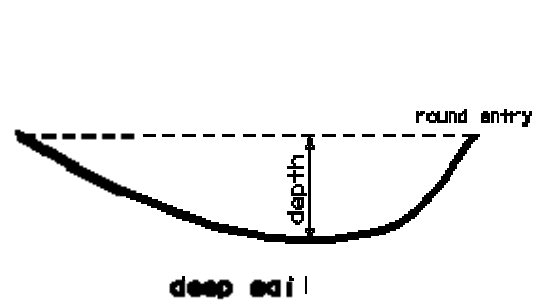
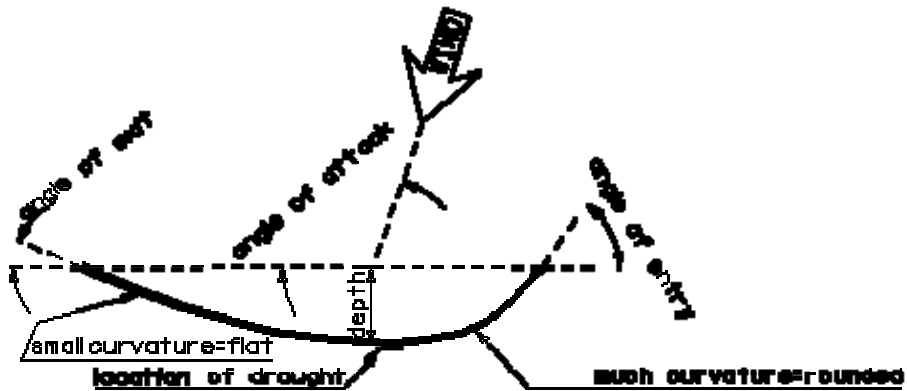
But watch out for:

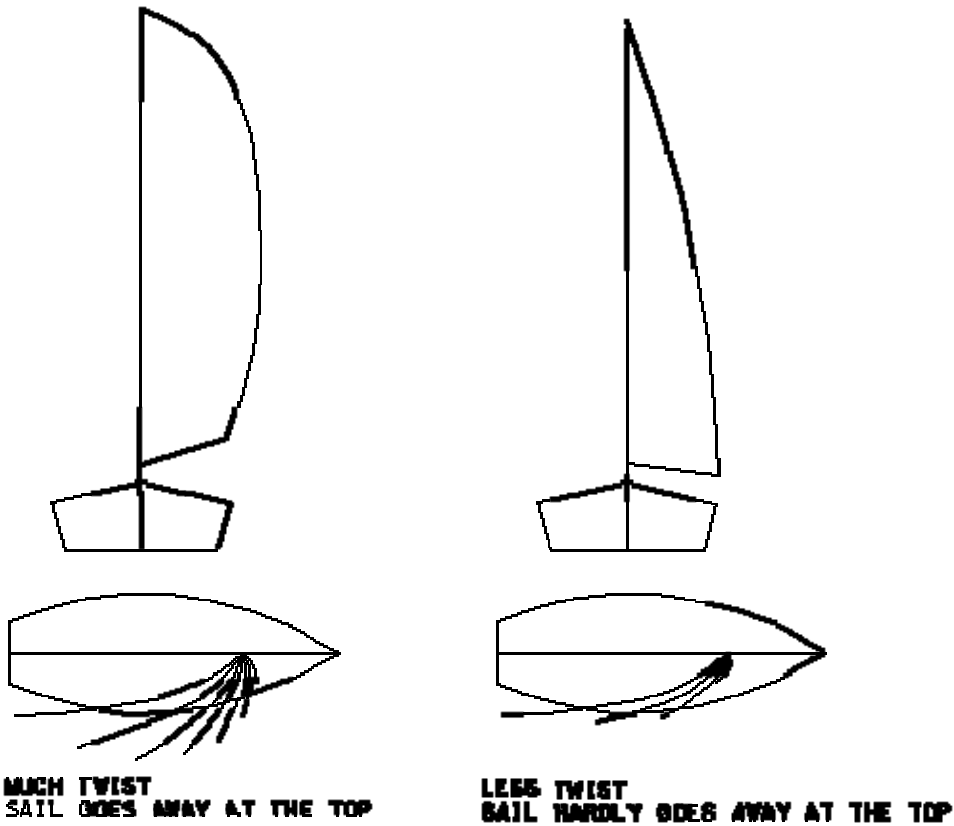
- flow separation (=stall). Stall can be detected by the tell tales on the trailing edge going to leeward. This can be caused by:
  - Your sail is too tight
  - Somewhere the curvature is too much for the air to follow.
- The luff may not backwind.  
If this happens it can be caused by:
  - The sail is eased too much, the wind is then simply blowing on the wrong side of the luff.
  - The angle of attack is too much for the luff.
- The telltales should point aft over the full height of the sail.  
If this is not happening this can be caused by:
  - If only the upper telltales are going to leeward: Not enough twist.
  - If only the lower telltales are going to leeward: Too much twist.
- That you still sail the boat, and not the other way around, and your heel is acceptable.  
If you are over powered you are deflecting too much wind, so you have to
  - Ease the sail a little, then you are deflecting the wind less, (and your luff might backwind, so you need less curvature)
  - Give more twist, then the upper part of the sail has less force, (And the upper part also delivers the most heeling moment because it higher.
  - to reduce sail, resulting in simply less force, and the upper part of the sail that gives the most heeling moment is away.

