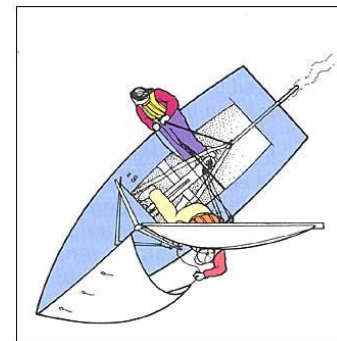


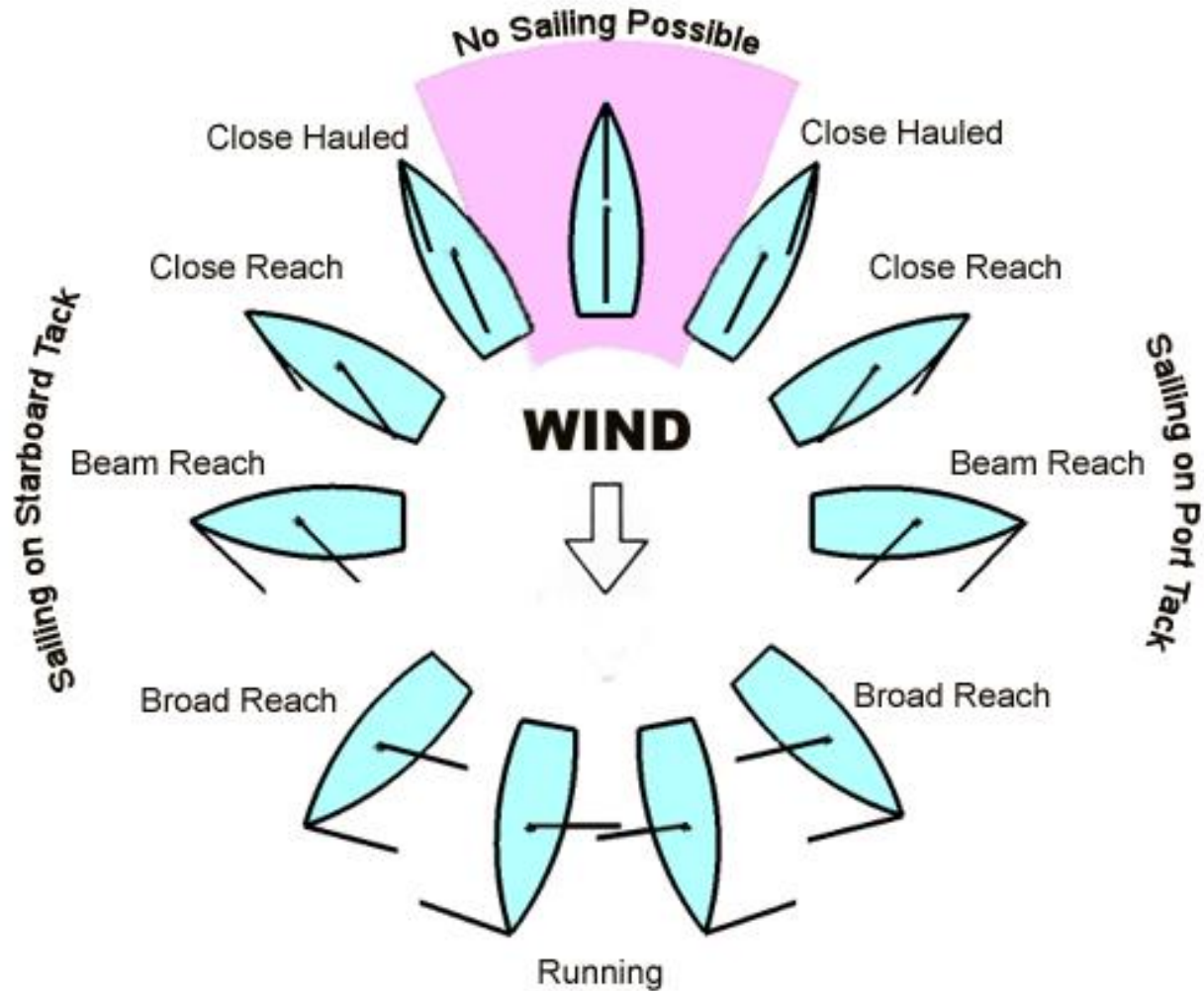
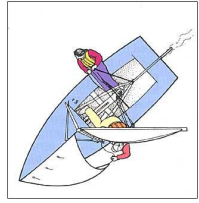
Sail Trim



