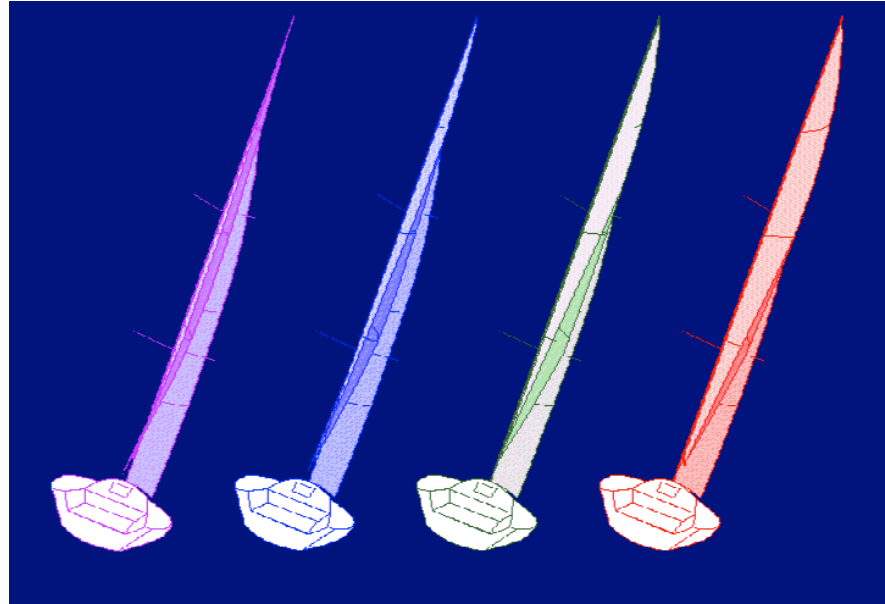


# Sail Trim



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2 October 2012



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Terminology

Tools of the trade

Some theory – lift, slots, twist and all that stuff

The Genoa (jib)

The Mainsail

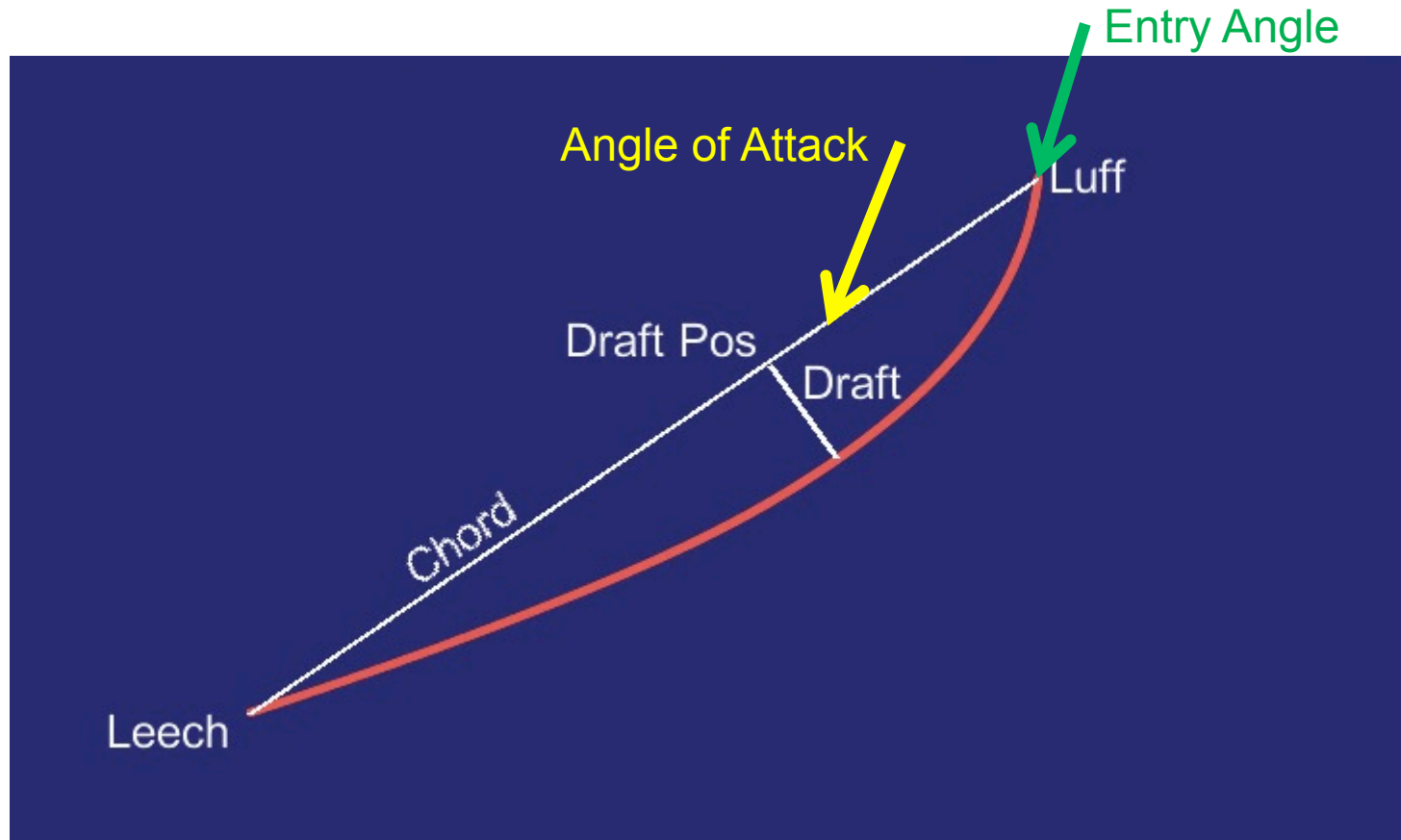
A bit about Spinnakers (symmetric and asymmetric)