For more information about telltales I recommend to go to: [telltales \(WB sails\)](#) (although I do not fully agree with their last graph.)

Below is an illustrated glossary of some of the words to describe the sail profile.

I would like it a lot if someone can correct them to the right words for it.

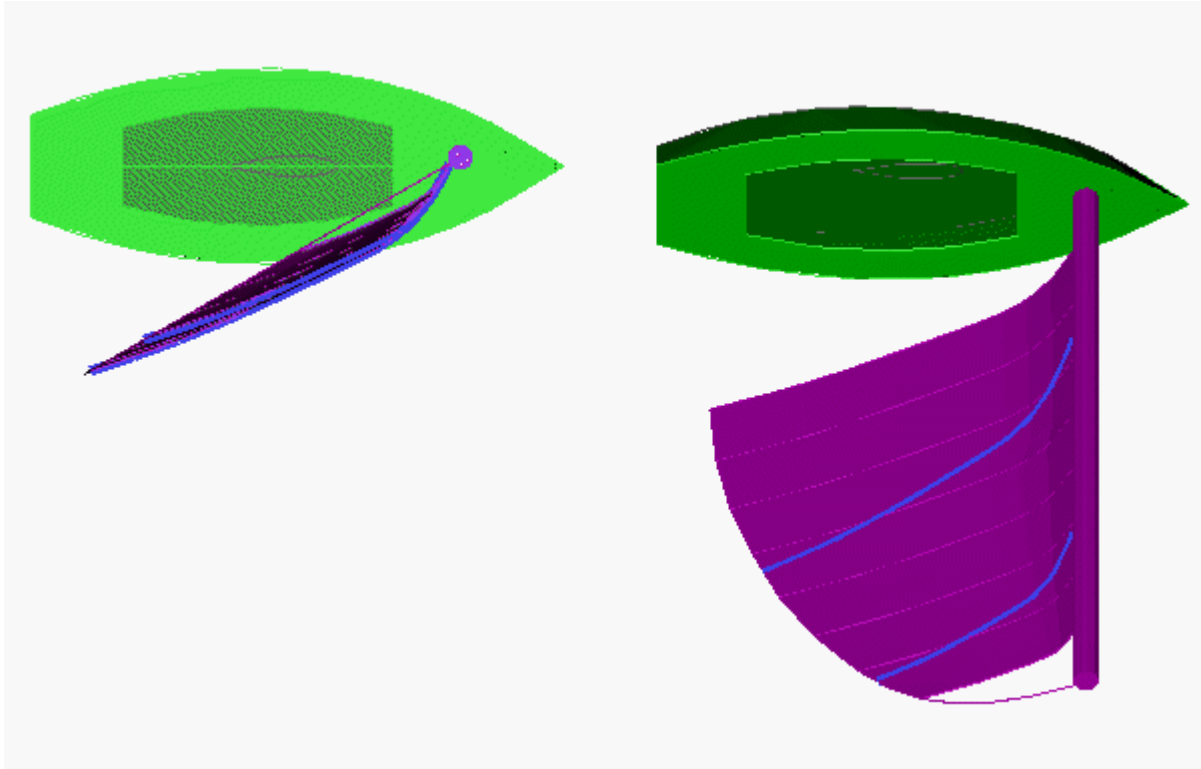




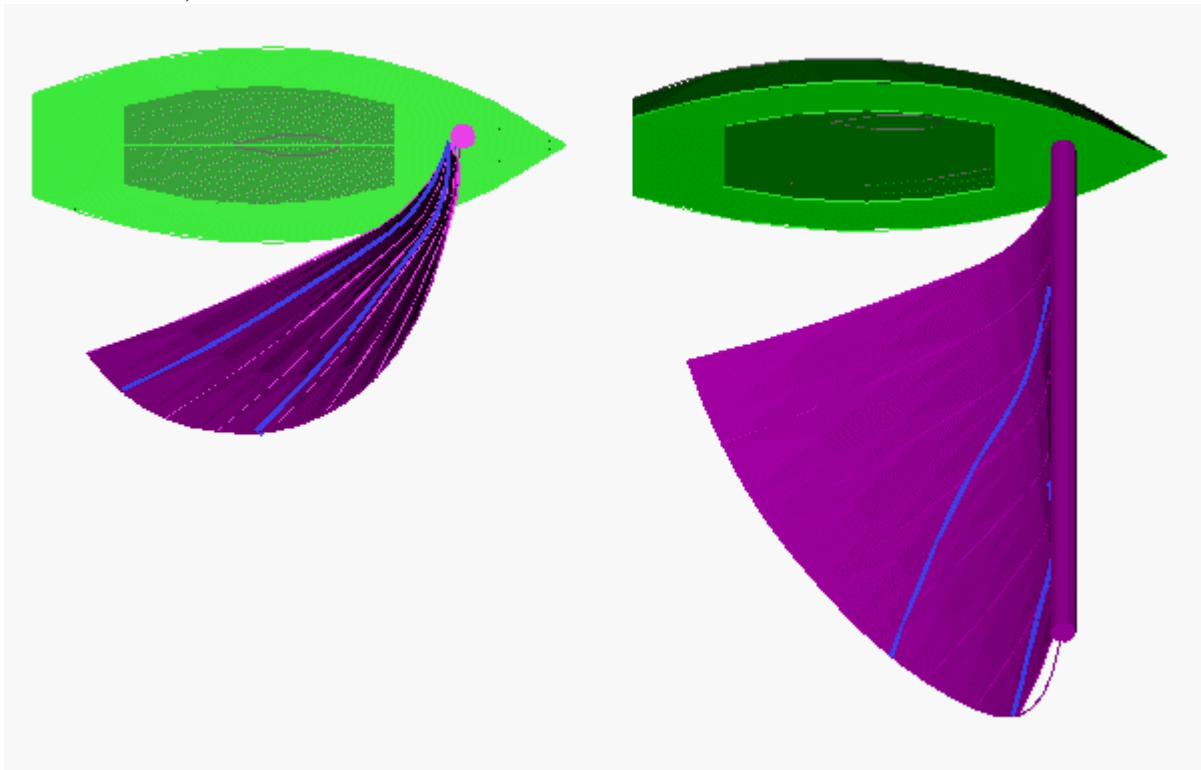
## Twist

The higher you go the more wind there is. Because of the difference in this apparent and true wind speed, the wind will come more from the true wind direction than below. That is an explanation of why you need a little twist. Another explanation is "taper induced twist" like explained at the bottom of [how a sail works](#).

