Performance Racing Trim

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Chapter No	Contents
1	Boat Speed, Boat Handling and the Racing Pyramid
2	Introduction to Boat Handling
3	Introduction to Trim
4	Upwind Boat Handling
5	Genoa Trim & Controls Trim
6	Mainsail Trim & Controls
7	Upwind Helmsmanship

Chapter 1: Boat Speed, Boat Handling and the Racing Pyramid

1.1 Why Do We Race Sailboats?

1.2 The Racing Pyramid

1.3 Boat Speed and Boat Handling

1.4 Performance Analysis

1.5 Using This Book

1.1 Why Do We Race Sailboats?

Sailboat racing requires a broad mix of skills: We need sailing and boat handling skills; an understanding of wind and weather; and knowledge of tactics, strategy, and rules. We also need specialized sail trimming technique; organizational skills to manage crew; and analytical skills to grapple with information. We need to be able to set goals and establish priorities, concentrate amidst chaos, ignore discomfort, and learn from our mistakes.

None of us can master all the skills. Part of the enduring appeal of racing is the breadth of the challenge it presents. Not only can we never master all the skills; we are challenged in new ways every race, for no two races present the same mix of challenges.

Sailing's appeal goes beyond these challenges. We enjoy racing for the chance to be out on the water, for the thrill of working with the wind, for the challenge of competition, and for the camaraderie it brings.

1.2 The Pyramid

The building blocks of successful racing can be diagrammed in a hierarchical pyramid. Tactics lie at the top of the racing pyramid. Beneath tactics lie Boat Speed and Boat Handling. In order to race successfully you must work your way up the pyramid. To win races your boat handling must be second nature, and you boat speed second to none.

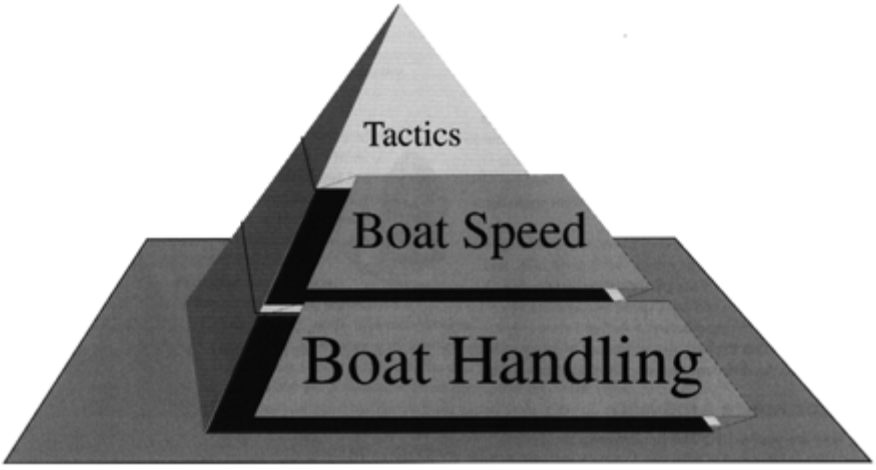


Fig. 1 - The Racing Pyramid

Boat Handling and Boat Speed form the base of our racing pyramid. You will win races when your Boat Handling is second nature, and your Boat Speed second to none.

Boat speed and boat handling are distinguished from tactics in several ways. For one, boat speed and boat handling are entirely within your control, while tactics involves factors of wind, current, and competitors which are decidedly beyond our control. Boat speed and boat handling, like a strong defense in basketball, will make you competitive everyday. Tactics, like a hot shooting touch, is great when you've got it - but is not something you can count on day in and day out.

Boat speed and boat handling are distinguished from tactics in another way: Tactically there are opportunities for enormous gains and losses, particularly in shifty wind conditions. The gains and losses from boat speed and boat handling accrue much more subtly. Sure, you can lose plenty if you drop your spinnaker in the water and wrap it around your keel, but more commonly the gains are a few feet here, a boat length there. But they add up, and they are the margin of victory.

1.3 Boat Speed and Boat Handling

In this book we will explore boat handling and boat speed. If you believe you need help with tactics you may be in for a surprise. When your boat handling is second nature, and your boat speed second to none, you may suddenly find you are a tactical wizard. If you'd still like to know more about tactics refer to the companion volume, Performance Racing Tactics.

Good boat handling is a prerequisite to successful racing. You must sail well before you can race well. Fundamental to good boat handling is good, regular crew. We'll explore how to find, organize, and train crew. We'll also look into specific techniques for boat handling upwind and down, including spinnaker work for conventional and asymmetrical spinnakers.

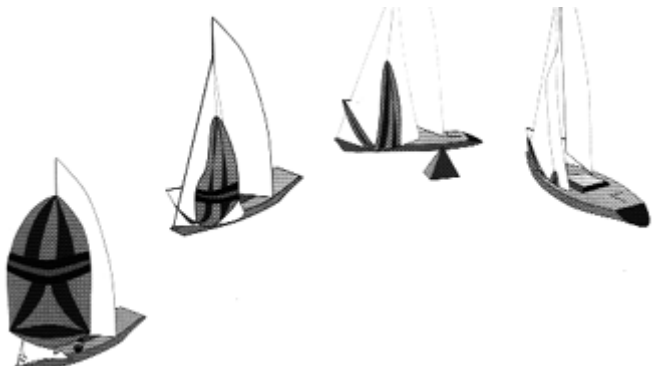


Fig. 2 - *Consistent performance requires that you master the things you can control - boat handling and boat speed; while making the best of things beyond your control - tactics.*

Good boat speed is also essential to successful racing. We will look at trim theory, and study each sail individually, and then as an integrated piece of the performance puzzle.

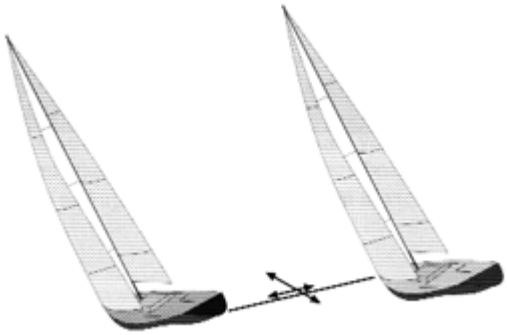


Fig. 3 - *The difference between good and great boat speed is just 1 or 2%. The difference is subtle, but critical to racing success.*

As we study sail trim and boat speed issues more closely we will see that the difference between fast and slow is just 1%to 2%. We'll find that the cumulative impact of every nuance of trim adds up to the difference between winning and losing.

1.4 Performance Analysis

So, how are your skills? The Performance Analysis presented here is intended to help you look at your own racing skills and focus on areas of strength and weakness.

Fig. 4 - Performance Analysis

Which are your strengths? Where are your weaknesses?	*Strength*	*Weakness*
TACTICS		
Tactics Section:		
Upwind strategy, tactics, and rules.	____	____
Downwind strategy, tactics, and rules.	____	____
Starting strategy, tactics, and rules.	____	____
Round the buoys and port to port / distance racing.	____	____
BOAT SPEED		
Boat Speed Section:		
Upwind in light, moderate, and heavy winds.	____	____
Helming, mainsail trim, headsail trim.	____	____
Reaching in light, moderate, and heavy winds.	____	____
Helming, mainsail trim, headsail trim.	____	____
Running in light, moderate, and heavy winds.	____	____
Helming, mainsail trim, headsail trim.	____	____
BOAT HANDLING		
Boat Handling Section:		
Do you have a full, regular crew?	____	____
Upwind: Tacks, reefs, and sail changes.	____	____
Downwind: Spinnaker sets, jibe sets, jibes,	____	____
Take downs, floater takedowns, and peels.	____	____
Consider each maneuver from each position on the boat.	____	____
Can you work the cockpit, pit, mast, or bow for all evolutions?	____	____
PREPARATION		
Last years fleet position:	____	
Goal for next season:	____	

Equipment:

The hidden foundation of the pyramid is preparation. Your boat and equipment must be in competitive condition. Yes, every little bit does matter. The difference between winning and mid-fleet is the sum of many little things.