Some video to wake you up

Summary

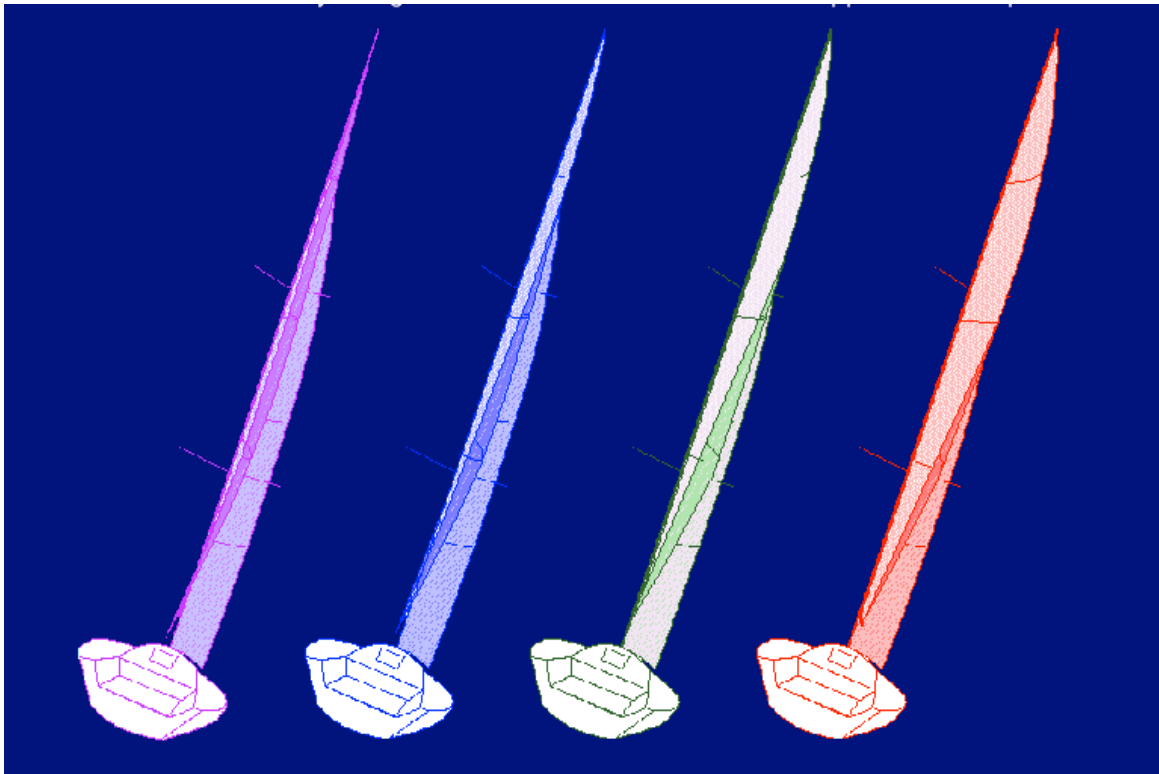


# Terminology



# Terminology

Twist – variation of angle of attack with height



# Tools of the Trade

## Boat Controls

- Backstay
- Halyards / Cunningham
- Sheets
- Kicker (vang)
- Mainsheet traveller
- Outhaul
- Genoa fairlead / track
- Snatch block / third jib sheet
- Calibrated log

## Sundries

- Wool
- Small strips of spinnaker nylon
- Small pot of paint / brush
- Indelible marker pen
- Tape
- Notebook
- Polar (boatspeed) targets



# Boat Controls

- Backstay (nb fractional vs masthead)
  - Mast bend > mainsail draft (upper) (& forestay sag)
- Halyards / Cunningham
  - Luff tension > draft position (depth) > entry angle
- Sheets
  - Angle of attack & twist
- Kicker
  - Mainsail twist
- Traveller
  - Mainsail angle of attack
- Outhaul
  - Foot tension > mainsail draft (lower)



# Boat Controls

- Genoa fairlead fore/aft position
  - Twist
- Snatch block / third jib sheet
  - Genoa angle of attack / (twist)
- Calibrated log
  - Accurate speed data
  - Accurate derived information – AWA, AWS, TWA, TWS



# Sundries

- Wool
  - Paired tell tales down luff of jib
- Nylon
  - Tell tales down leech of main and upper leach of jib
- Paint
  - Marker point on forestay
- Indelible pen
  - Marker point on luff of jib, reef marker for furling genoa
- Tape
  - Marker points on spreaders
  - Marker points on jib fairlead track





# Jib tell tales



- Wool pairs on each side of luff
  - Two paired columns for furling genoas
- Nylon upper leach tell tale



# Main tell tales



Usually 3 or 4 nylon tell tales at batten pocket ends



# Trim markings

Forestay / jib luff

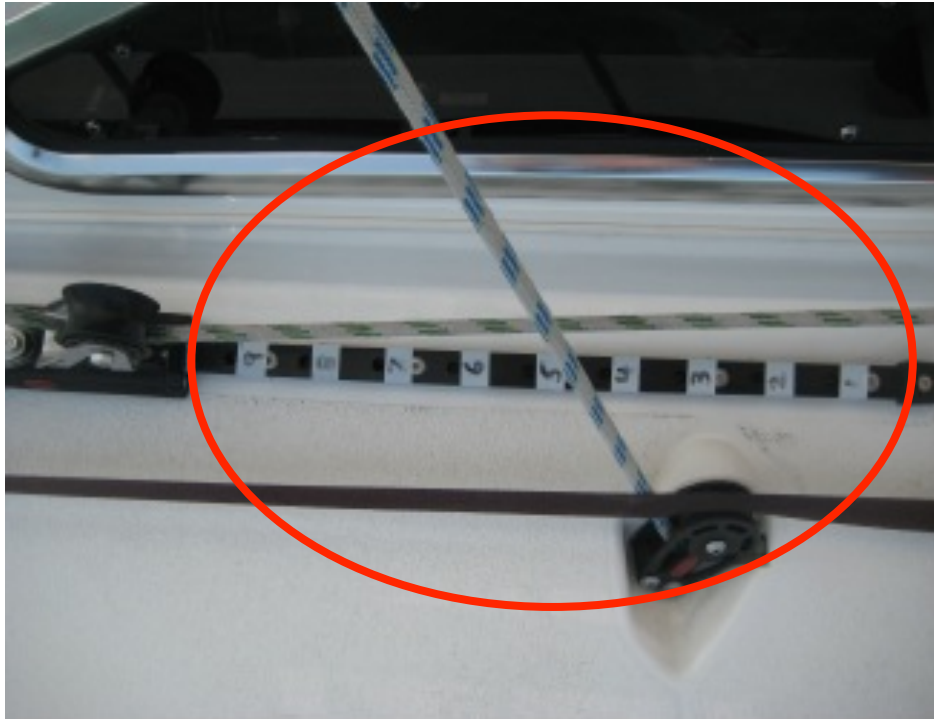


Spreaders

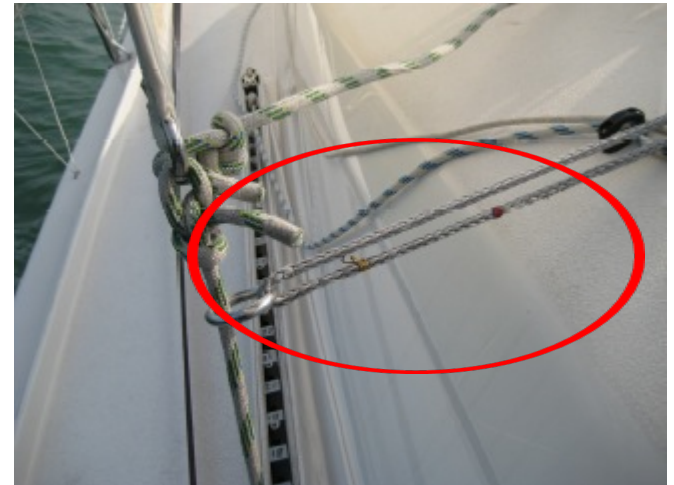


# Trim markings

Genoa / jib fairlead  
track



Inhaulers



Outhaul, backstay, traveller  
track etc, etc – if it affects  
sail shape, mark it!