When heeling, twist also influences the flow in another way. For high twist and high heeling the wind will be deflected less, and the sail seems more flat from the wind point of view. In the picture below the blue line indicates the flow path.



Now the same, but now with some twist:

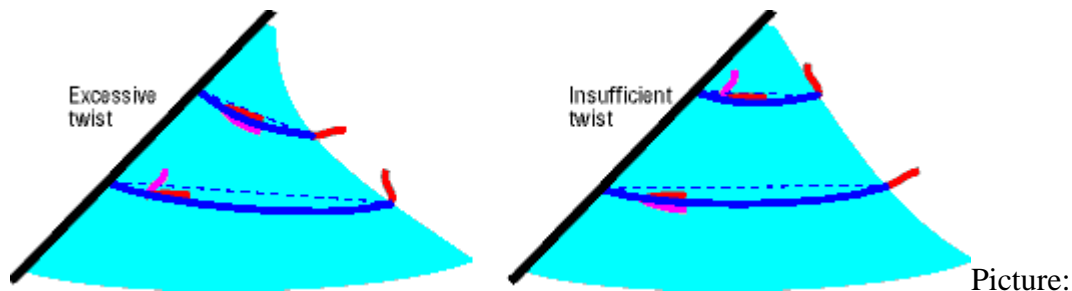


I hope this clarifies the influence of twist when heeled.

When is the twist right?:

If all telltales on the trailing edge are directed aft.

If you do not have telltales (which you should) a good indication could be that the luff starts back winding from top to bottom if you let go of the sail just a little.



