



S.A.I.L. 2010 Winter Seminar Series – Sail Synergy

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Introduction

- Sail Trim Resources
- North U Race Trim
 - Race Trim CD and graphics used by permission in the presentation and not reproduced here

Recommended Reading

- The Art & Science of Sails – Whidden
- Sailing Theory and Practice - Marchaj
- Looking at Sails - Kenny
- The Symmetry of Sailing - Garrett

Agenda

- About Sails
- Sail Controls
- Upwind Sailing
- Downwind Sailing
- Symptoms & Solutions

Sail Synergy

- A paradigm shift (Synergy from Webster's):
 - A combined action or operation
 - A mutually advantageous conjunction or compatibility of distinct elements (as resources or efforts)

About Sails

- Apparent Wind
- Local Wind
- Lift (Side Force)
- Symmetry of Sailing
- Sail Sources of Power

Apparent Wind I

- Wind velocity experienced by the sails on a moving boat
 - Always forward of True Wind
 - Velocity Triangle: Vector sum of $V_a = V_t + V_s$
- Upwash on a Sloop Rig
 - Headsail in a relative lift
 - Mains'l in a relative header

Apparent Wind II

Two notable helmsman want to race a section of a navigable river with only one boat is available They agree to use the same boat in a timed race The course will be the same one mile stretch of the river And the will be acing downstream with a steady 10 knot current.

1st racer completes the course with a 10 knot wind on the stern

2nd racer completes the course but the wind has gone completely calm (0 knots)

Who wins? (owt rebmun rolías)

Local Wind

- Wind Variation
- Velocity increase aloft
- Boundary Layer Surface friction allow
- Twisted Flowfield Sail design implications

Lift (Side Force)

- Accelerating flow to leeward (low)
- Decelerating flow to windward (high)
- Pressure differential produces force in direction of arrows

Drag

- Pressure and friction drag 25%
 - Mast, wire/rope, crew
 - Angle of attack too large
 - DDW (drag provides force)
- Induced Drag 75%
 - Side effect of airfoil producing lift
 - Sails & Trim

Symmetry of Sailing

- A precise and well defined concept of balance
 - Helm feel
 - Even angle of heel
 - Sailing in the groove
- Balanced proportions between air and water forces
 - Extracting maximum energy from air and water flow (Aero-Hydrodynamic Lift)
 - Opposite and equal forces with steady speed
- Minimize leeway (angle of incidence)
 - Exists on all points of sail except DDW
 - Must have leeway to sail to windward

Sail Sources of Power

- Angle of Attack
- Shape
- Twist

Angle of Attack

- Upper and lower limits to useful angle of attack
 - Too low - luff or backwind
 - Too high - stall or loss of lift due to separation

Sail Shape I

- Depth – curve or camber
 - Proportion of chord length
 - Main 10-15%
 - Headsail 12-20%
- Draft Position
 - Position of maximum depth
 - Main 40-45%
 - Headsail 30-40%

Sail Shape II

- Depth
 - More for power in chop
 - Low gear
 - Less for smooth water
- High gear
 - Less drag
 - Flatten to depower
- Draft Position
 - Forward – less drag, wider groove in chop, depower
 - Back – lighter air and higher pointing

Sail Twist

- Leech profile
 - Direct correlation to pointing ability
 - Match headsail to main
 - Top batten relationship to boom
 - Leech telltales
- More twist is “open leech”
 - Slightly open by design to minimize stall
 - Spill power
- Less twist is “closed” leech
 - Upper leech parallel with lower
 - More power

Mainsail Upwind I

- Mainsheet
 - Reduce twist
 - Top batten parallel to boom
 - Leech telltales flowing with occasional stall
- Traveler
 - Maximize angle of attack with boom on centerline
 - Maintain balance
- Vang
 - Vang sheeting in heavier air
 - Two forces; boom and mast

Mainsail Upwind II

- Mast Bend
 - Backstay; vang; shroud tension
 - Affects shape of mid to upper sail
 - Adds twist aloft
- Outhaul
 - Lower third of main
 - Tighten to reduce depth and depower
- Halyard and Cunningham or Downhaul
 - Holds draft position
 - Tension for draft forward as wind builds
 - Add tension when you add mast bend
- Mainsail Shape

Headsail Upwind I

- Sail sized to match conditions or one-design
- Halyard Tension
 - Preset to match conditions
 - Increase as wind builds
- Sheet
 - Trim to increase angle of attack and improve pointing
 - Mid-leech parallel to centerline
 - Foot “rounder” than main
 - Shape to match main