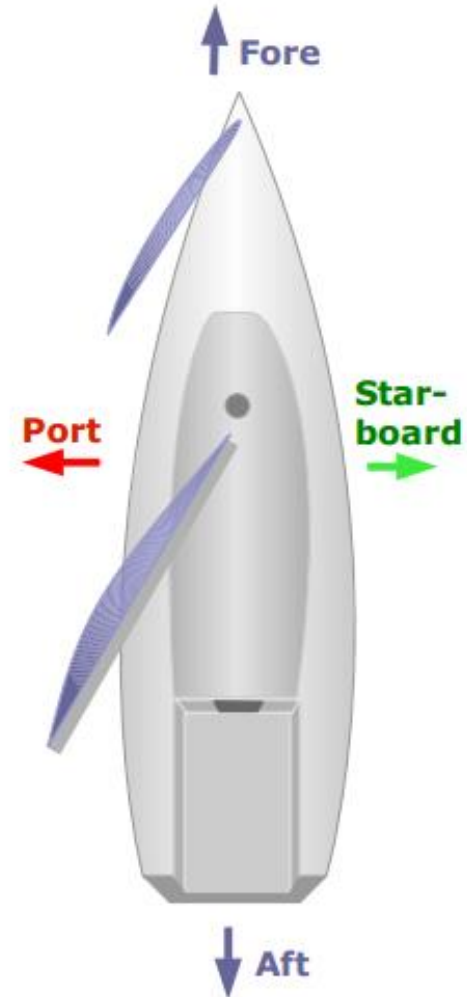
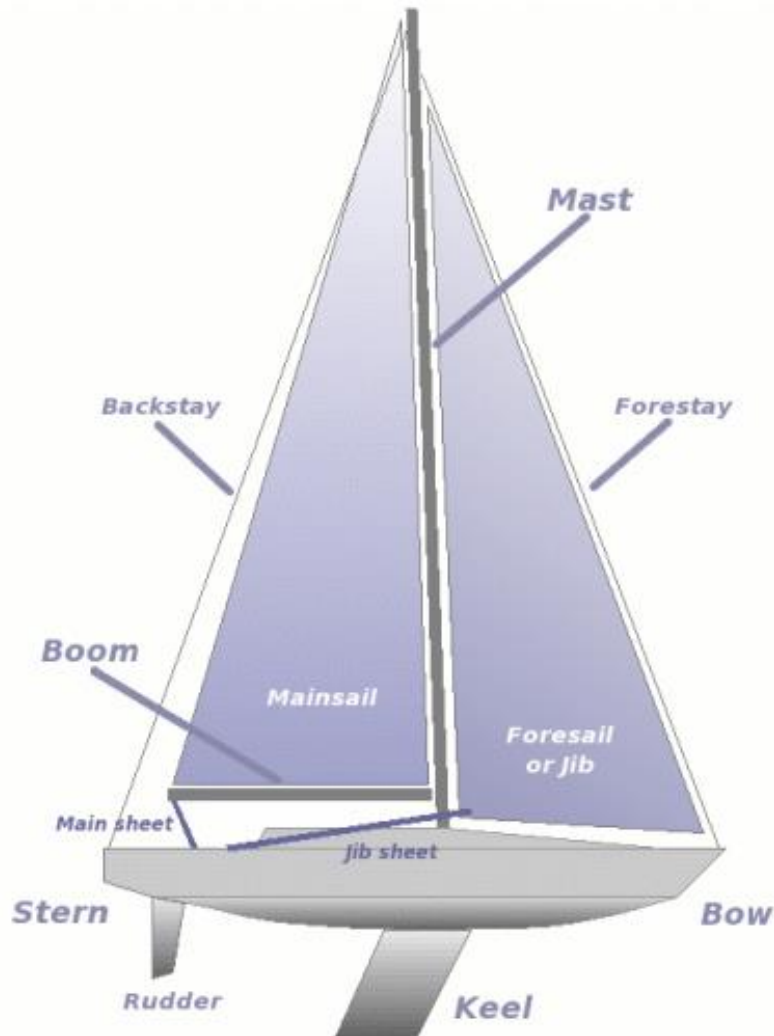
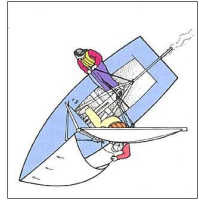
- Points of Sail
- Sailboat Terminology
- Sailing Basics
- Sail Theory
- Upwind Trim
 - Sail Draft and Lift
 - Sail Draft and Drag
 - Sail Controls – Wind Indicators
 - Telltales – Jib and Main
 - Leech Shape – Main and Jib
 - Main Sheets and Jib Sheets Together

Ray Williams
Quantico Yacht Club
April 2013

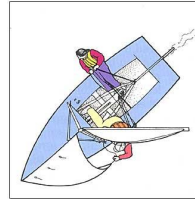
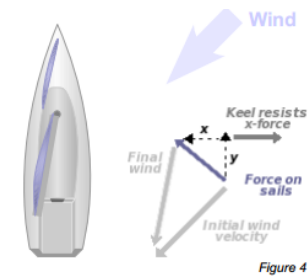
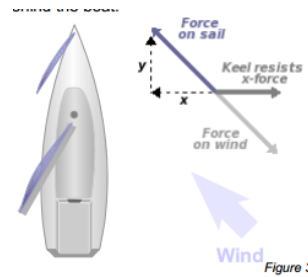
Points of Sail



Part of the Boat and Sails

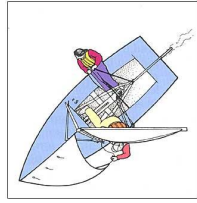


Sailing Basics



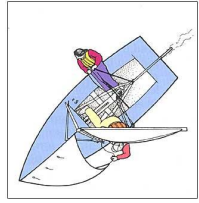
- When the wind blows, the boat wants to move forward and sideways
- Keel prevents boat from going sideways, so it goes forwards
- Angle of sails important - must be set at the right angle to the wind to generate lift
- Action of adjusting the sails is called trimming
- Points of sail - relationship of boat to direction of wind
 - Boat cannot sail directly into the wind
 - If wind gets too far forward (in front) of boat it won't generate 'lift' and boat stops – In Irons
 - Most boats can sail about 45° to the wind, any closer and it loses speed - close hauled.
 - If the wind is coming from side of the boat
 - From 90° to the axis of the boat it is on a beam reach
 - Forward of 90° it's a close reach - aft of this a broad reach
 - Behind the boat it is running - directly behind the boat is a dead run
 - Downwind is sailing “with the wind” - in the direction the wind is blowing. Upwind is against the wind.