Boat: Hull condition, keel and rudder shape.

Weight distribution below decks.

Equip: Rigging, hardware condition and suitability.

Instrumentation - working, calibrated, integrated?

Sails: Is your inventory complete, and in excellent condition?

You should think not only about your own skills but the overall skills on the boat you race. If you are a tactical king you need to team up with a boat speed druid and a boat handling wizard. Of course, if you race single handed you'll need to be all these things!

1.5 Using this Book

Performance Racing Trim is the most complete book on racing sail trim, boat speed, and boat handling. As such, the book covers a broad spectrum of topics, some of which you will find of more immediate interest than others. While the material in later sections builds on earlier chapters, each chapter is written to stand alone, and can be read independently.

If you are looking for an answer to a particular question, you can skim quickly by studying the illustrations and reading the captions. When you hit upon an area of particular interest, dig into the text for more details. You can also use this skimming technique for a quick review as needed.

The ideas presented here are by no means the final word on racing technique. They are a starting point. Use the information here as a foundation. Build on it to further your own racing success.

Chapter 2 - Introduction to Boat Handling

2.1 Introduction

2.2 Crew Organization Principles

2.3 Practice

2.4 Finding & Training Crew

2.5 Don't Kill the Messenger

2.6 Can We Talk?

Crew are made through careful training in practice sessions, not with animated gestures in the heat of battle.

Find another boat to practice with to add competitive fervor.

2.1 Introduction

If you want to drive the boat, trim the sails, watch the instruments, read the compass, track the fleet, and call tactics, then you should race single-handed. A skipper who fails to make good use of his crew through careful division of responsibilities is handicapping himself, and will not succeed against well balanced teams.

This chapter will explore Crew Organization and Boat Handling. We'll start by defining broad areas of responsibility on a boat. We also will explore a set of principles to help guide you and your team, and then explore specific training methods. Finally, we will delve into the mystery of where to find good crew.

Subsequent chapters will look at specific upwind and downwind boat handling techniques. We assume here that your boat is properly laid out and equipped. In fact, the equipping and preparation of your boat is the hidden foundation of your racing pyramid. It is covered in detail in Chapter 14 of this book.

2.2 Crew Organization Principles

Crew assignments should be based on the number, skill, experience and interest of your crew. Each crew position should have clearly defined responsibilities during each maneuver. The maneuvers should be executed the same way each time.

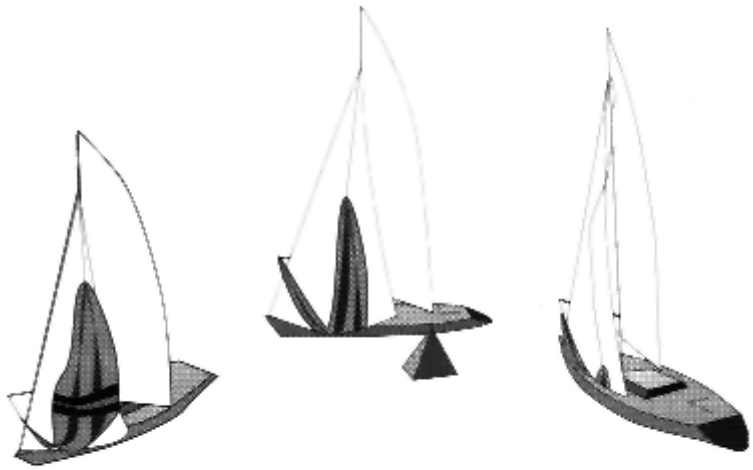
Your crew must be organized so each block of the pyramid gets the attention required. A crew boss is needed to orchestrate boat handling. Sail trimmers and a driver are needed to focus on boat speed, and a tactician is needed to manage the course. As soon as you have more than one person on the boat it is time to divide up the chores. On championship two person boats the driver drives and the crew does tactics. As the crew number increases the responsibilities

should be further divided. On a three person crew the forward crew and driver focus on trim, while the middle crew handles tactics.

Boat Handling Principles

As you train and organize your crew it will help to have general principles to guide you: Fig. 1.

Several principles should guide you in crew organizations:
First, for each maneuver the crew should be divided into two teams - one to sail fast with the sails you've got, the other to get sails up and down....
Second, each boat handling evolution - tacks, jibs, sail changes - should be broken down into step by step procedures. Each crew member should have specific responsibilities during each maneuver.
At a spinnaker set, for example, the driver and trimmers should sail fast with the main and jib, while other crew manage the hoist.



Divide and Conquer

Perhaps the most powerful principle is Divide and Conquer. During each boat handling evolution divide the crew into two teams: One team should sail the boat with what you've got while the other team takes care of the evolution. No one should serve on both teams.

Define crew positions.

Each crew position has a specific responsibility during each evolution or maneuver. You need to figure out the correct number of crew, define each position, and then sail with a full complement of crew each time you race. Once positions are defined then you can plug new people into a specific position with clearly defined responsibilities. It helps to write out and diagram your standard maneuvers. This will help during routine evolutions, and during the inevitable ad-lib.

Create crew pairs

A second guideline which is particularly useful as you bring aboard new crew is crew pairs. Ideally, you would have the same people in the same position for every race [yea, right - if pigs could fly]. Since you can't expect to have all the same people all the time, you want to have a nucleus you can count on. New (or less experienced) crew should be paired with a regular crew member. For example, a new mast crew can be paired with an experienced foredeck, an experienced trimmer can watch over a new grinder or trimmer.

Do your job

One final principle is Do Your Job. If one person is having trouble completing a task that can create a problem. When the next person tries to help out, and leaves part of his job undone, the problem grows. Pretty soon the entire crew is one half position out of place - each trying to help another - and you have a huge mess.

2.3 Practice

The key to developing good crew work is practice. It is simply impossible to train crew during a race. There is not enough time teach and learn, and there is too much to do. You must practice to win. It is that simple.

Practice Drills

As you plan your maneuvers keep the Divide and Conquer principle in mind. Always have part of the crew focused on racing fast with what you've got, while the balance of the crew attend to the boat handling maneuver. Try a simple walk through with no sails to figure out the rough details and positioning. Then, go out on the water and go through maneuvers one at a time. Tacks, jibes, sets, douses, reefs, sail changes, plus straight line trim and speed. Detail each person's responsibility during each maneuver. Once you can run through each evolution smoothly in open water try it around a closed course of buoys to add the element of timing. Fig. 2.

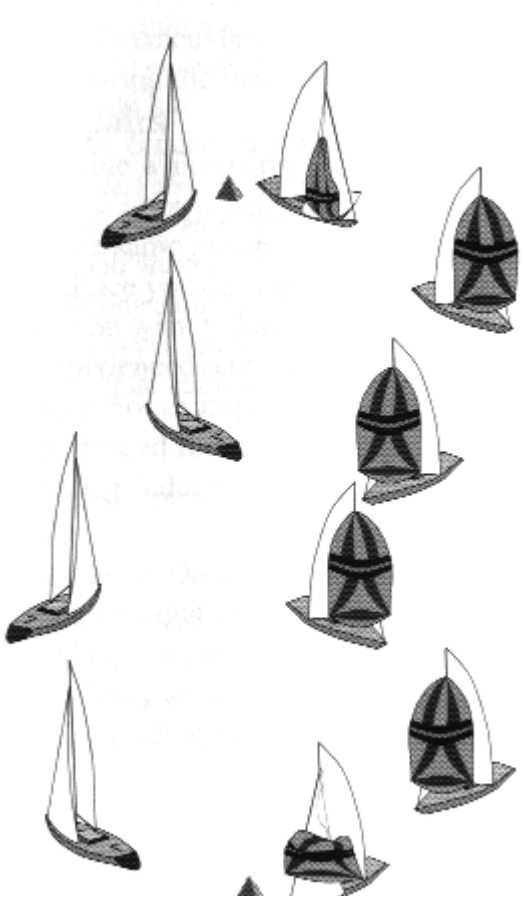


Fig. 2 Practice each maneuver, one at a time, in open water; and then around a fix set of buoys.