<http://ourworld.compuserve.com/homepages/lestergilbert/>

## Telltales

As you might have noticed by now it is important to know how the wind is flowing along your sail. Because you cannot see air, you need some sensors. The most simple sensors are some light ropes or tapes hanging free and connected to the trailing edge. They give you the information if the flow is attached or separated. If the flow separates, they are blowing to leeward instead of aft. You can make telltales yourself, ask your sail maker, or buy them at a good sailing sports shop. I have made them myself from some light fabric or you can use tape from a tape recorder.

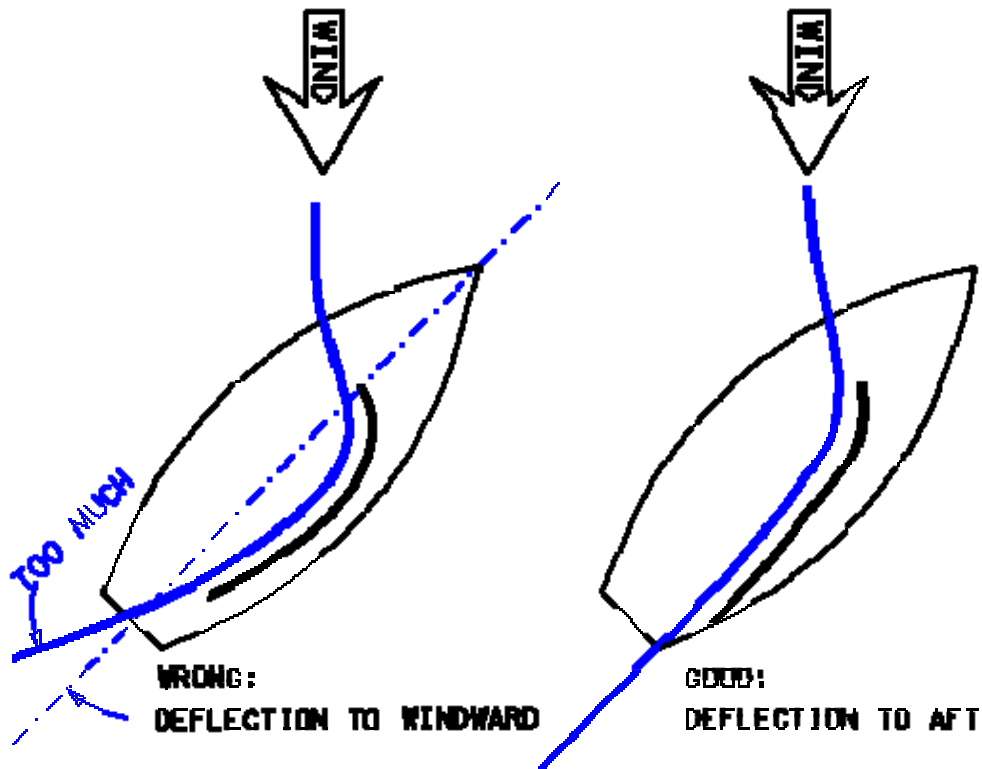
Because the leech is not in your normal point of view it is common practice to also have some gentry tales in your luff (1/3 aft from the mast, at three heights.) Often this is where the flow separates, so this can give you good information. Please note that sometimes these gentry tales are dancing, while the telltales are nicely streaming. This dancing of the gentry tales can then be neglected. Probably they are dancing because they are in the turbulent boundary layer. Often it helps placing them a little more aft, (maybe because there is less turbulence from the mast there, so the flow has re-attached itself again)

I tune by the telltales, the gentry tales more forward are only a help because they are much easier to see. For more details about telltales I recommend to go to: [telltales \(WB sails\)](#) (although I do not fully agree with their last graph.)

## Sail tuning sailing close hauled.

Speed vs. closer to the wind.

When sailing close hauled you want to go as fast as possible up the wind. You will have the tendency to have the sail too tight, so with the leech directed somewhat to windward. This has no use. If you want to go closer to the wind, flatten your sail. Of course you will lose speed with a flattened sail.



Often it is not possible to flatten the sail, giving some more twist and more heeling might help in that case. Please note on the above picture the deflection of the air is before it has reached the sail. This is often called "upwash", the name makes sense if you look at a wing:



Often it helps to make the point of maximal curvature a little more forward. It helps flattening the leech.

### **Sail tuning when sailing abeam**

When sailing abeam, sailing closer to the wind is of no importance. So, you need as much curvature as you can get, or you can handle.

### **Sail tuning sailing in waves.**

Waves will make the ship move. This will make the sail move through the air, constantly changing angle of attack, speed etc. This makes it necessary to use a tuning that performs well over a wider region. Often it helps to go for more speed.