Parts of the Hull; Sails, Stays and Spars; Sheets and Halyards; Other

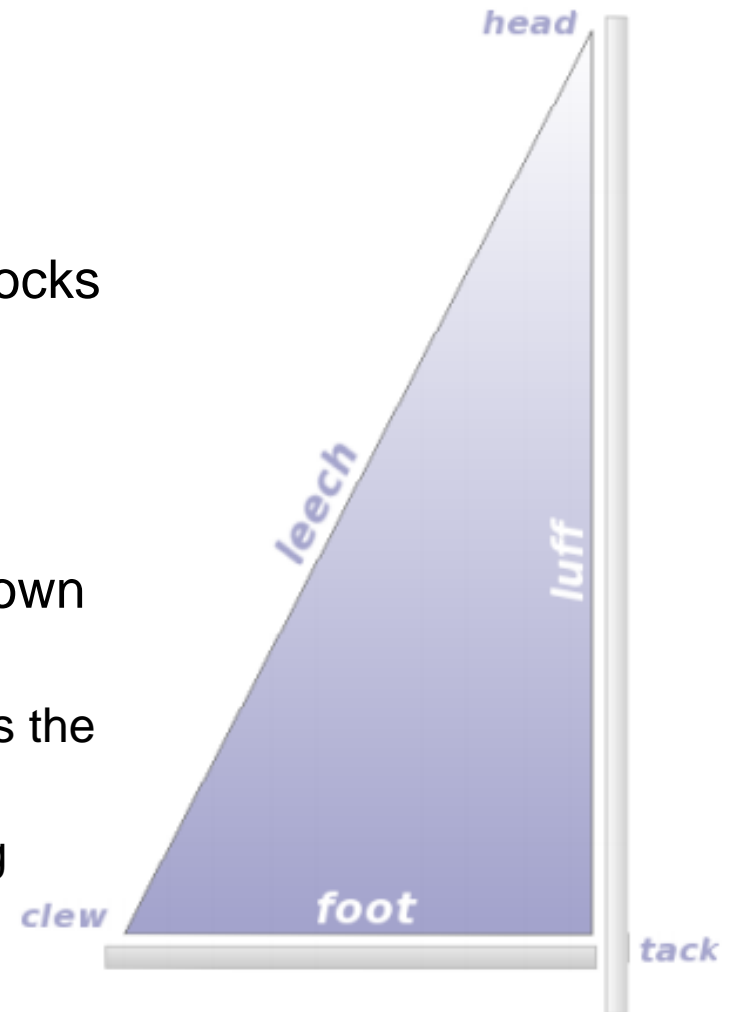


- Hull
 - Bow – pointy bit at the front the boat
 - Stern – blunt bit at the back
 - Cabin – lump in the middle you sleep in
 - Keel – big heavy fin-thing on the bottom of the boat that keeps it from flipping over
 - Rudder – a movable fin at the back that steers the boat, connected to a wheel or tiller for steering
- Sails, Stays and Spars
 - Mast – tall vertical stick the sails hang off
 - Boom – horizontal stick hanging off the mast
 - Forestay – front wire keeping the mast up
 - Backstay – back wire keeping the mast up
 - Sidestay – work it out genius...
 - Mainsail or Main – the big sail behind the mast
 - Foresail or Jib – the 'little' sail in front of the mast (sometimes known as a genoa, 'jennie' etc)
- Sheets and Halyards
 - Main sheet – rope for controlling the mainsail
 - Jib sheets – ropes for controlling the jib, usually one on either side of the mast
 - Halyard – a rope for raising or lowering a sail
- Directions
 - Fore – towards the bow
 - Aft – towards the stern
 - Port – to the left as you face the bow
 - Starboard – to the right as you face the bow

Sails – Types and Terminology

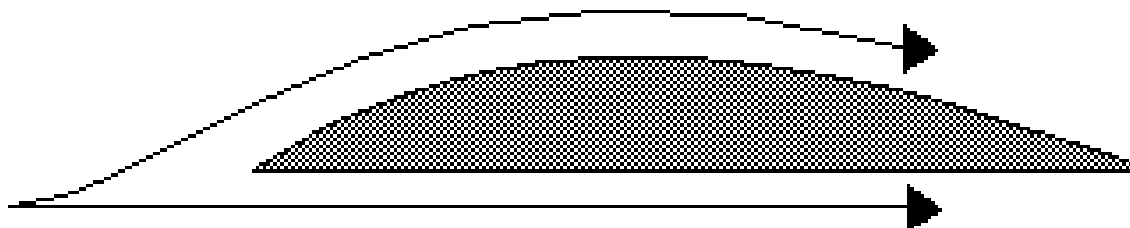
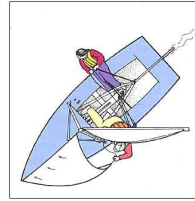
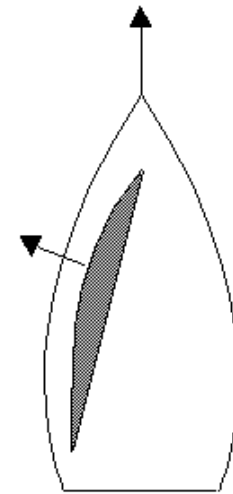


- Two main types of sails
 - Main
 - Big sail behind the mast
 - Controlled by a mainsheet run to blocks on a traveler
 - Jib
 - Sail in front of the mast
 - Controlled by two sheets that run down each side of the boat
 - Working sheet, under load as it holds the force of the wind
 - Lazy sheet, lying slack doing nothing

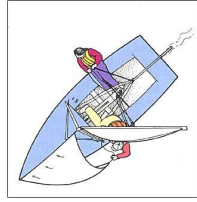


Basic Sail Theory

- Lift and Flow
 - Lift is the force that makes the boat move
 - Flow of air over sails generates lift
 - Flow also generates drag, which slows the boat down
- Sail is like the wing of an airplane - an airfoil that changes the shape of the wind as it flows over the sail surface
 - With change in the shape of the wind come pressure and directional changes
 - Air particles on top travel further than particles going over the bottom
 - These two want to reach the back of the sail at the same time
 - Particles over the top needs to travel faster.
 - With air traveling faster over the top, the "Bernoulli Effect" kicks in – since speed on top is faster, pressure drops, "sucking" the foil up or sideways

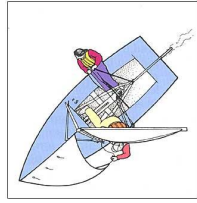


Upwind – Adjusting Trim

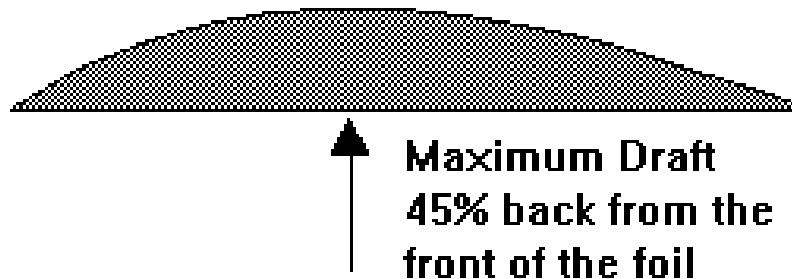


- Adjusting a sail is called trimming it
- Sail trim a complicated and poorly understood subject
- Simple rule of thumb is : ease the sheet until it starts to ‘luff’ and then pull it in “a little bit”
 - If in doubt ‘let it out’
 - Luff means to flap at the front edge - at the luff
 - If sail is too tight it ‘luffs’, front edge is loose/floppy
 - A taut smooth sail that looks like an airplane wing is probably doing its job
 - The “closer to the wind” you sail the tighter you have to sheet in your sails - when you sail into the wind pull the sails in tighter than if the wind is behind you