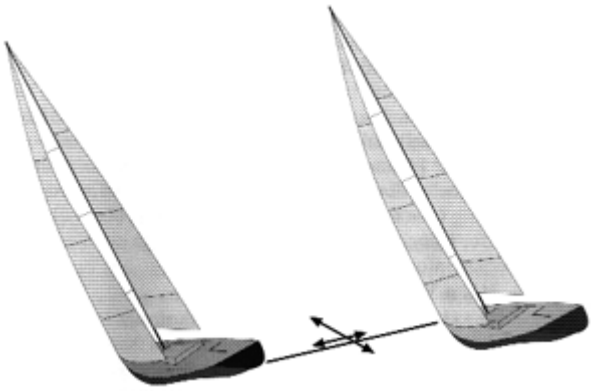
Another excellent drill is to perform maneuvers in total silence. A single word from the helmsman (or crew boss) is all that is needed to initiate the maneuver. In silence you learn to watch and work with your crew mates. Learning to work quietly keeps the airwaves open for remarks to deal with the unexpected.

Another effective practice tool is rotating crew positions. If the pit and foredeck, for example, switch places, each will understand better what is going on and anticipate the other's needs during a race. Similarly, trimmers and drivers can trade places and better understand how the impact each other.

Find a Tuning Partner

When your crew work is smooth find another boat to practice with. Sail parallel courses to work on boat speed. Use cat and mouse drills to improve boat handling. Try short match races to add competitive fervor. When you are confident of your boat handling and speed then you are ready to race. Fig. 3.

Fig. 3 (at right) - *To really learn trim you need to find another (well sailed) boat to practice and tune with. A training partner also adds competitive fervor to boat handling drills.*



The difficulty of boat handling increases with the wind. Keep practicing until you are confident in all conditions. Try to refine your techniques to reduce crew movement. Pay attention to weight placement all the time. Figure out ways to keep weight properly placed as much as possible.

Your crew organization and crew assignments are dictated in part by your boat's layout. If you find one crew member is over burdened during a particular maneuver look into reorganizing the crew - and perhaps changing your layout, to redistribute the load.

2.4 Finding & Training Crew

Q. Where do you find good crew?

A. Good crew are not found, they are made.

Find eager inexperienced crew and train them. There are plenty of people out there who would love to be involved. Put up notices at the local sailing school, yacht club, and college sailing programs. Find people whose company you enjoy and train them carefully, with patience and understanding; in practice sessions, not on the race course; with big ears and a small voice.

A crew you train will be loyal and trustworthy. S/he will not run off when the next hot new "fast rideÓ comes along. Plus, you will be able to train your crew to your standards.

Women are among the best crew, and they are often overlooked. While some women may not have the raw muscle bulk of men they overcome this through more careful attention to detail and technique. Note also that some of the very fastest helmsmen are women.

Q. I've trained 'em. Now, how do I keep 'em?

A. As each crew member masters the responsibilities of a particular position new responsibilities must be added. One way to add new responsibilities for your crew (and reduce your burden) is to turn over part of the care of the boat, or crew finding, or regatta planning, to your crew.

Another way to keep crew involved is to rotate crew positions for some low key events. Get off the helm for the beer can races; put the pit crew on the bow; see what the crew want to try. This will give the crew the chance to learn new skills, and the better understanding of the whole boat will also improve crew performance when they go back to first string positions for major events.

If your crew are stuck in a rut they will go elsewhere to seek new challenges. You also have to keep your boat, sails, and equipment competitive. If your crew feel the boat is holding them back they will look for a new ride. You may have to seek new challenges by seeking out tougher competition. Eventually, after you have mastered your present boat and retired all the trophies in your fleet, you will have to get a more sophisticated boat.

Another way to keep crew is to win. Aye - there's the rub.

2.5 Don't Kill the Messenger

No one likes to receive bad news, and no one likes to deliver it. Legend has it that in Medieval times if a messenger delivered bad news he was put to death.

On the race course bad news can be the most important information you receive. Bad news is needed promptly because it often requires action. Good news can more easily wait. When things are going well there is no urgency for change. Yet most crew members are eager to deliver good news, while bad news is often slow to get through.

How often have you sailed a windward leg with reports that all was well only to arrive at the windward mark in the middle of the fleet? The bad news - "We are slow" or "We're going the wrong way" - must get through, and the sooner the better, so you still have time to do something about it.

Of course, no one likes to be a "nay sayer" so how can you get your crew to give you the bad news you so desperately need?

The goal is quality information without distracting chatter. You can find out what is going on without looking by asking your crew for reports. Ask specific questions until the crew understand what kind of information you are after.

You need to create an atmosphere where you view your performance objectively and work to solve problems as a team.

Without accurate information you have no basis for evaluating your performance and responding appropriately. Of course there is a downside - the more information you have the greater the chance for truth to get in the way of opinion and wishful thinking.

Remember. Also, that a crew member's report of something you already know is not necessarily chatter. A snap response of "I know" will discourage further reports. A simple

"Thank you" will do. The report has, after all, confirmed something (you thought) you knew. The goal is not to claim credit for being the first to know. The idea is to circulate any important information.

It's a Write Off

The same principles apply to your business. If you want to be able to continue to afford to race sailboats then you need to confront problems in your business head-on. If you ignore problems, pretend they don't exist, or discourage your staff from openly dealing with troubles then your business will soon be in trouble. There; now this is a management training text - you can write off the cost as a business expense.

And while we are on the subject, you can also apply the pyramid to your business. The base of your business pyramid is product (or service). If the thing you are selling is not fundamentally sound then success is difficult. Next are your production, distribution, and sales efforts. These bring your product to market. We all know that a great product is not enough.

Finally there are tactical business issues for dealing with things you cannot control - like behavior of competitors, and other outside forces.

Structure your business and focus your effort [Sorry - got a little carried away with this digression. If you'd like to know more about our business services, and what we can do for your business, give us a call, or drop us a line.]

2.6 Can We Talk?

Driver to Trimmer: "Give me a little jib sheet."

Foredeck to Pit: "Give me a little halyard."

Sheet trimmer to guy trimmer: "Give me a little guy."

Effective communications requires a common language. You can improve communications on your boat by agreeing on consistent terminology and avoiding ambiguous or non specific instructions. It doesn't really matter what words you use as long as everybody is using them in the same way.

Here's a catalog of terms I like to use:

For sail trim, including sheets, guys, and other running controls, like vang, cunningham, outhaul, backstay, runners, use Trim and Ease, and use specific amounts. Instead of Give me a little jib try Trim the jib two inches. If you aren't sure how much you need make your request with a specific reference so the trimmer will know the order of magnitude: Trim about two inches will give the trimmer a better idea of what you want.

By using trim and ease for sails we can save in and out for weight. People move in and out, with sails you trim and ease.

Halyards can be tricky for a couple of reasons. One is that there are times to hoist or drop, and times to take up or ease down a little. You need to make clear which is which. Problems are compounded by difficulties hearing requests from the bow as the foredeck crew bounce around. Hand signals to reinforce words can minimize misunderstandings. Here are some ideas:

Take up - Take up slack (and one finger up).

Hoist - All the way up (and thumbs up).

Slack or Ease - Ease down a little (and one finger down)

Lower - Ease down all the way (and one thumb down).

Drop - Let halyard run (and two thumbs down).

Hold - Hold it there or stop (gets a fist).