# Trim targets

- Polar data from the designer

WIND	6	8	10	12	14	16	20
BEAT	44	44	42	41	40	40	40
SPEED	4.9	5.9	6.4	6.6	6.7	6.7	6.8
60	5.8	6.8	7.4	7.6	7.7	7.8	7.9
90	6.4	7.3	7.8	8.0	8.2	8.4	8.7
120	5.7	6.7	7.4	7.8	8.2	8.7	9.5
150	4.1	5.1	6.1	6.8	7.3	7.7	8.4
RUN	143	149	152	164	169	172	174
SPEED	4.4	5.2	5.9	6.3	6.8	7.2	7.9

- Or polar data from your notebook!



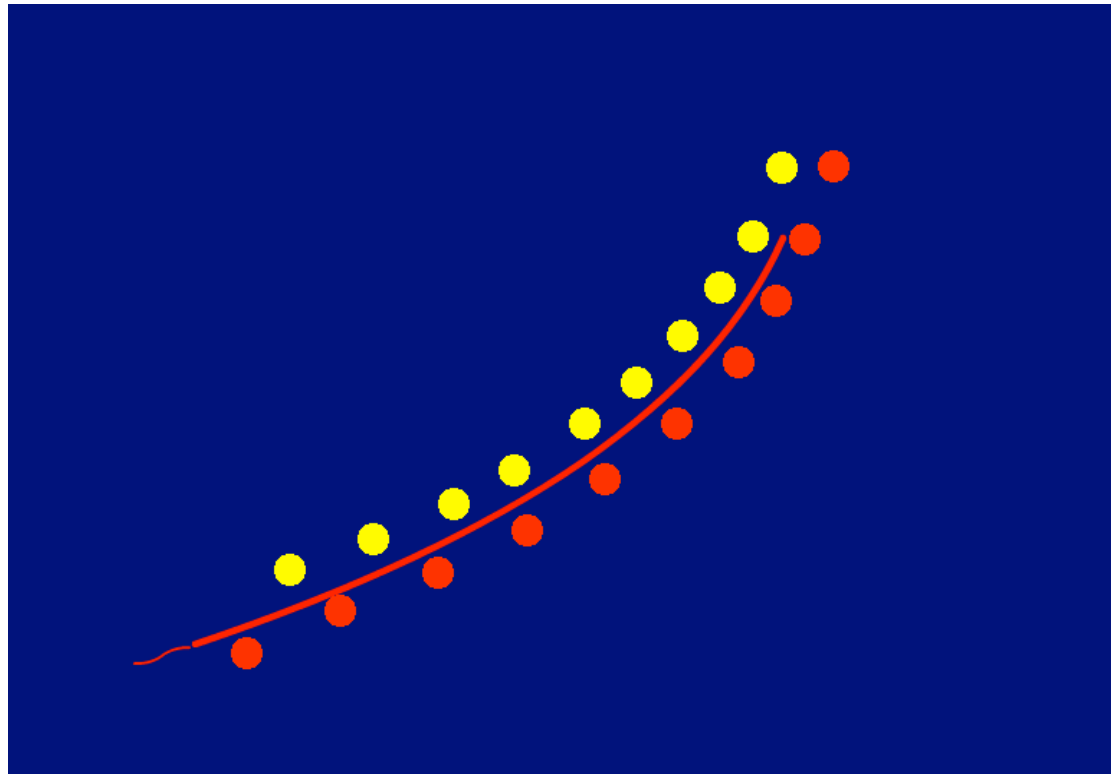
# Some theory

- What makes a sail boat go?
  - Downwind, the wind pushes the sails/boat
  - Upwind, how does it work?
- What is “upwind” in this context?
  - Rig dependent
  - From head to wind until you can't let out the main any more – say 90-100° AWA?



# How boats sail upwind

- Air flows around a sail (or wing)



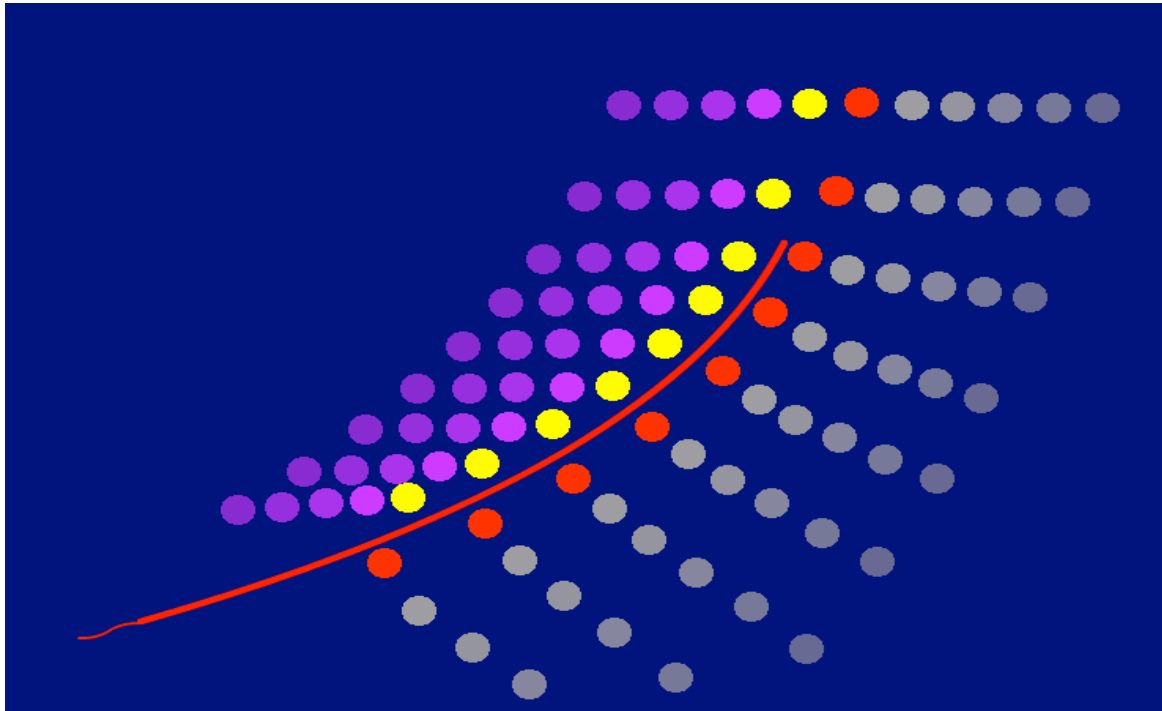
- It flows further *and faster* round the outside