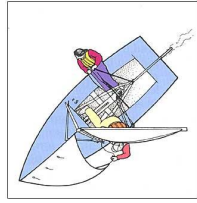
Sail Draft and Lift



- The sail is the foil driving the boat
- To maximize boat speed in different conditions, you must change the depth of the foil - called the draft of the sail
 - Size and location can be changed using the sail controls
 - Position: Best to have sail draft a little forward of halfway
 - Size: In general, the bigger the draft, the more power
 - Large draft is like first gear in a car - lots of power to accelerate, but topping out at a fairly low speed
 - A flat sail is fifth gear - sail attains higher speed, will point higher to wind, but takes longer to accelerate

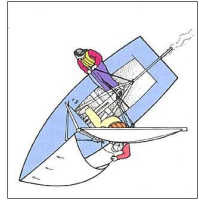


Sail Draft and Lift (Continued)

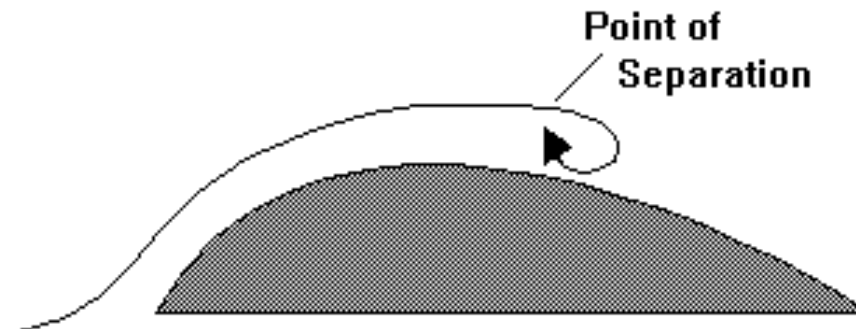


- Light Winds
 - Air, traveling slowly, doesn't have the same energy as fast air
 - Light wind tries to get around sail as best it can - gives up if draft too large
 - Keeping sail flat helps light wind get around the sail
 - When a puff hits, those with fuller sails will pass you
 - If wind is steady, a flatter sail will make you faster in long runs upwind
- Moderate Winds - follow the rule
 - Bigger draft = more power, smaller draft = more speed
 - If sailing and speed okay, but boat is not accelerating as quickly as others, put more "bag," or draft in the sail
 - If acceleration is good, but you lack top speed upwind, flatten the sail
- Heavy Winds
 - In heavy winds, there is an excess of sail power
 - With too much heel bad things happen
 - Squeeze excess power out of sails by flattening them
 - Easy to get the boat up to speed since there is plenty of power

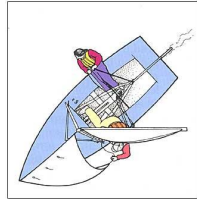
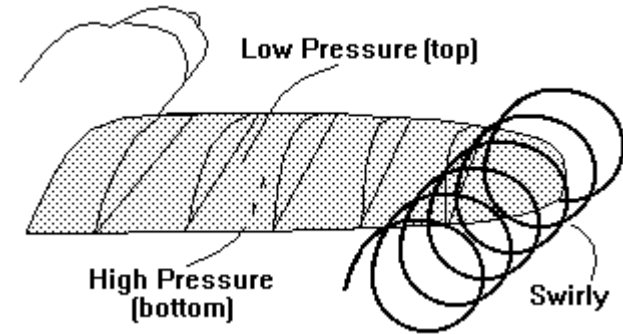
Sail Draft and Lift (Continued)



- Attached Flow
 - Lift is a product of the flow of air around the sails
 - Classified as attached or unattached
 - Attached flow is a smooth flow of air that "sticks" to the sail - very desirable when going upwind - generates much more lift than does unattached flow
 - Unattached flow breaks off the sails with little swirlies in it
 - Telltales (coming up) help you see the winds effects
 - When wind is light it separates from the sail when there is too much draft
 - Flattening the sail helps air stay attached, generating more lift
 - Generally, separation occurs when the wind has to make a sharp turn, like when the draft is too large

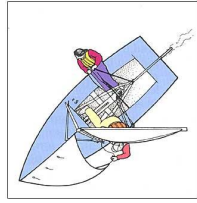


Sail Draft and Drag

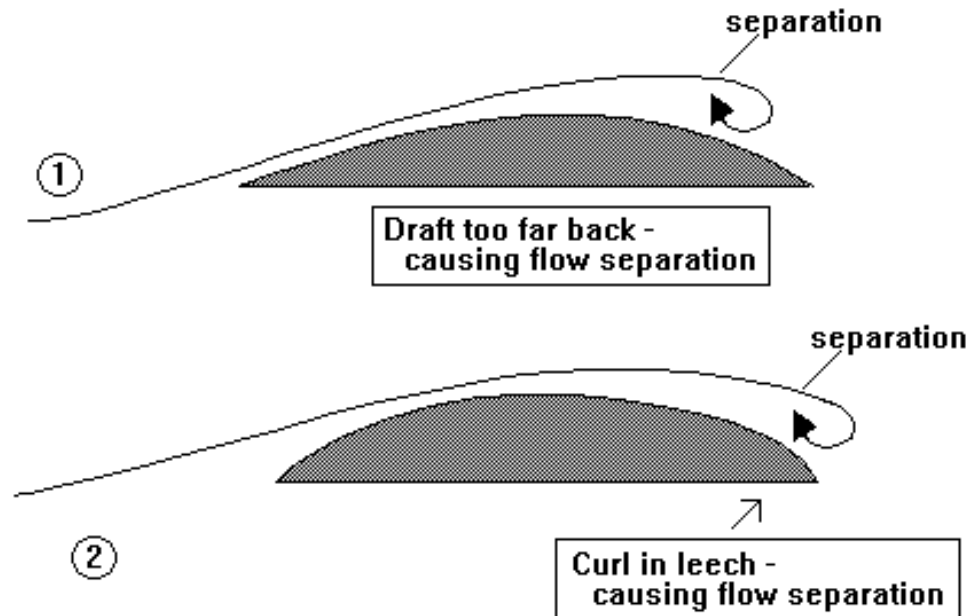


- Two types of drag Frictional and Induced Drag
- Drag holds the boat back, but can be partially reduced
- Frictional and Form Drag
 - Like scraping a box on the ground as you try to push it - the reason there is oil in car engines or we use edible body oils
 - Frictional drag is generated from
 - Side stays, seams in the sails, and the skipper and crew (time to lose weight)
- Induced Drag
 - Airplanes generate large vortices that come off of wing tips
 - Caused by the low and high pressure areas meeting at the wing tips
 - Air "leaks" suddenly from the high pressure side (windward) to the lower pressure side, creating big swirlies
 - Swirlies require lots of energy to form-energy better used to propel the boat