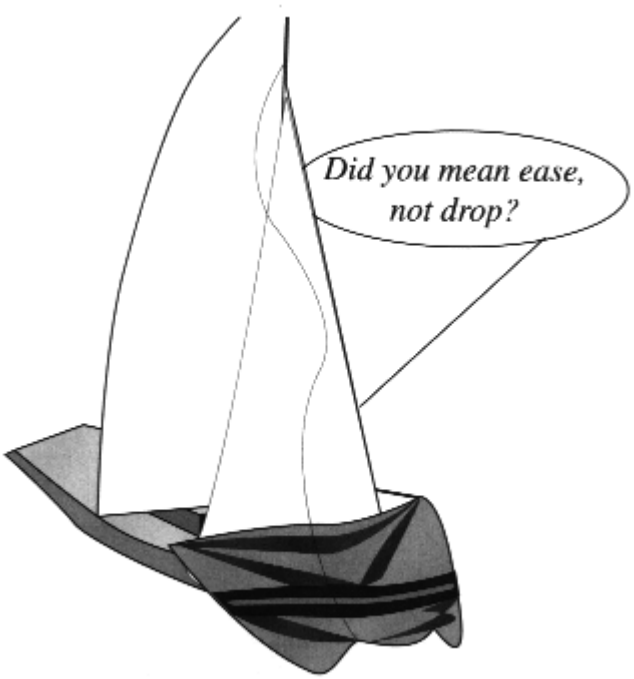


Fig. 4 - To get what you want you have to know how to ask for it. Use specific terms. Trim and Ease apply to sheets and other sail controls. In and Out apply to crew weight, which also moves fore and aft. With halyards, you often ease down or take up slack before you hoist all the way. Sometimes you ease a halyard, sometimes you drop it.

The other area of confusion is in amounts. How much is a little trim or a little halyard? Guess at specific amounts. With new or less experienced crew "a little" can go a long way. Try, "Take up the jib halyard three inches" instead of "Give me a little jib halyard," which might get you six inches and a ruined sail. Sometimes you ease a halyard to make sure it isn't jammed before you drop it. Fig. 4

Specific directions will get you the desired results. Otherwise you may end up exchanging words and gestures not repeatable in this family oriented text.

Chapter 3 - Introduction to Trim

3.1 Introduction

3.2 Theory of Lift

3.3 Tuning Shape to Conditions

3.4 Performance Goals

3.5 Conclusion

3.1 Introduction

What makes a boat go? Downwind, at least, it would appear to be pretty straight forward; but sailing upwind is quite another matter. While perhaps not a miracle, efficient upwind performance- working against the force that drives you - is certainly a marvel of modern design. The forces at work are complex, and they are not entirely understood - at least not by me.

In this chapter we will take a look at the theory of upwind sailing and attempt to create a theoretical framework to guide us in trim. We'll start with some definitions to establish a common language. We will also look at a variety of performance factors and see how they fit into our theory.

Sailboats are sometimes described as airplanes with one wing in the air and the other wing in the water. This is of course a lie. Wings provide the lift for planes, but not the thrust. Yet sails, like wings, are lifting foils. They are shaped to maximize lift and minimize drag for the expected conditions. Like adjusting flaps on a wing, sail shape can be fine tuned to suit particular conditions.

Basic sail shape is described in terms of the amount and position of depth or draft. A sail could be described as having a draft of 10% at 40% for example. This would mean that the draft at the deepest point would be one tenth (10%) the chord length or distance from the luff to leech; and that the deepest point is located 4/10
(40%) from the luff to the leech. Fig.1.

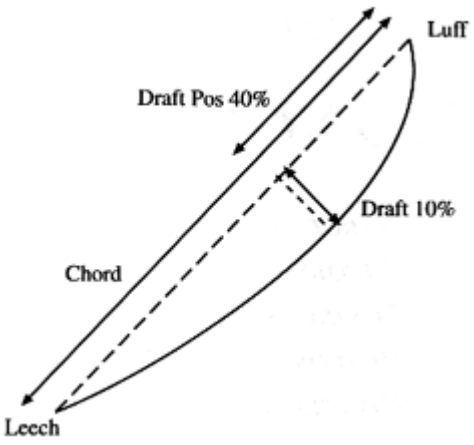


Fig. 1 - Basic sail shape is described by the amount of

depth (draft) and the position of the depth along the length (chord).

In addition to basic concepts of draft amount and position, sail shape can be further described in several ways. Smoothness of shape, horizontal shape distribution and exit shape, vertical shape distribution, angle of attack, and twist. The overall dimensions of a sail can be described as the ratio of height to width, or aspect ratio. In a moment we will take a closer look at each of these concepts, and how variations in sail shape effect performance; but first it is time to discuss the theory of lift (and other lies).

3.2 Theory of Lift

While the existence of lift and related forces are generally recognized (planes fly and boats sail) the theory of how lift is generated remains a point of contention. The old slot affect and venturi models have been debunked,, and replaced with Circulation Theory , which center on satisfying the Kuta Condition and so forth. Without getting into deep theory - which I don't grasp well enough to write about - let's take a look at what we know about sail shape, lift, and performance. We'll start with flow:

Flow

Air flows around a sail (or wing). The air flowing around the outside travels further, and faster, than the air inside. Wait right there: Why must it flow faster just because if flows further?

Why Faster Flow Around the Outside?

Imagine if the air flowing around the outside did not flow faster than that on the inside. As the inside air reached the leech the outside air would not be there yet. A vacuum would form on the outside of the leech. The air on top is then drawn in to fill the vacuum, which accelerates its progress - it flows faster to fill the vacuum. Fig. 2ab.

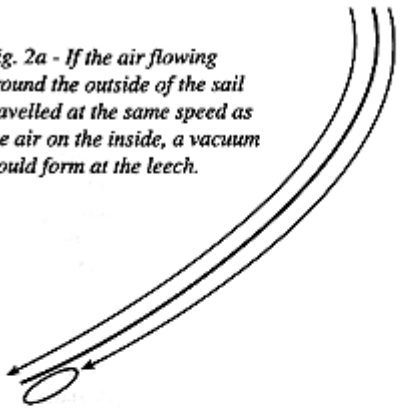


Fig. 2a - If the air flowing around the outside of the sail travelled at the same speed as the air on the inside, a vacuum would form at the leech.

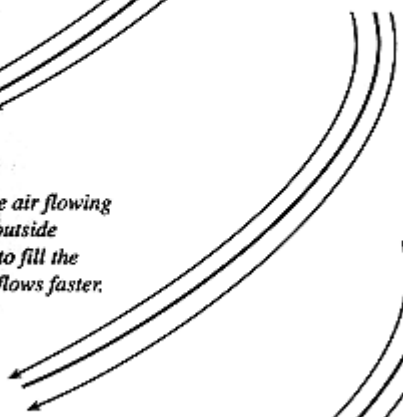


Fig. 2b - The air flowing around the outside accelerates to fill the vacuum - it flows faster.

Stall

Incidentally, accelerating the air around the outside is not the only way to fill the vacuum. Air from the inside can double back around the trailing edge to fill void. This happens when the flow around the outside separates from the sail before it reaches the leech. When this happens the sail, (or wing) is stalled. (We see

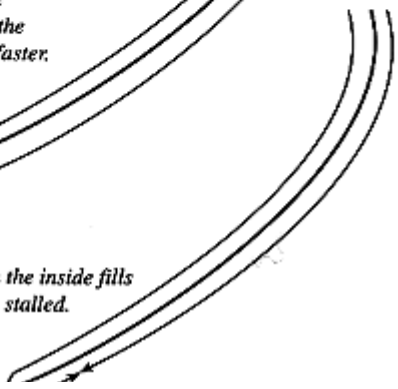


Fig. 3 - If air from the inside fills the void the sail is stalled.

this on mainsails when the leech telltales disappear behind the leech.) Fig. 3.

How Much Further?

So the air does flow faster around the outside because it flows farther - but sails aren't very thick. It doesn't seem far enough farther to make a difference.

In fact the air flowing on the inside of the sail does not follow the exact contour of the sail. The high pressure on the inside creates a cushion, or boundary layer, that the air flows over. In effect, the air cuts the corner - taking a much shorter route. On the outside of the sail there is also a thin boundary layer. The low pressure on the outside pulls the flow to the sail, keeping it attached.

Forces of Lift

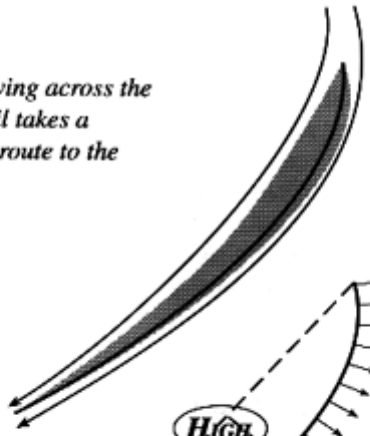


Fig. 4 - Air flowing across the inside of the sail takes a shorter, slower route to the leech.