The keel is also moving through the water. The drift angle varies constantly, and so does the drift

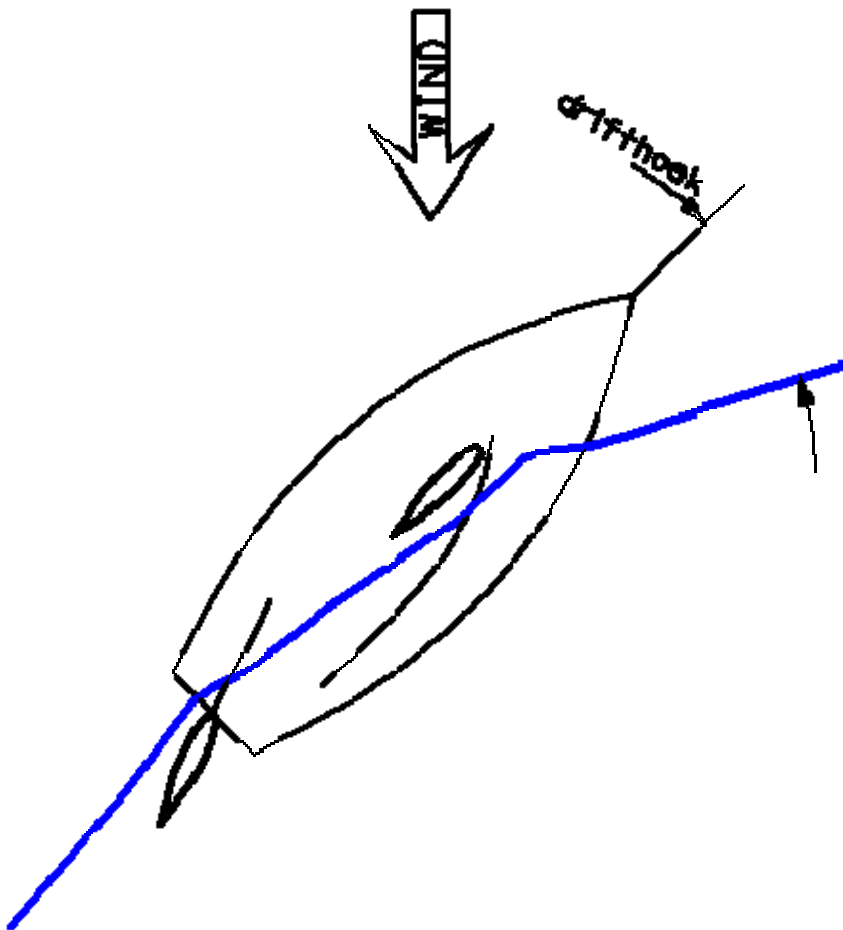
resistance. To have as low as possible drift resistance you need some extra speed to reduce the drift angle.

### **Balancing the sail force and the keel force.**

When you have the sail tuned optimally it might happen that the ship is extremely coming up or bearing away. You will need a lot of rudder to stay on course, and excessive rudder is slowing the ship down. This would be a waste of the sail tuning. A little tendency to come up is good. This can be explained by the same effect the main and the jib have on each other.

The jib (here keel) deflected the water already a little for the main (here rudder), so the main needs to be a little tighter than the jib. It is bad to have a ship that has the tendency to bear away. This is comparable with sailing with the jib set for the other tag.

The "argument" is how much the tiller should be to leeward. This is hard to say, but something like half the drift angle should be about right.



Please note above picture is exaggerated. The right balance can be obtained with moving the sail force by moving or raking the mast, or with the heel.

## **Tuning with the heel.**

Beside the influence of heel on the twisted sails, the heel can be of great importance to the ships resistance. Many ships perform best with a small heel.

## **Tuning with the heel in length direction.**

If the boat is hanging to the aft the stern tends to submerge too much. Too much is when the flat vertical part is coming so much down, that it gives a turbulent wake.

If the boat is hanging too much forward the stern may be above water, reducing the length of the ship what will result in a lower "hull speed" so more wave making resistance.

## **With what lines to tune your sail.**

This is depending upon what boat you have and what your sail maker had in mind. My recommendation is to go out for a sail in light winds and just pull and loosen every line you can find so that you know what line does what. One remark: If you fully tighten the vang when sailing close hauled with a tight main, your mast might break or bend if you loosen the sheet only. Use the traveler to set twist when sailing close hauled, and not the vang.

Enjoy the art of tuning!