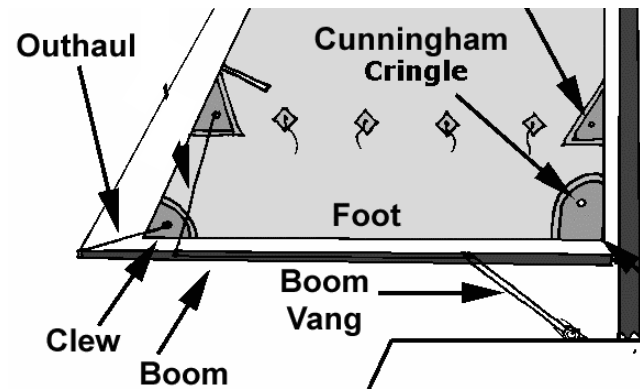
Avoiding Sail Drag (Continued)



- Another place vortices can form and sap energy is at the sail's trailing edge, or leech
- Air needs a smooth exit from the sail to keep it from swirling
- Two ways to make air swirl are
 - Put the draft too far back, so air makes a sharp turn right before exiting
 - Curl the leech of the sail inwards with too much boom vang

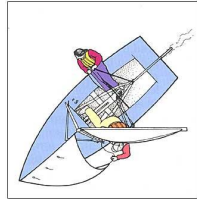


Changing Draft

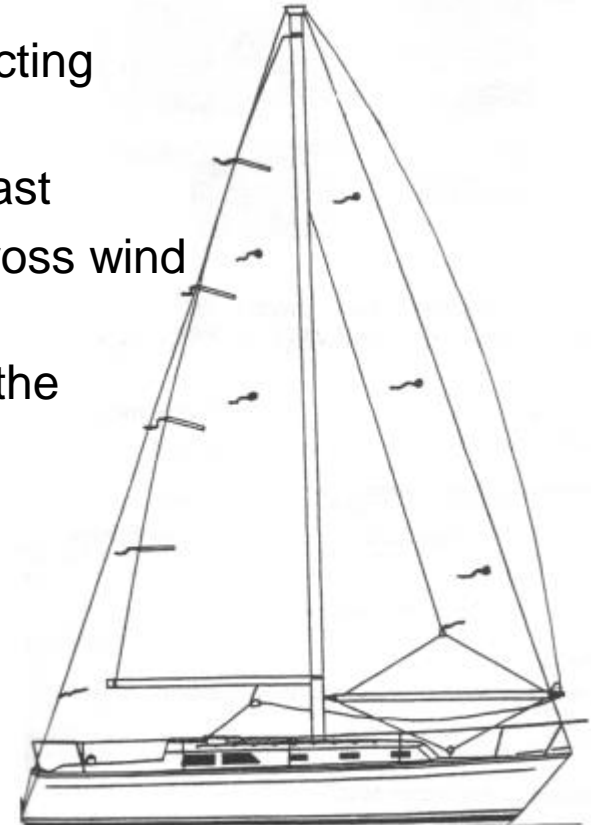


- Outhaul - what the name says- hauls the back of the sail out
 - Controls draft size in the bottom 40% of the mainsail
 - To flatten sail, pull on the outhaul
 - To give the sail more "bag", or draft, let out the outhaul
 - Most useful on loose footed mains - in-mast furling
- Cunningham - (draft location)
 - Important control for moving the location of the draft
 - When the Cunningham is pulled on, draft in the sail moves forward
 - As wind speed increases, draft tends to blow back towards the leech
 - Undesirable as it causes overpowering and extra drag
 - Draft should be between 40% and 45% back from the luff of the sail
 - By-product of tighter Cunningham is the leech begins to "open up" - sighting straight up above the boom, top batten should be parallel with the boom
 - If Cunningham is too tight, top batten will point outward, away from boom
 - Don't use Cunningham to flatten as it moves the draft while flattening

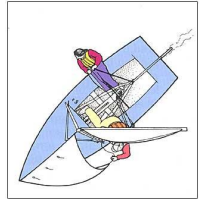
Sail Controls – Wind Indicators



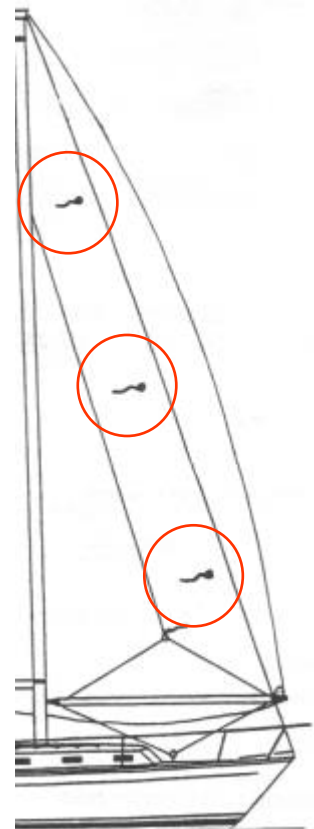
- Wind Indicators
 - Before you change sail shape you need to know changes to make
 - Much is done by the feel of the wind
 - Telltales and the Windex are visual aids for detecting wind direction sail interaction
 - Windex - small weather vane at the top of the mast
 - Sidestay Telltales - same task as the windex - gross wind direction
 - Telltales Most sensitive, accurate, and useful of the bunch
 - On the Sails