The faster moving air exerts less pressure on the sail than the slower moving air. (Bernoulli';s Principle states that a fast moving fluid exerts less pressure than a slow moving fluid). The relatively low pressure on the outside of the sail creates lift perpendicular to the chord of the sail. Fig. 5.

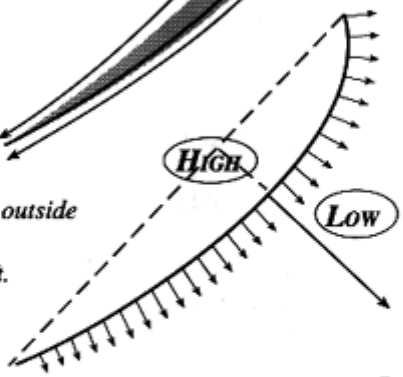


Fig. 5 - The fast outside flow creates low pressure, and lift.

When we put these sail lift forces on a boat we find a large, unwanted, heeling force; and a relatively small forward force. One goal of trim is to improve this mix. Fig. 6.

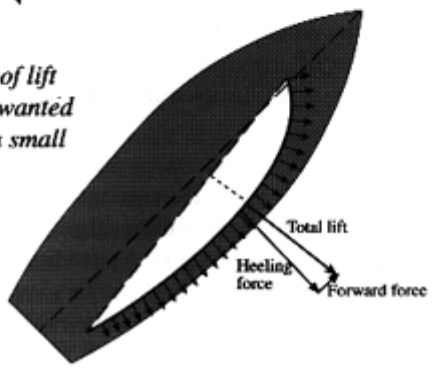


Fig. 6 - The forces of lift include a large, unwanted heeling force and a small forward force.

Main, Jib and Upwash

The combined effect and interaction of the main and jib is a dangerous theoretical frontier. What is known is that the two sails work together to create a combined lifting force greater than the sum either could create alone.

We also know that as the air approaches the sails it is slowed and bent. Since this slowing and bending of the air occurs upstream of the sails it is called upwash. As a consequence of upwash the jib sails in a relative lift and the main in a relative header. This is manifest in the way we trim, since the main is often trimmed to center line while the jib is trimmed ten degrees off center (more or less). This lift makes the jib more efficient; that is, its lifting force is rotated further forward, creating more forward force and less heeling force. While the main sails in a relative header it benefits in that the jib helps shape the flow of air around the main. Thus, although it is trimmed to the center line, air flows all the way to the main leech. Fig. 7.

Fig. 7a - Air approaching the sail plan splits, putting the jib in a relative lift, and the main in a relative header.

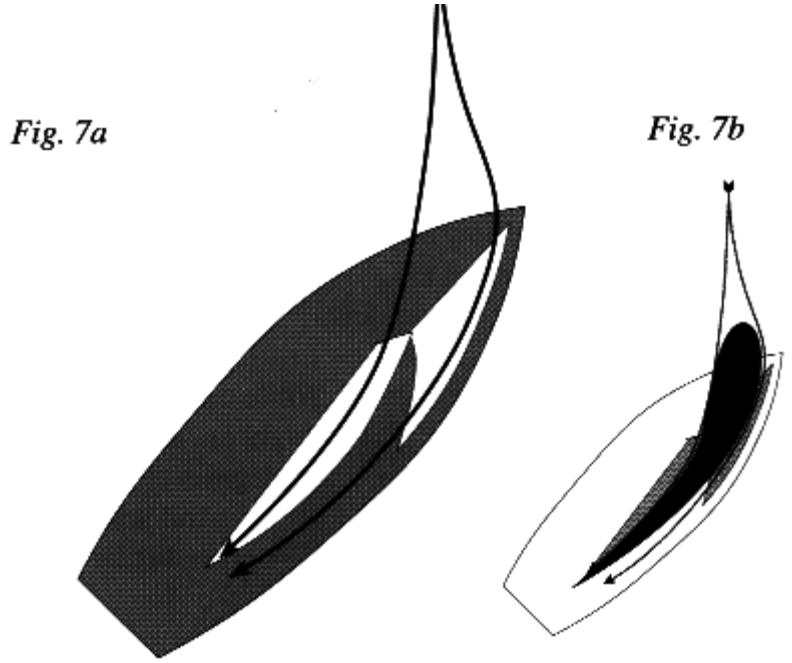


Fig. 7b - Think of the sails as elements of a single foil.

The Slot

Not all the air flows outside the jib or inside the main. Some flows through the slot, but not as much as you might imagine. Upwash steers air around the slot. The air which does flow through the slot is slowed as it approaches. It accelerates through the slot and is bent to flow onto the back of the main.

Add it Up

You can even view the main and jib as inside and outside sections of a single foil. The full shape of the foil is filled out by a pressure bubble around which the upwash flows.

No matter how you look at it, when you takethe main and jib together we find a combined force which is predominantly heeling force, with a very small forward force. Fig.8.

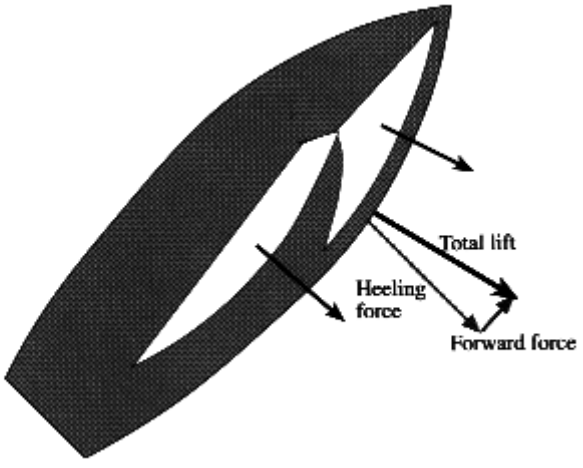


Fig. 8 - The total force from the sails can be broken down into a large heeling force and a small forward force.

Keel Lift

Were it not for the boats underbody, particularly the keel (or other foil), the side force would be dominant; and we would not be able to sail upwind. Fortunately, the keel generates lift which nearly offsets the side force of the sails and allows us to sail to weather (with only a few degrees of leeway).
Fig. 9.

But wait a minute, how can the keel generate lift when it is symmetrical? I hear you ask.

Ever see a plane fly upside-down? I reply cleverly.
Fig. 10.

The issue here is angle of attack. While the keel is symmetrical the water does not hit it straight on; due to leeway the water hits the keel from a few degrees to leeward and does not see a symmetrical shape. It sees a foil with a long and a short side; and lift is generated perpendicular to the angle of attack. Fig. 11.

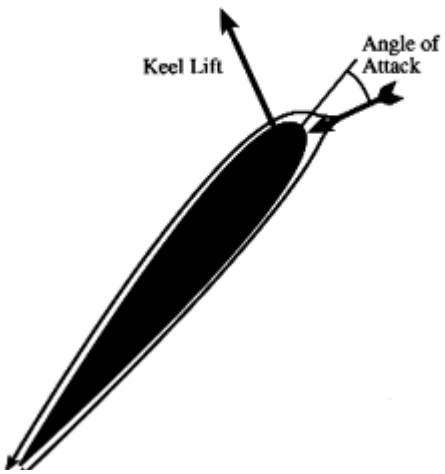
Speed First

In order for the keel to generate lift it must first be moving through the water. You need speed first, before you try to point. Look again at the forces on the boat: Only the keel takes you upwind. The sails push you downwind. The keel will take you upwind when you are moving fast. Speed First.