Air on the inside slows as it “piles up”

Air on the outside speeds up to travel further

- if it did not a vacuum would form



OR – the sail stalls, air on the outside detaches, and air from the front fills the vacuum at the leach

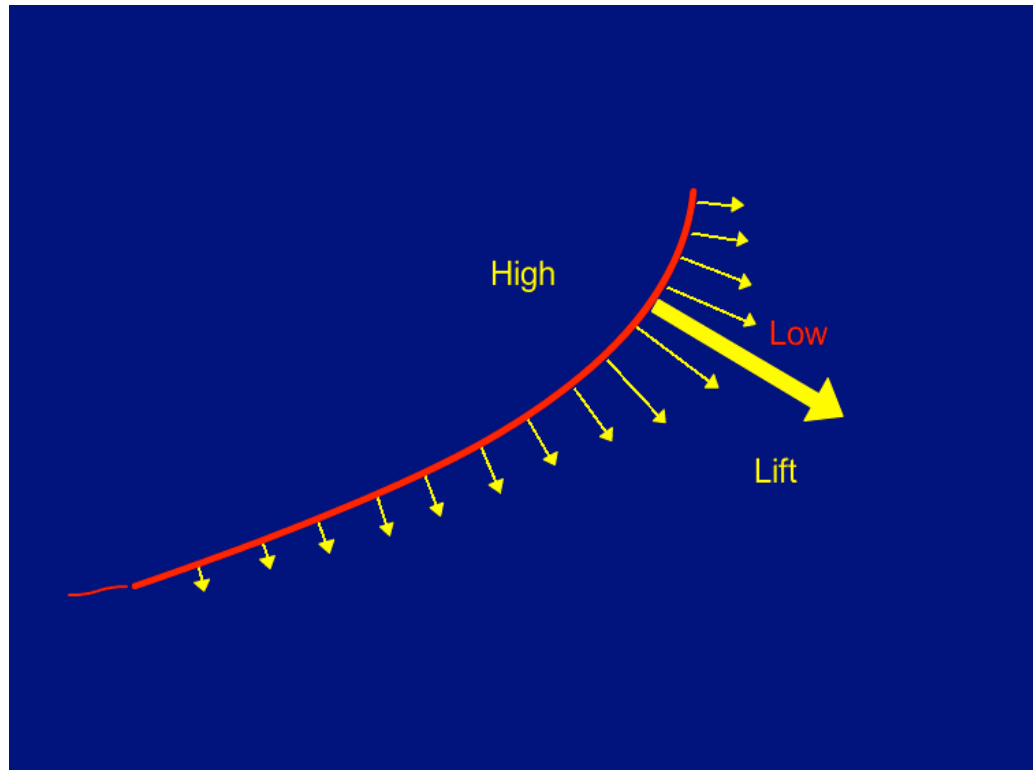
- and the leach tell tale hooks round behind the sail





Faster moving air exerts less pressure on the convex side (Bernoulli's Principle)

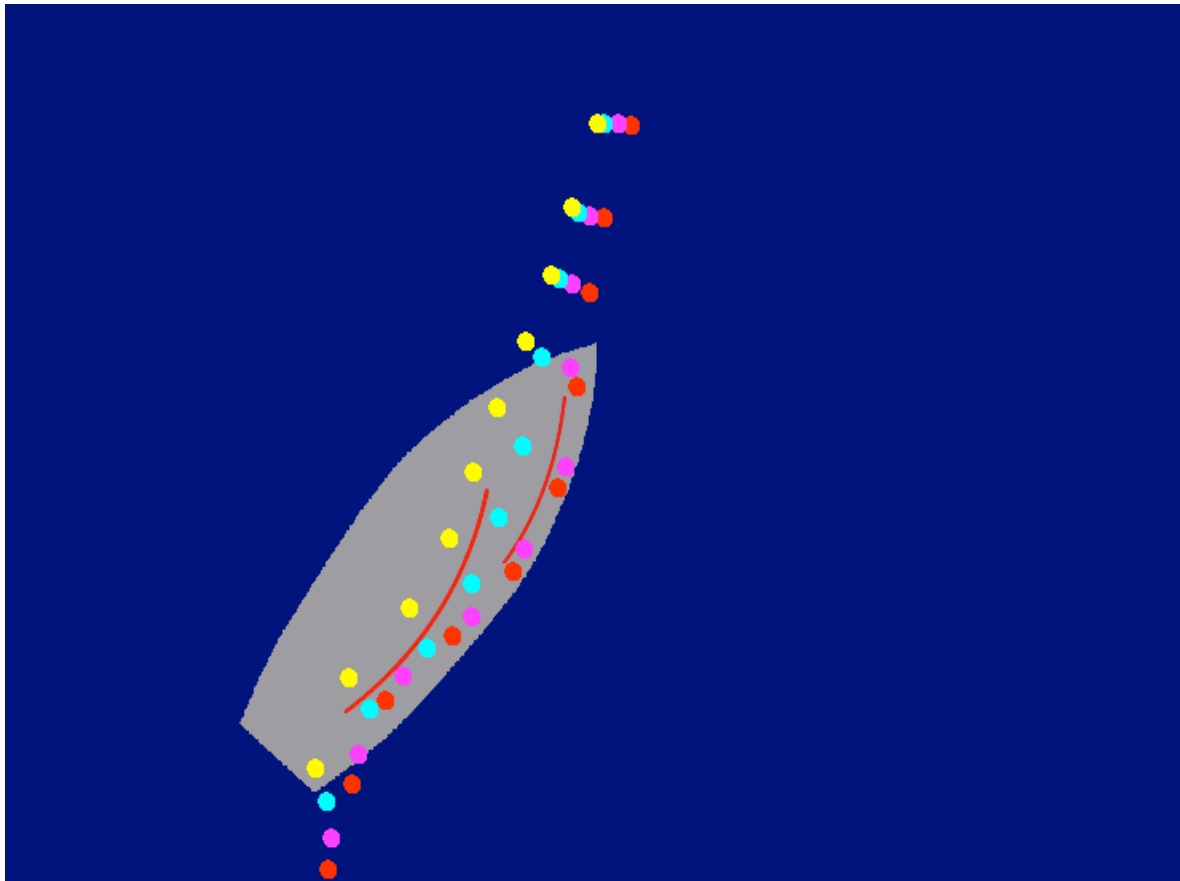
Relatively LOW PRESSURE on the outside creates LIFT