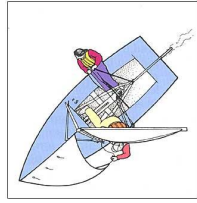
Jib Telltales



- Most sensitive, accurate, and useful of the bunch
- Should be placed 1/3 the way back from the luff at 1/4, 1/2, 3/4 the distance from bottom to top
- Made of a light material that does not stick to the sail - yarn or nylon tape
- Going upwind, with sail mostly flat telltales should flow straight back
- Sometimes, as when reaching, both will not flow back because of a large draft in the jib
- Imperative outside flow is maintained – keep outside telltale streaming back

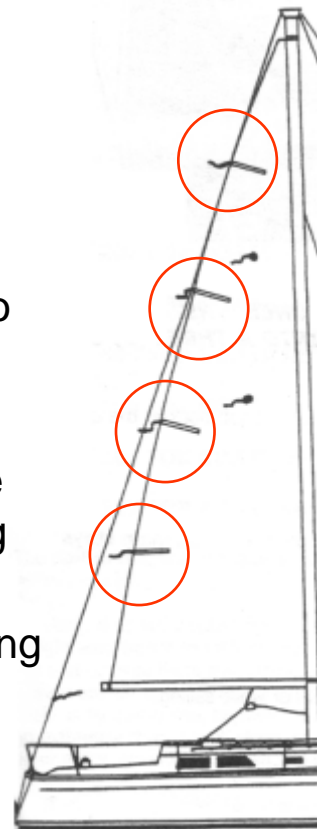


Main Telltales

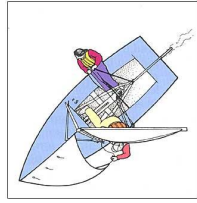


- Mainsail Telltales

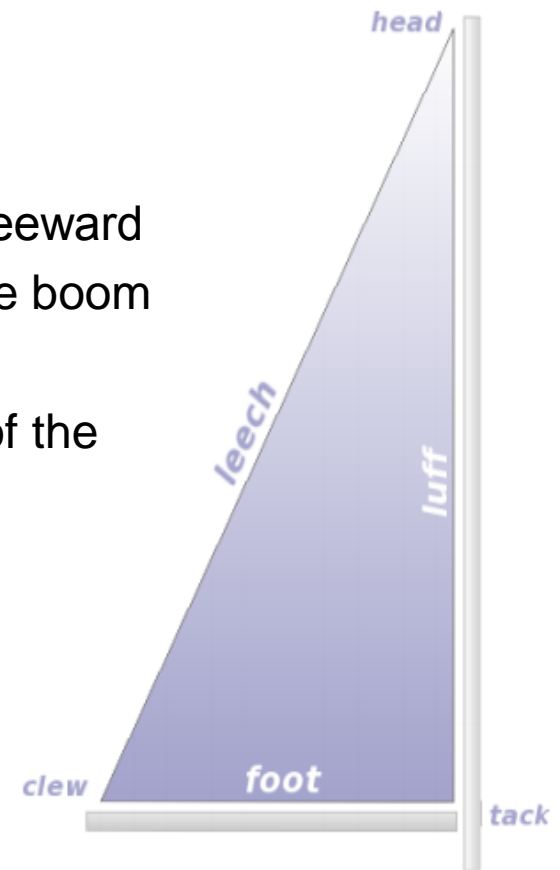
- Mainsail used to keep boat flat and it is best to trim it by feel
- Draft Telltales (front of main)
 - Give the same information as those on the jib
 - If they are flowing straight back, there is attachment, and if not, separation
- Leech Telltales
 - Attach to the leech at the points where battens are inserted
 - When air is leaving smoothly they will flow straight back, as they do on the surface of the sails
 - Goal for these is to have them lifting (flowing) 1/2 the time
 - If they lift more than 1/2 the time, too much air flowing freely off the leech - you need to capture more by trimming the sail, or tightening the vang
 - If they lift less than 1/2 - leech is too tight, let up on mainsheet or vang



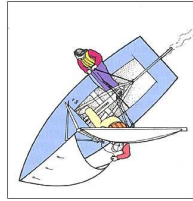
Leech Shape - Main



- Boom Vang
 - Controls the shape of mainsail leech
 - When pulled on leech gets tighter
 - When released leech gets loose, and "twists" to leeward
 - Top batten should be approximately parallel to the boom
 - If pulled in too much, there is excess drag
 - If left loose, too much power is lost out the back of the sail

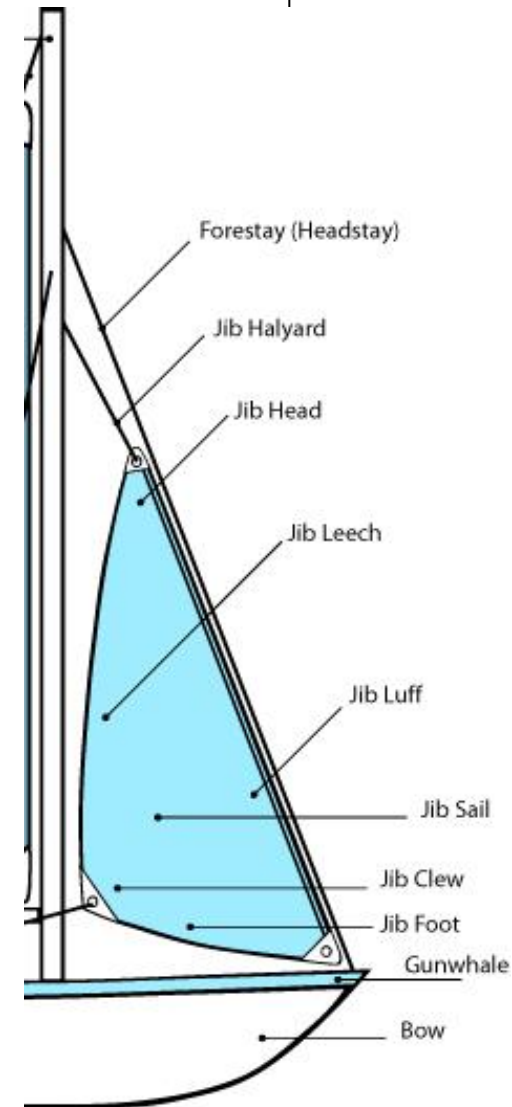
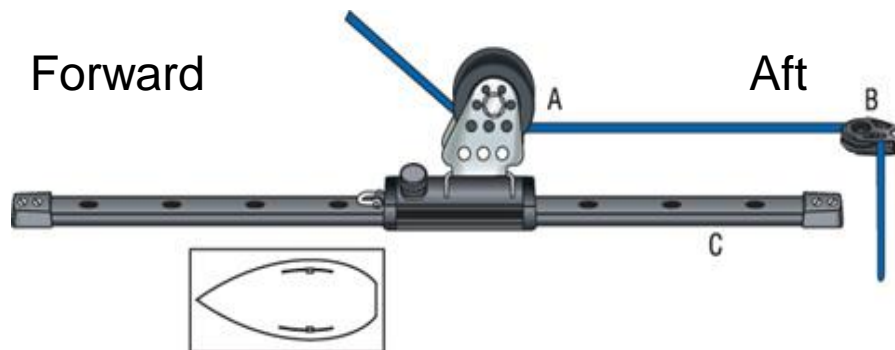