The Combined Force of Keel and Sails

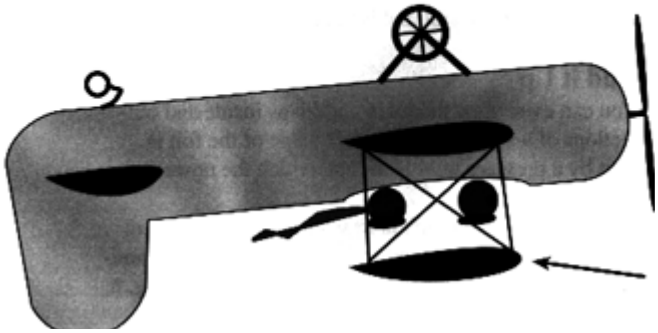
The combined forces of the keel and sails drive us forward. Note that only a very small fraction of the forces generated are actually translated into forward force. Most of our trimming and fine tuning effort is directed at improving this mix of useful and useless forces. Even a slight improvement in the mix can make a big difference in performance. Every little bit counts alot. Fig. 11.

Fig. 11 - Keel Lift. The keel generates lift perpendicular to the angle of attack of the water. The angle of attack is created by leeway.



This small forward force must then fight a tremendous amount of friction

Fig. 10 - Although the keel is symmetrical, the forces on the keel a not symmetrical. It generates lift due to angle of attack. The same principle allows a plane to fly upside down.



(drag) to push the boat through the water. Here again, a very small reduction in friction through better bottom preparation and refined keel shape can result in a significant gain in speed.

Theoretical Conclusion

Most races are won or lost by minutes, or even seconds, over many miles and hours. The margin of victory is the sum of many small things. Every detail is important. Everything shows up in the results.

3.3 Tuning Shape to Conditions

The sailmaker';s goals in designing and building a sail are two; first, to create a fast shape, and second, to create a shape which can be fine tuned to perform well in a variety of conditions.

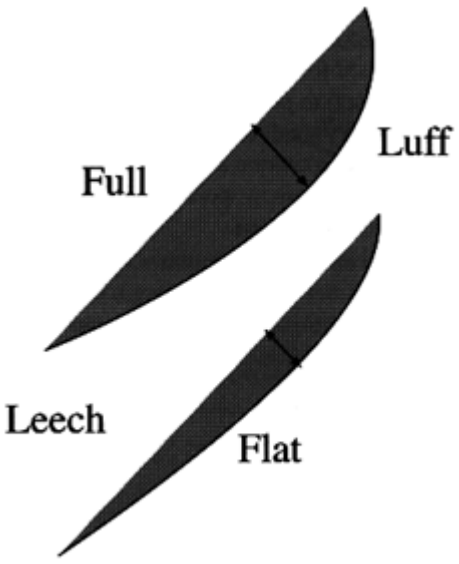
As sail trimmers our goals parallel those of the sailmaker; first to achieve the designed shape, and then to fine tune to conditions. We must consider each element of sail shape in striving toward these goals.

Draft

The depth, or amount of draft, in a sail controls the power, acceleration, and drag of the sail. More depth creates more power and acceleration; while a flatter sail has less drag and a narrower angle of attack for closer pointing. A deep sail is best to punch through waves and chop, and after tacking. A flat sail will be faster in smooth water. In overpowering conditions a flat sail is also best. Fig. 12.

Fig. 12 - DRAFT. Depth equals power.

A deep or full shape is best for power and acceleration.



Airliners create a deep shape with the flaps down for extra lift at low speeds during takeoff and landing; but pull the flaps in for a flatter shape and less drag for high speed cruising.

Draft Position

Generally, the goal is to maintain the designed draft position (about 40%-45% in mains, 30-40% in jibs) to keep a smooth, even shape. A draft forward sail will be more forgiving steering in waves, and will create less drag; a draft aft sail will be better for pointing, but is a higher drag shape.

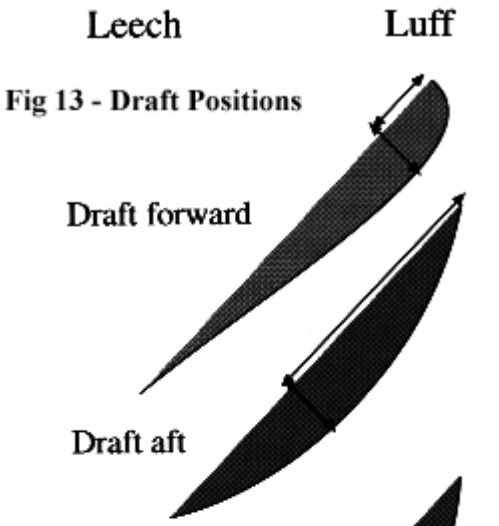


Fig 13 - Draft Positions

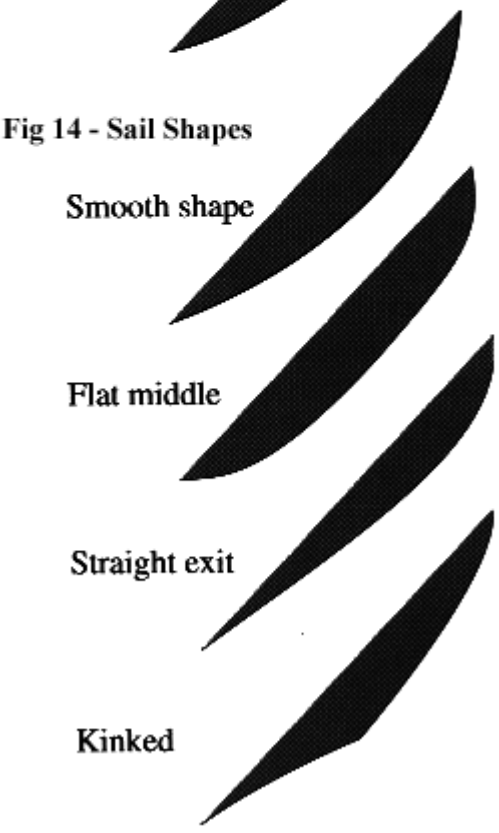


Fig 14 - Sail Shapes

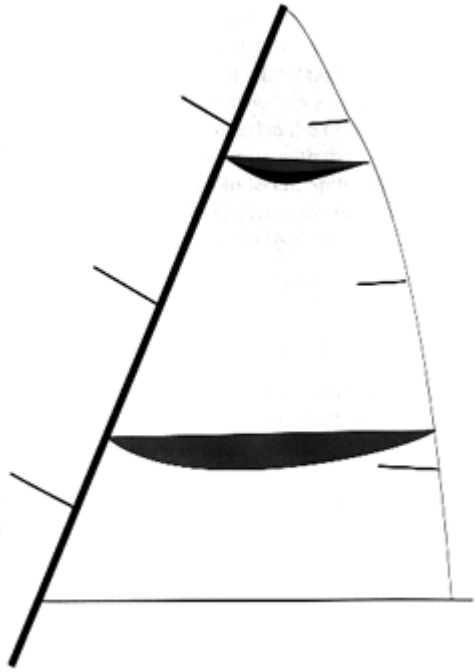
Horizontal Shape

There is more to sail shape then depth and position of draft. Horizontal Shape describes the shape from luff to leech. Most sails are designed with a fair, even curve to promote attached flow. Large overlap genoas are cut flatter in the aft sections where they overlap the main to allow for close sheeting without interfering with the main. Main sails are shaped evenly from luff to leech. Spinnakers are shaped round at the edges and flatter across the middle. Some sails have a kinked shape, though not by design. Fig. 14.

Vertical Shape Distribution

Sail shape varies vertically as well as horizontally. Different wind characteristics and sail dimensions necessitate a slightly deeper shape aloft than alow. This fact is counter to the intuitive response, which suggests more shape down low for less heeling moment. We want more shape aloft for three reasons: Fig. 15.

Fig. 15 - In light and moderate winds sails are trimmed to be deeper aloft than alow. In heavy air the top of the sail is flattened to reduce heeling forces.



There is stronger wind up high. More draft aloft helps pull extra power from this fresh breeze.

The short chord length necessitates a more powerful shape, to get all the available power over the short distance. The short chord length has a better lift/drag ratio, so the extra shape gives extra power but does not create excessive drag.

A deeper shape aloft keeps air from escaping up the sail in a path perpendicular to the leech. The air is forced into a more nearly horizontal path. The air stays on the sail longer for extra power, and there is less tip vortex as well.