Adding a jib improves matters:  $2+2 = 5$

Air bends upwind of the rig (upwash)

- Most round front of main and back of jib / main
- Not so much in slot



Can even think of rig as single foil

- Pressure bubble between main and jib helps push air outside both sails

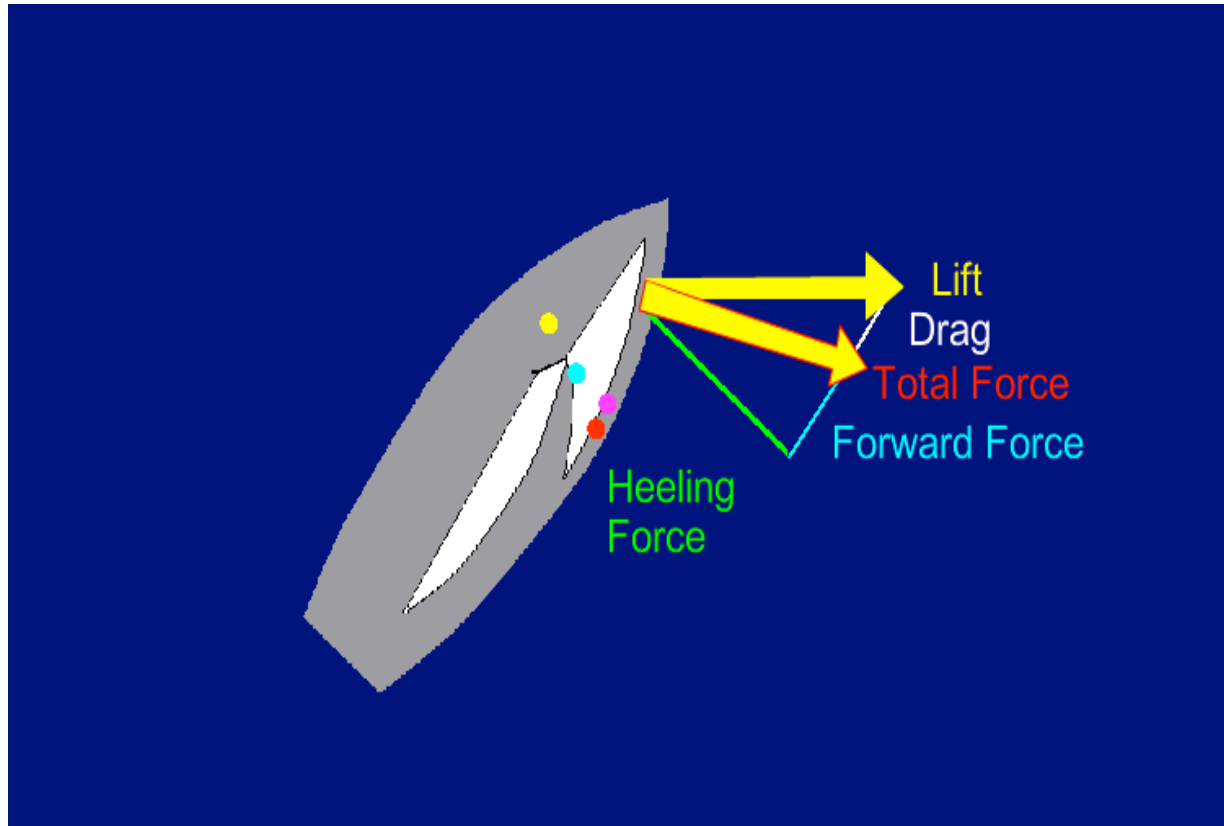


Explains why both sails should be trimmed to the same shape



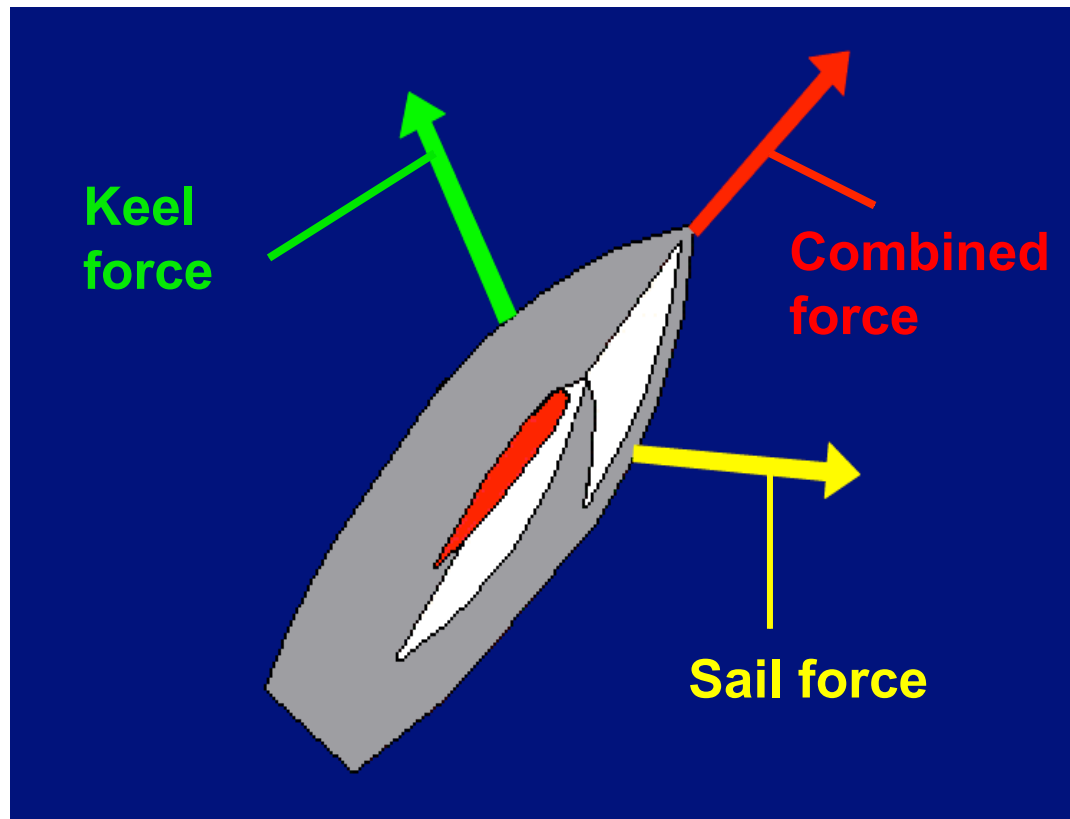
Components of force developed by sails, note:

- minimal FORWARD component
- no UPWIND component
- goal to maximise forward element



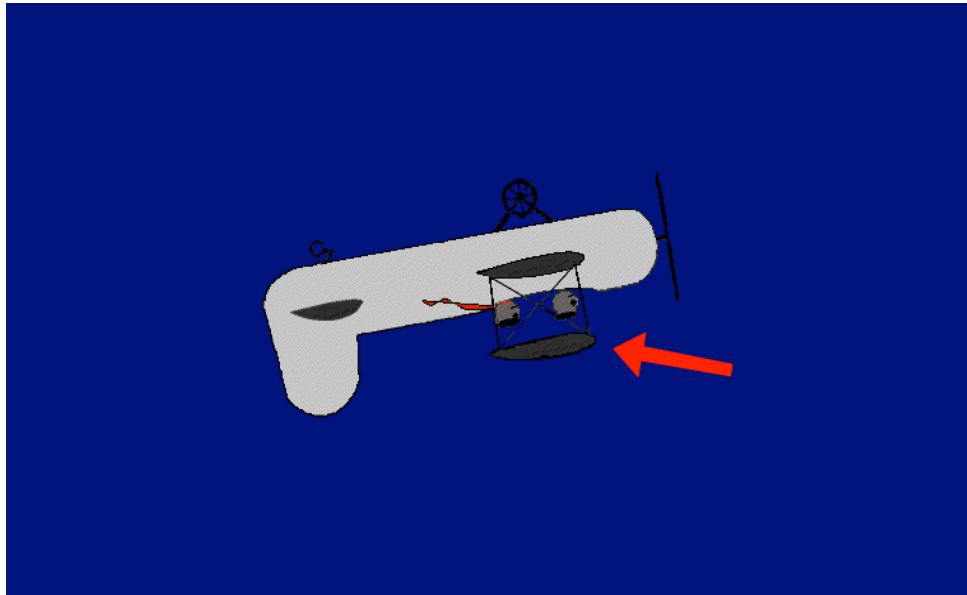
# The secret is the keel

Leeward force developed by sails  $>$  water flow over keel  
 $>$  lift to windward  $>$  resultant movement of boat



BUT you cry  
The keel is symmetric

The secret is angle of attack – the same way  
a plane flies upside down



FIRST RULE OF TRIM

SPEED IS KING – no water flow, no lift

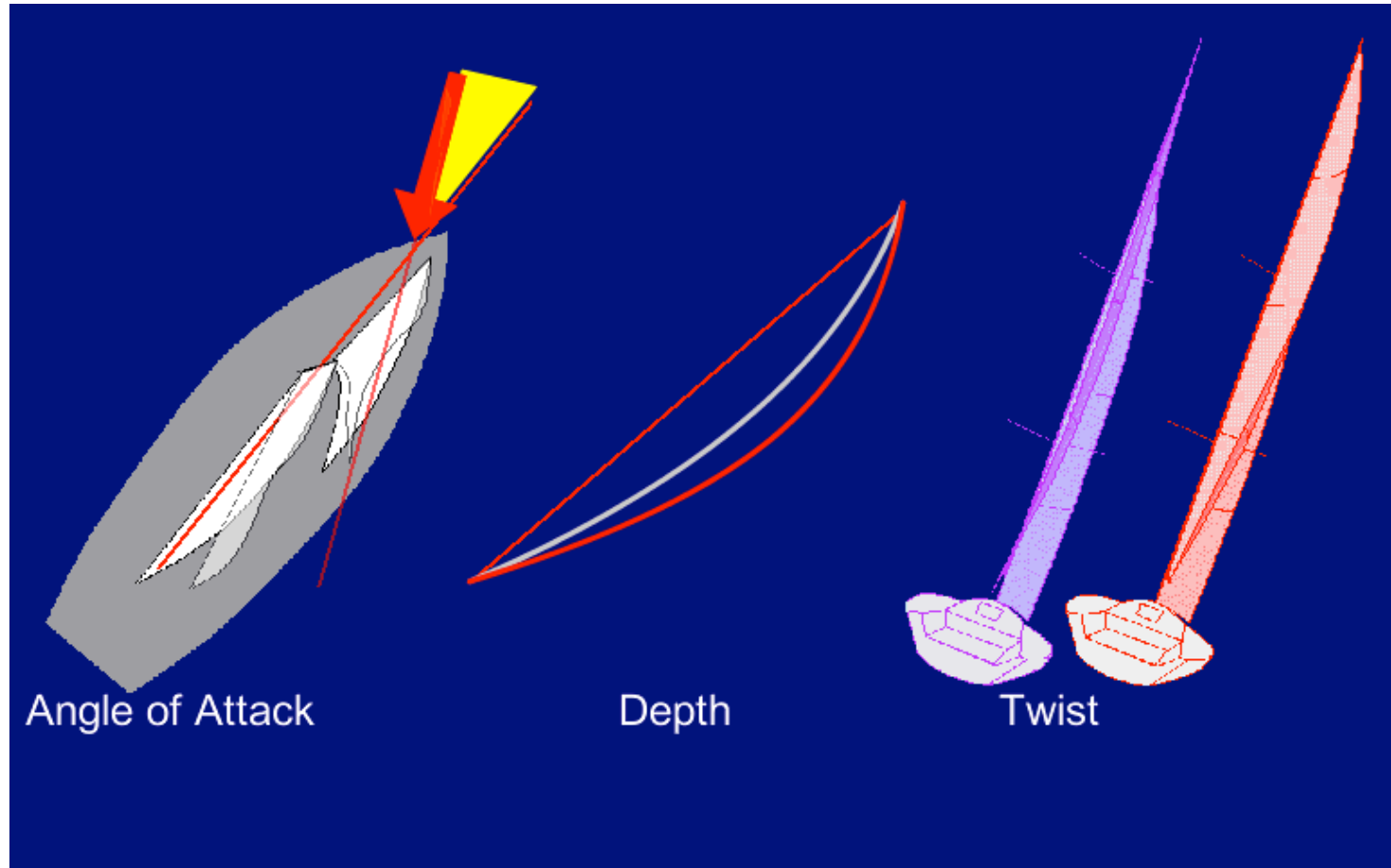


# Upwind trim objectives

- Maximise water speed over the keel
- Maximise sail force
  - Maintain laminar airflow over the sails
    - No “detachment” of flow off the back of the sail
  - Generate maximum forward component of sail lift force
  - Minimise heeling component