Leech Shape - Jib

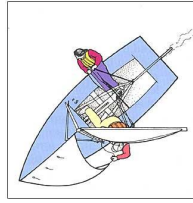


- Jib Leads

- Jib does not have as many controls as the main
- Most of the time, sheets offer only interactive control
- Important to remember the "slot" between jib and main
 - Should be kept fairly open to allow correct flow to form
 - Leech should be kept parallel with the closest part of the main
 - If slot is too wide at the top (i.e. leech of the jib too open), too much air escapes without affecting the jib
 - If too narrow, flow is "choked," and boat will not go as fast, or point as high

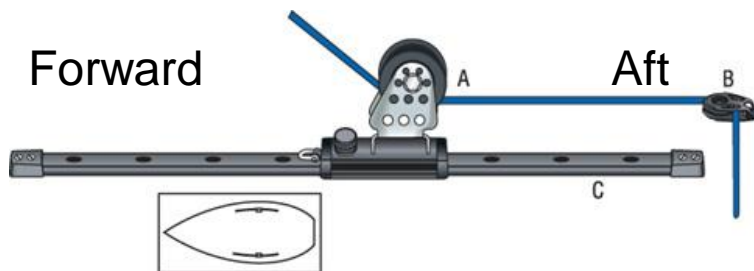
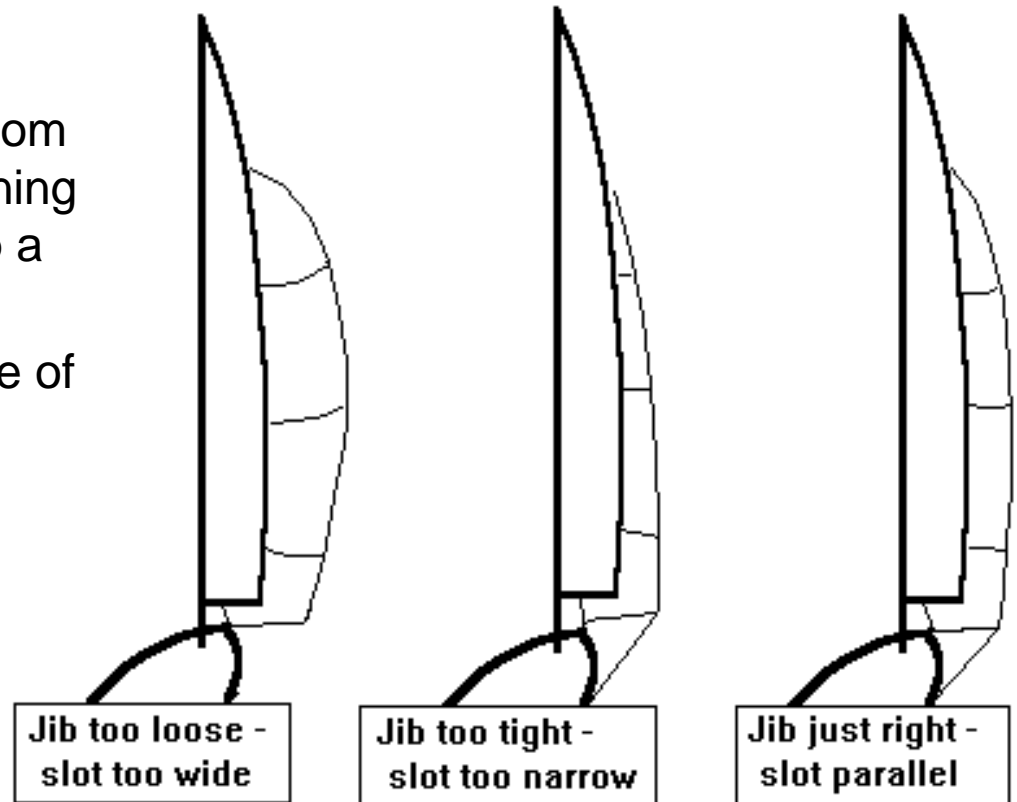


Leech Shape – Jib (Continued)

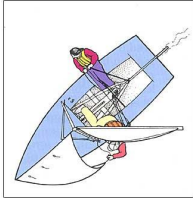


- Control the slot through the jib leads - two blocks for the sheets moved forward and back
 - When moved **back** sail bottom is pulled toward stern flattening the sail – leech will open up a little
 - When moved **forward**, force of sheeting is mostly down, closing leech sail allowing more bag to into the middle

View of jib/main "slot" from behind boat



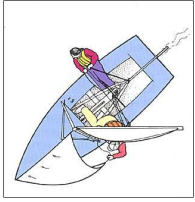
Main Sheets and Jib Sheets Together



- Mainsail gives the headsail a "lift" while the headsail gives the mainsail a "header"
 - If you adjust one sail, you must adjust the other
 - These controls together the most interactive of all
- Major function to control angle of attack on the wind – angle the wind hits the sail, with respect to the boom
- When sail is brought in, angle increases and power increases
 - If angle of attack **too large** (sail pulled in too tight), the sail will "stall" and the lift will be destroyed
 - It will look the same, but won't be working as it should any longer
 - If angle is **too small** (sail isn't pulled in enough), it will luff, generating no lift at all
- Use telltales to judge whether flow you need is being generated
- Flow can be created and destroyed by changing angle of attack
 - Little changes at a time are better than big changes