In heavy air heeling moment does become a factor, and a flatter shape up high is desirable. In fact, much of our sail shaping effort is devoted to flattening (and spilling) the upper part of our sails as the wind speed builds.

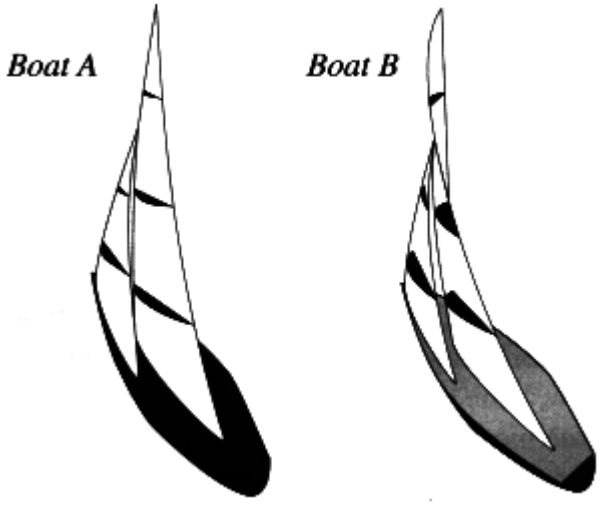
Twist

Twist is the relative trim of the sail high and low. A sail has lots of twist when the upper part of the sail is open. The opposite is a closed leech, with little twist. Fig.16.

Fig. 16 - Twist is the difference in trim of the sail high and low. Sails are designed with some twist to match differences in wind high and low. We fine tune twist to match sailing conditions and performance goals.

Boat A has closed leeches, with little twist.

Boat B has open leeches, or lots of twist.



The stronger winds aloft necessitate some twist. The stronger wind up high creates a more open apparent wind angle aloft. The upper part of the sail is twisted out relative to the lower part of the sail to match the more open apparent wind angle. The sailmaker designs twist into the sail.

Twist can be fine tuned to match sail shape to the prevailing wind and sea conditions, and to match our performance goals.

Fine tuning twist is one the most powerful trim adjustments we can make. We';ll offer a few generalizations here; details will be covered in upcoming upwind trim chapters.

We increase twist by easing the sheets, and reduce twist by trimming. Generally, less twist will provide better pointing, more twist is preferred for speed and acceleration. For example, coming out of a tack sails are trimmed with extra twist, with final trim coming only as the boat accelerates to full speed.

In overpowering conditions power can be reduced by easing the sheets and increasing twist - spilling the top of the sail, or by flattening the sail shape. Either way, you reduce power. Which is preferred? Generally, in wavy conditions it is preferred to use twist to control power. In smooth water conditions reducing power through flatter sail shapes is preferred. One of the challenges of trimming is achieving the correct total power, and achieving the correct mix of power - the correct mix of shape and twist.

One final generalization: The shape and twist of the main and jib should be matched.

Mains and Genoas

Designed shapes in genoas and mainsails have a number of differences, some of which have already been mentioned.

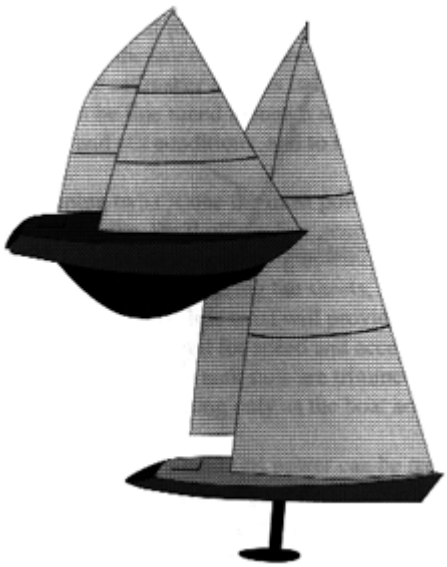
Genoas are generally deeper than mainsails, and more difficult to adjust. When one genoa is overpowered we change to another. Large overlap genoas are designed with a flat or straight shape aft. This exit shape allows closer sheeting without clogging the slot or interfering with the main, and it also reduces drag. Consequently most of the shape in genoas is built in the forward section, and our trim efforts are concentrated in tuning this forward shape.

Mainsails, on the other hand, carry shape throughout. The turbulence from the mast reduces efficiency in the forward part of the sail, so we focus on the leech to trim for speed, pointing, helm balance, and heel.

Aspect Ratio.

Experience has confirmed the theoretical notion that tall sails with short chord length (high aspect ratio) are more efficient than low, wide (low aspect) sails. High aspect sails (and keels) create more lift with less drag. This efficiency is particularly strong when main and jib are considered together. Adding overlap offers diminishing returns. A 150% genoa, even with all its extra area, is not much faster than a 110% sail. Fig.17.

Fig. 17 - A tall narrow (high aspect) sail (or keel) is more efficient than a low aspect sail. A high aspect sail will be closer pointing, while the low aspect sail is more powerful. We are limited by materials and heeling forces in the design of rigs, and water depth in the design of keels.



Development of higher, narrower sails is limited by sail material strength, rig engineering constraints, rules, and righting moment (heeling forces).

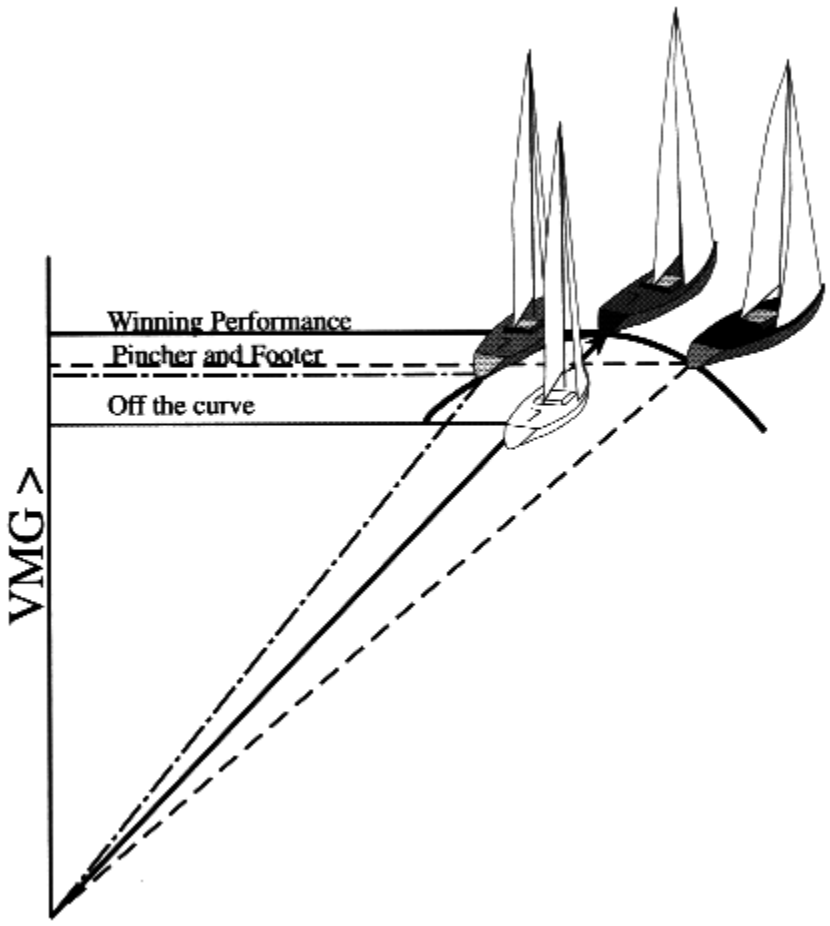
In fact, new sail materials and rig designs have brought us to new heights in high aspect design. #3 genoas are now built to hold shape and withstand tremendous leech loads. The efficiency of various sail mixes will be discussed in more detail as we cover trim technique.

Keels

While we can';t trim Ôem (thank goodness - racing is complicated enough) the shape and condition of your keel is as important to your upwind performance as the shape and condition of your sails. See Chapter 14 - Boat Preparation for more on keels and keel shapes.