Headsail Upwind II

- Headstay Sag
 - Adj backstay or shroudtension
 - Tension to flatten and
 - depower
- Leech Line
 - Just enough tension to stop any leech flutter
- Headsail Shape
- Sheet Leads
 - Initially set base on luff break when you head to wind (Remember “Bottom Back”)

- Leads forward for fuller sail and open leech
- Leads aft for flatter and close leech

Upwind Sailing: Light Air < 8 knots

- Speed comes first
 - Bear off
 - More headstay sag
 - Jib leads forward
 - Foot round
 - Slight twist to encourage flow
- As Speed builds
 - Head up
 - Trim to reduce twist and maintain angle of attack

Upwind Sailing: Medium Air 8 – 15 knots

- Trim for full power and max pointing
- Boom at or near centerline
 - Main twist so top telltale stalling occasionally
 - Main depth and headstay firmed for slight weather helm and comfortable heel
- Jib just shy of spreader or occasional bubble on main luff
 - Jib leads so leech matches main

Upwind Sailing: Medium Air II

- Smooth water
 - Flatter, more trim, less twist – higher pointing
 - Increase mast bend
 - Tighten forestay
 - Jib leads aft
 - Main telltale stall 50%
- Chop
 - Straighten mast & sag headstay
 - Jib leads forward, restore twist
 - Bear off a couple degrees

Upwind Sailing: Heavy Air > 15 knots

- Reduce drag
 - Reduce sail power
 - Flatten sails
 - Increase mast bend and tighten headstay
 - Increase outhaul and cunningham
 - Vang sheeting (some boats)
 - Jib leads aft
- Reduce Angle of Attack
 - Feather
 - Drop traveler
 - Add Twist (open leech)
- Reduce sail area

Upwind Sailing 15+ knots

- Maintain power in chop to punch through waves
- Focus on depowering sails (shape and twist) before angle of attack
- Steer for consistent heel angle
- Flying by the battens (backwind or luff bubble)
- Reduce headsail area before main

Downwind Sailing I - Close Reaching

- Ease jib, move lead out and forward
- Ease main and/or drop traveler with vang tight for leech power
- Dump vang to depower
- Ease outhaul and backstay
- Keep leech telltales flowing

Downwind Sailing II - Beam to Broad Reaching

- Bear off and ease to stand up boat
- Main out to rig
- Just enough vang to keep top batten parallel

Symptoms & Solutions

- The Boat is Slow
 - Try deeper sails
 - Light air or chop add twist, bear off
 - Moderate breeze over smooth water trim deep sails hard (nearly stalling)
 - Heavy air reduce sail depth and power to reduce heel and balance helm

Symptoms & Solutions

- Poor Pointing
 - Too much twist
 - Trim main to the verge of stalling
 - Trim jib to hint of backwinding main
 - When overpowered it is common to drop traveler or ease sheet – better to keep main trimmed and leech firm while feathering or depowering the jib

Symptoms & Solutions

- The Boat is Low and Slow
 - Sign of overtrimmed or undercanvassed
 - Ease sheet to build speed, add power all around, bigger genoa
 - Work on speed first, then pointing
 - Fresh breeze may be too much shape or jib
 - leads too far forward, creating drag

Symptoms & Solutions

- Too Much Weather Helm
 - Reduce heel with flatter sails and more twist & feather.
 - Add power to jib and ease main
 - Shorten sail

Symptoms & Solutions

- Too Little Weather Helm
 - Add power – traveler up, backstay, outhaul
 - and halyards eased, jib leads forward
 - Bear off, move weight leeward to increase heel
 - Light air – may be overtrimmed, ease main and jib and bear off

Symptoms & Solutions

- Too Narrow Steering Groove
 - Draft forward – halyard tension to round entry
 - Ease jib, sag headstay

Symptoms & Solutions

- Overpowered One Moment; upright and luffing the next
 - Sail plan filling and dumping – need to give a more gradual onset and release of power
 - Add twist, move jib leads aft, ease mainsheet and raise traveler

Symptoms & Solutions

- Excessive Pitching
 - Sailing too high or sails too flat
 - Foot off, add depth, add twist
 - Get weight out of ends of boat

Symptoms & Solutions

- Pounding in Waves
 - Need more power
 - Fall off and add twist to keep from being overpowered

Summary – Top Ten of Sail Trim

- Helm balance
- Heel angle
- Angle of Attack
- Attached flow
- Jib luff break
- Sail Twist
- The slot
- Sail Shape
- Shifting Gears
- Let it out

Sail Trim - Its Kind of Like Jazz

- Expressive (sail shape)
- Improvisation
- Syncopation
- Don't be a *DRAG*, get in the *GROOVE!*

U20 North Americans @ Lake Dillon

- August 2-4, 2010 (day after Dillon Open) <http://www.u20northamericans.typepad.com>