Main Sheets and Jib Sheets Together

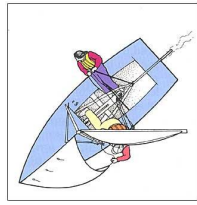
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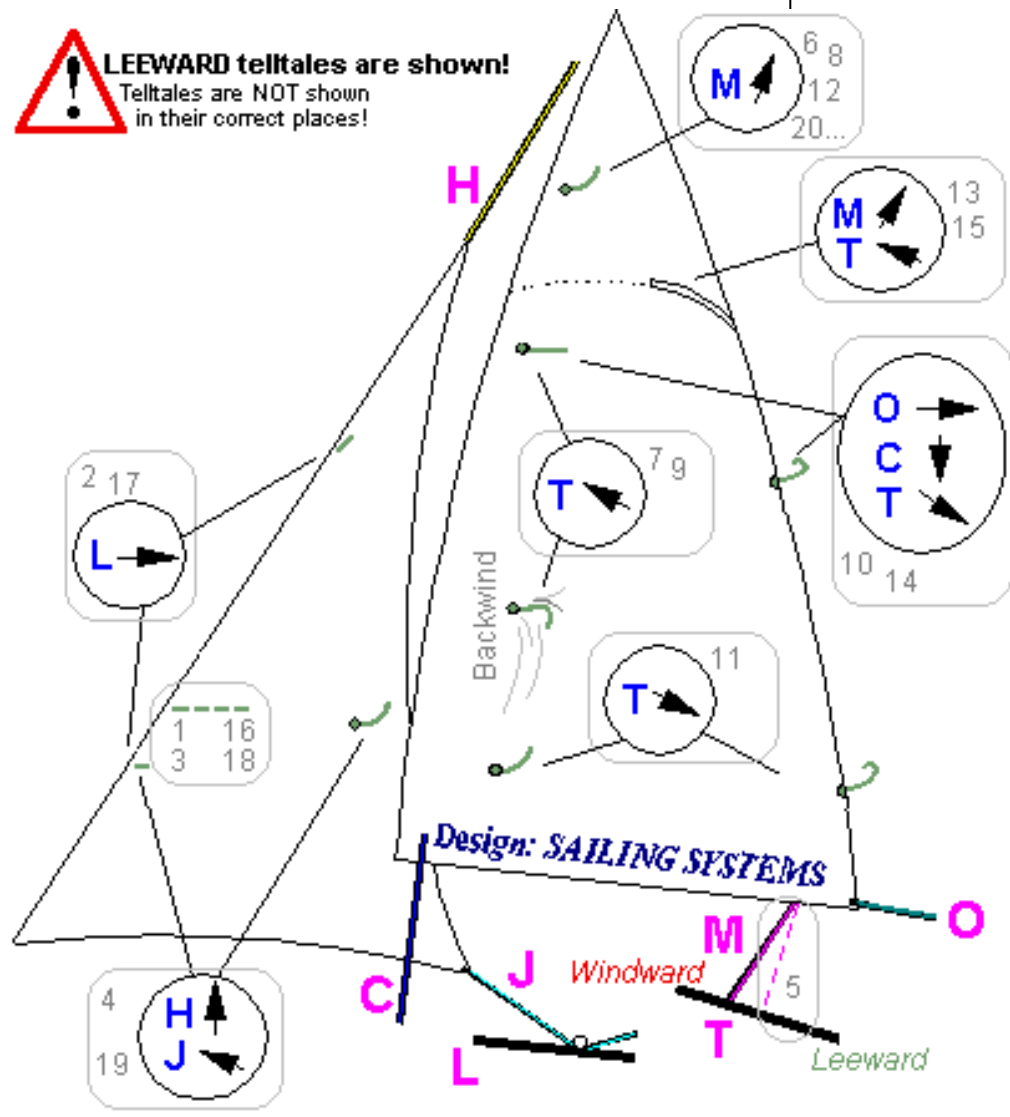
- Before the first race starts, you should spend 15 minutes
 - First trim the genoa
 - Then trim the main
 - Then trim the genoa again
 - Then trim the main again
 - and so on, until all secondary sail controls are set
 - Everything except for the controls (sheets, mainsail traveler) that are set for the current wind conditions.
 - You will frequently adjust during the sheets and mainsail traveler during the upwind leg

Main Sheets and Jib Sheets Together

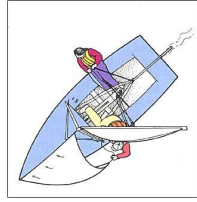
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- Telltale States:
 - Shown in green or red (depends on tack shown) as:
 - "stalled" (lifting up); or
 - "flying" (straight back); or
 - "back winded" (shaking, drooping)
- Sail-shape Control Lines:
 - C=Main Cunningham
 - H=Jib Halyard
 - J=Jib Sheet
 - L=Jib sheet lead (car)
 - M=Mainsheet
 - O=Main outhaul
 - T=Mainsheet traveler car
- Trim Adjustment Directions:
 - Adjustments are noted in black "action circles"
 - If action circle involves multiple adjustments, they are undertaken in sequence, top to bottom, with bottom adjustment light
 - Adjustment directions shown in arrows WRT control axis
 - EXAMPLE: "H" goes up or down; "T" goes up (to windward) or down (to leeward); "O" goes right (in) or left (out), etc.
- Execution Sequence:
 - Shown as light gray numbers (i), inside light gray boxes
 - Action(s) noted within box are taken as (i)th step(s)
- Trim Adjustment Criterion
 - Shown by one or pair of black lines originating from an action circle
 - Adjustment noted in action circle undertaken if telltales/ black lines point to are in the state depicted



References



- [How to Sail a Boat, A sailing primer for Novices,](http://www.cityisland.com/pdf/sailingprimer.pdf)
<http://www.cityisland.com/pdf/sailingprimer.pdf>
- [RACING BASICS, by Mark Johnson \[copyright 1/19/95\],](http://www.uiowa.edu/~sail/skills/racing_basics/chap2.shtml)
http://www.uiowa.edu/~sail/skills/racing_basics/chap2.shtml
- [A Trim Primer for Main and Headsail Balance by Shevy Gunter,](http://www.arvelgentry.com/A_Trim_Primer.htm)
http://www.arvelgentry.com/A_Trim_Primer.htm