# Three sources of sail power





# Angle of attack

- A luffing sail = zero angle of attack
- Increase power by either / both
  - Sheeting in
  - Bearing away
- Reduce power by either / both
  - Easing sheets
  - Luffing up
- Optimum efficiency angle is just short of stalling – “luff just lifting”



# Depth (draft)

- More draft = more power/acceleration
  - Punch through waves, after tacking
- Less draft = less power, less drag
  - Faster in smooth water
  - Also in overpowering conditions



# Draft position

- General aim to maintain designed shape
  - 40-45% aft in mains
  - 30-40% aft in jibs
- Draft forward
  - More forgiving steering in waves, less drag
- Draft aft
  - More power and pointing, but higher drag
- Vertical shape
  - More depth aloft in light-moderate
  - Flatten off in heavy



# Twist

- We always want some
  - Less surface friction aloft > stronger wind > freer apparent wind > need more open angle of attack
- Increase twist by
  - Easing sheets, (easing kicker/car aft) > better acceleration (eg after tacks, in waves)
- Reduce twist by
  - Trimming in > full power at high pointing angle (eg after speed builds, in flat water)



# Twist

- In overpowering conditions reduce power by increasing twist OR reducing draft
  - Waves - use twist
  - Smooth – flatten sail
- Main and Genoa/jib should always have the same twist



# Genoa trim - sheet

- Primary control, affects angle of attack, twist and depth
- Initial trim changes angle of attack
  - final trim closes leach and reduces twist
- If you change halyard tension, backstay tension or car position
  - Need to alter sheet
  - Eg more halyard tension > need to ease sheet to keep same leach profile

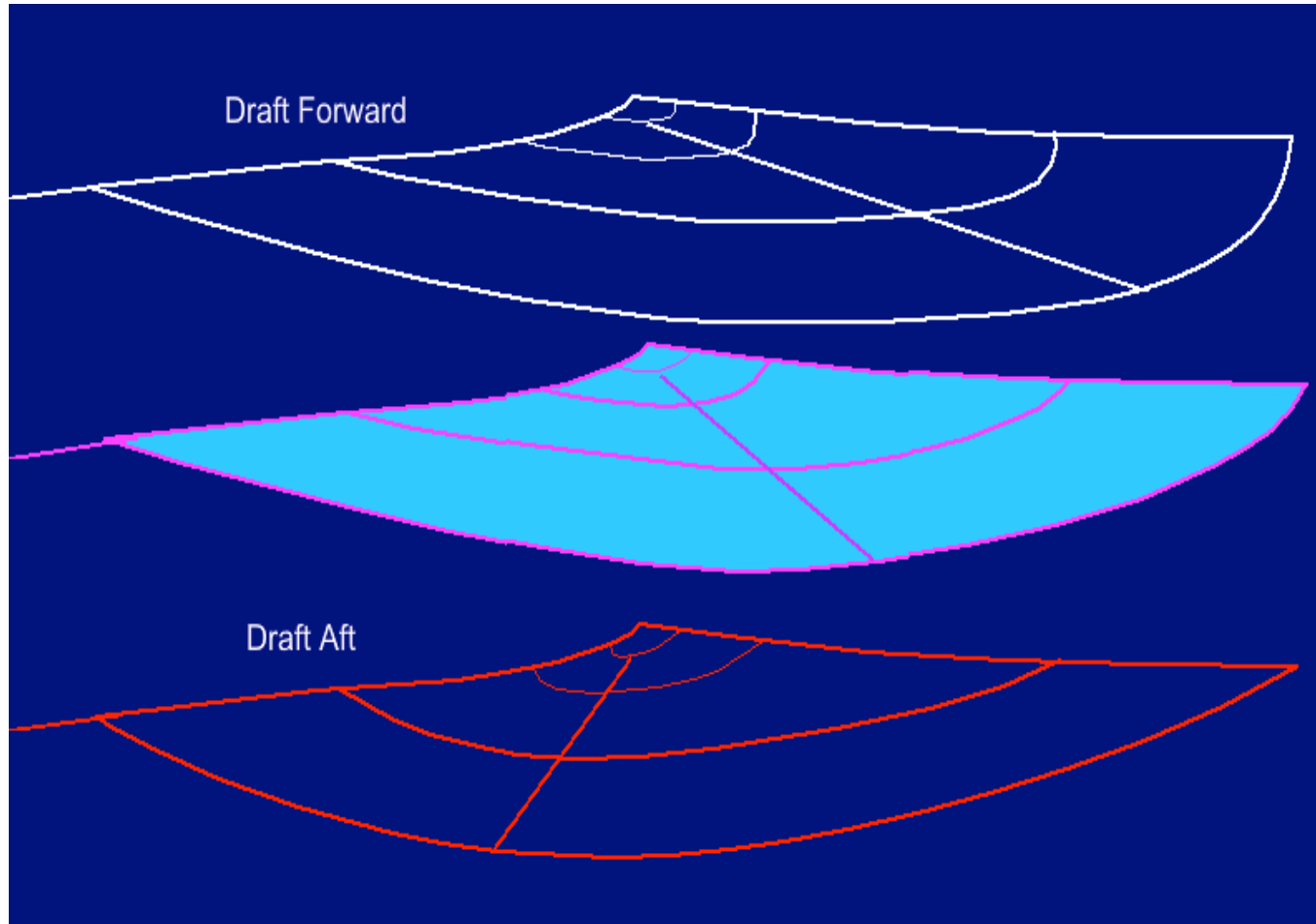


# Genoa trim - halyard

- Used to position draft
  - Initial trim – light winds, leave some wrinkles
  - Heavier winds – smooth luff
- As wind builds, draft blows aft
  - Bring forward again by tightening halyard
- Fine tuning
  - Tighten - draft forward, rounder entry, easier steering in waves
  - Slacken - draft aft, finer entry, narrower groove, higher pointing in smooth sea



# Genoa trim – draft position





# Genoa trim – cars (fore/aft)

- Initial trim – set so windward tell tales break *sequentially from top to bottom*
- Movement
  - Forward - pulls in top of sail, reducing twist
  - Aft - tightens foot (like main outhaul), allows twist
- Fine tune
  - Waves/chop – forward for deeper/more power
  - Smooth – aft for flatter/pointing
  - Heavy wind – aft for twist and de-power



# Genoa trim – cars (lateral)

- Inhaulers – permit closer pointing in smooth water, further out position in heavy breeze widens slot
- Barber hauler (snatch block/third sheet)
  - Easing sheet for a reach adds twist, reduces power
  - Set up snatch block on rail and use third sheet to take load
    - Widens angle of attack without adding twist/losing power



# Furling genoas

- Have at least one “reef position” marked on foot (repeatability)
- Tighten the halyard before you reef
  - If it’s getting windier you want to move draft forward/flatten
- Move the car when you reef/un-reef
- Have at least 2 sets of “luff” tell tales
  - Full sail and first reef position



# Mainsail trim

- The jib leads upwind trim, the main follows
- Lots more control over main – can be confusing!
- Sheet is primary control
  - Initial trim to bring aft end of top batten parallel to boom
  - Boom on centreline
  - Leach tell tales flying all time (top one 90% is OK)



# Mainsail trim

- Fine tune with sheet
  - Over trim / less twist (top tell tale stalled  $\geq 50\%$ ) – more pointing
  - Under trim / more twist (never stalled) – more speed
- Different wind strengths
  - Light – over trim > stall when need power
  - Moderate – trim harder for more pointing
  - Heavy – over trim > weather helm



# Mainsail trim

- Kicker
  - Primarily off wind control
  - Beware over tightening in light wind
- Mast bend
  - Used to flatten sail in mid to upper area
- Outhaul
  - Controls depth in lower area



# Mainsail trim

- Traveller
  - Controls angle of attack
- Sheet vs traveller?
  - In waves play sheet/twist
  - In flat play traveller
  - Lighter “over canvassed” boats – play sheet
  - Which ever is easier!



# Mainsail trim

- Halyard / Cunningham
  - Principally controls POSITION of draft
  - NB eg adding mast bend to flatten moves draft aft, so more luff tension needed
  - Aiming for 40-45% of chord





# Mainsail trim - reaching

- Pointing not an issue
  - Put fullness back in main
    - Less luff tension, less foot tension, less backstay
- Control twist with kicker
- Trim just short of a stall for maximum lift
- In heavy winds
  - Control issues may arise
  - Dump kicker to spill leach if overpowered



# Mainsail trim - running

- Ease till sail luffs or rests against the rig
- No flow
- Ease backstay, halyard and outhaul to add depth
- Set kicker to keep top batten parallel to boom
  - Batten hooked in – ease kicker
  - Batten spilling forward - tighten kicker



# Mainsail - reefing

- Heavy winds mean flat sails
- Even more so after reefing
  - Plenty of halyard tension first – position the draft forward
  - Then plenty of foot tension to reduce draft
- Essential to arrange reef pennant so pulls foot aft as tightened
- Too many “baggy” reefed mains
  - Just generating heeling force



# Spinnakers - asymmetric

- Just 3 controls
  - Halyard, tack line and sheet
- Tack line
  - Aim to keep the tack on the centre line or to windward
  - If you ease and the tack drops down to leeward, haul in again
- Don't sail dead downwind



# Spinnakers - symmetric

- Initial trim
  - Set pole perpendicular to AWA
  - Set pole height so clews are same height
  - Play the sheet – ease to a curl and trim
- There is flow over a spinnaker downwind
  - Lowering the pole > draft forward > rounder entry and open leach
  - Aim for max draft just forward of centre line
  - Heavy airs / lower pole,
  - Light airs / higher pole



# Summary

- “Upwind” progress relies on water flow over keel – so SPEED IS KING
  - Pointing comes second
- “Upwind” sails should act like foils and generate lift
  - So key is to maintain laminar flow
  - Optimum angle just short of a stall (luff lifting)
  - Aim to maximise forward component/minimise heeling force



# Summary

- Three components of sail power
  - Angle of attack
  - Depth
  - Twist
- Increase/Reduce power by
  - Increasing/reducing angle of attack
  - Adding/reducing depth
  - Reducing/adding twist



# Summary

- In light airs
  - More draft for power
    - Ease halyards / sheets / main outhaul
  - More twist – as wind gradient effect greater
    - Ease kicker
  - Pull main traveller up (boom still on centreline)



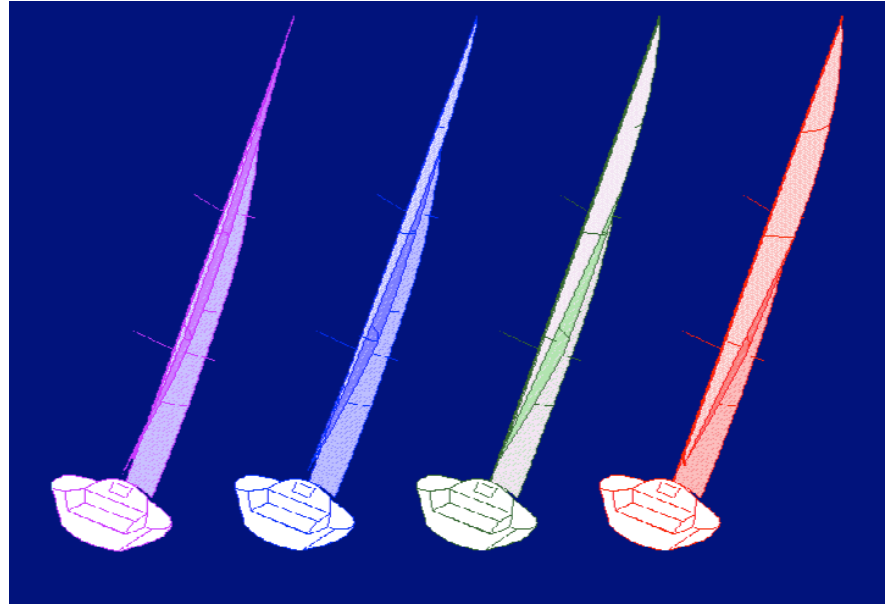


# Summary

- In medium - heavy airs
  - Shape blows aft so pull it forward with halyard/cunningham tension
  - Tighten backstay to flatten top of main
  - Tighten outhaul to flatten lower/mid main
  - Move the car after reefing the genoa
- Fit tell tales if you haven't got them!



# Sail Trim



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