3.4 Performance Goals

So much for a theoretical framework. In practical terms, what sort of performance framework will lead us to competitive upwind performance? We need performance goals.



For upwind racing the goal is to achieve the optimum mix of boat speed and pointing. The figure shows a performance curve. The high point on the curve shows the best mix of speed and pointing. The boat sailing there is achieving optimum VMG - Velocity Made Good. Fig. 18.

Measuring Performance

How do you know if you';re at the right spot on the curve? Sometimes it is hard to tell.

The best and truest measure of performance is racing in a strict one design. If you are higher and or faster than the boats around you then you are on the high point of the curve.

You can also measure performance against other boats of different design, although differences are hard to attribute: Are we beating him because our boat is faster, by design, than his, in these conditions; or are we outsailing him?

Judging performance independent of benchmarks is tricky. Without other boats around we tend to sail a little low and a little fast. Interestingly, we tend to sail a little too high and slow when other boats are around.

You can also measure performance with instruments. If you change trim and improve pointing with no loss of speed, or increase speed with no loss of pointing, then you are doing better. Harder to judge is a change which trades in some of one (speed/pointing) for the other. Without other boats to measure against it can be difficult to tell.

With integrated instruments and performance predictions you can race against yourself. Sophisticated computer and instrument packages will show you your performance against predicted performance. The best packages will record real world performance and add it to the stored data. You then compete against yourself, trying to improve upon past performance in similar conditions. The power of these systems is daunting, and is covered in some detail in Chapter 16 - Performance Instruments.

Trim and Performance

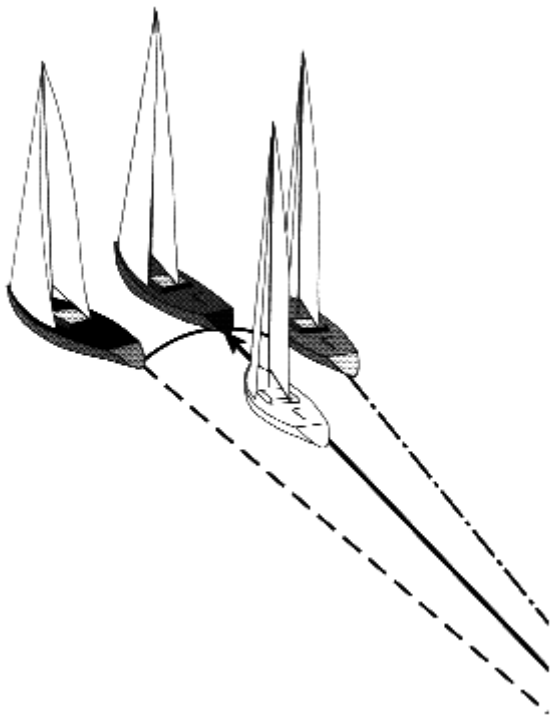
As we study the details and techniques for upwind trim we will consider three positions relative to the optimum: Low and fast, high and slow, and below the curve.

Generally, if you are on the curve, but at the wrong spot, subtle changes in trim will get you where you want to be.

On the other hand, if you are simply off the pace then a fresh approach may be needed. With so many factors involved in upwind performance it can be difficult to know were to begin. We will provide a framework to help you work through the variables. Fig. 19.

Fig. 18 - The goal of upwind performance is to optimize the mix of boat speed and pointing to maximize VMG.

Fig. 19 - The trimmers and driver work as a team to optimize performance. If you are on the curve, but a little high or low, then subtle changes in trim can set things right. If you are off the curve then more dramatic changes are called for.



Performance Conclusion

The next section will explore the variables in upwind sail trim and relate changes in trim to changes in sailing conditions. The next chapter will start our exploration of the details of upwind trim technique.

3.5 Conclusion

We now have a basic understanding of sail shapes and the terms used to describe

those shapes. This concludes the introductory section of the book. The next section - Chapters 4 through 8 - cover Upwind Performance.

Chapter 4 - Upwind Boat Handling

4.1 Introduction

4.2 Tacking

4.3 More Upwind Boat Handling

4.4 Conclusion

4.1 Introduction

It would be easy to dismiss this topic as easy and insignificant. Everybody can tack. What more is there? For starters, there are tacks. There are good tacks and bad tacks. Tacks in smooth water and chop. Roll tacks, slam tacks, and fake tacks.

There are other upwind boat handling issues as well. Reefs and genoa changes are rarely made during a leg, but there will be occasions each season when they are needed, and can win you a race. There are also good and bad ducking techniques, and there are ways the crew on the rail can help performance in subtle, but significant ways.

Don't forget: The difference between fast and slow, between the lead and the pack, is just a couple of boat lengths per mile.

4.2 Tacking

The difference between a good tack and a poor one can be measured in boat lengths. In a race where you tack ten times good tacks can provide the margin of victory. And in a close duel superior tacks will allow you to break free from, or keep control of, a rival. There are a number of elements which make up a good tack. Fig. 1.

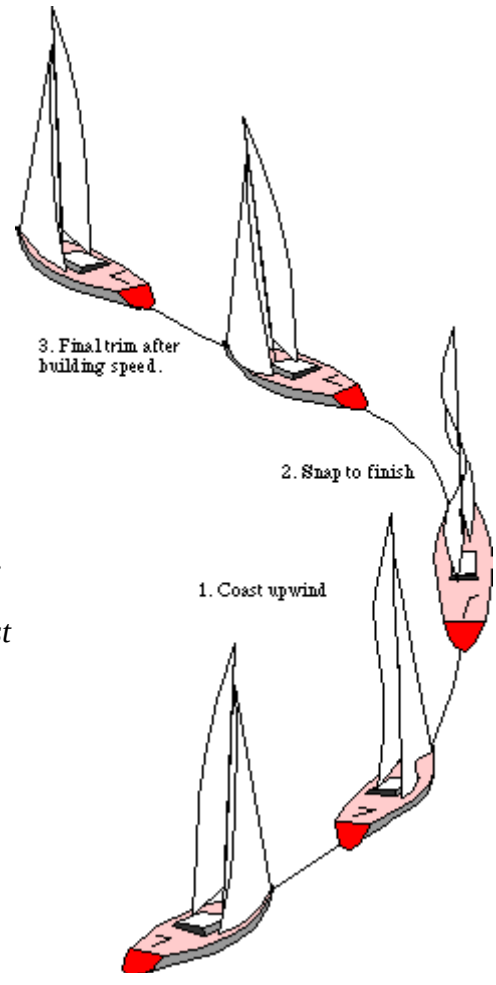


Fig. 1 - Tacking You should always be ready to tack. The winch should be pre-loaded with a full set of wraps. The working sheet should be flaked and ready to release. Start with a smooth easy turn. Let the boat coast upwind. Release when the sail luffs half way across the deck. By grinding full speed throughout the tack over-rides can be avoided and there will be no need to pause

to add wraps. Call speeds coming out of the tack. Gradually trim the sail home as full speed returns.

Tactician

First, if you have some flexibility in timing your tack, look ahead for a smooth spot to tack in. Avoid waves, chop, and wakes coming out of the tack. Also, make sure you will be in clear air coming out of the tack - don't tack into bad air.

Driver

The courtesy of a preparatory hail, "Ready about," increases the likelihood of a good tack on "Hard-a-Lee."

A proper tack starts with a slow, smooth turn. Many drivers turn too fast. Some wind up by bearing off before they turn, which is also wrong. A slow smooth turn will preserve momentum and allow the boat to coast upwind. As the boat comes head to wind and speed is lost, turn more quickly to finish the tack.

In waves a faster turn is called for, as momentum will be lost more rapidly. Start the turn on the face of one wave and turn quickly as the bow pops free over the crest. Try to get the bow around so the next wave pushes the bow down on the new tack, not back to the old tack. In a short chop it may not be possible to get around fast enough. Fig. 2 .

During the turn the helmsman must change sides and settle into position to work the boat up to speed. Come out of the tack a few degrees low of course and squeeze up as speed builds. Getting up to full speed is your priority coming out of the tack. Don't let anything distract you from your mission.

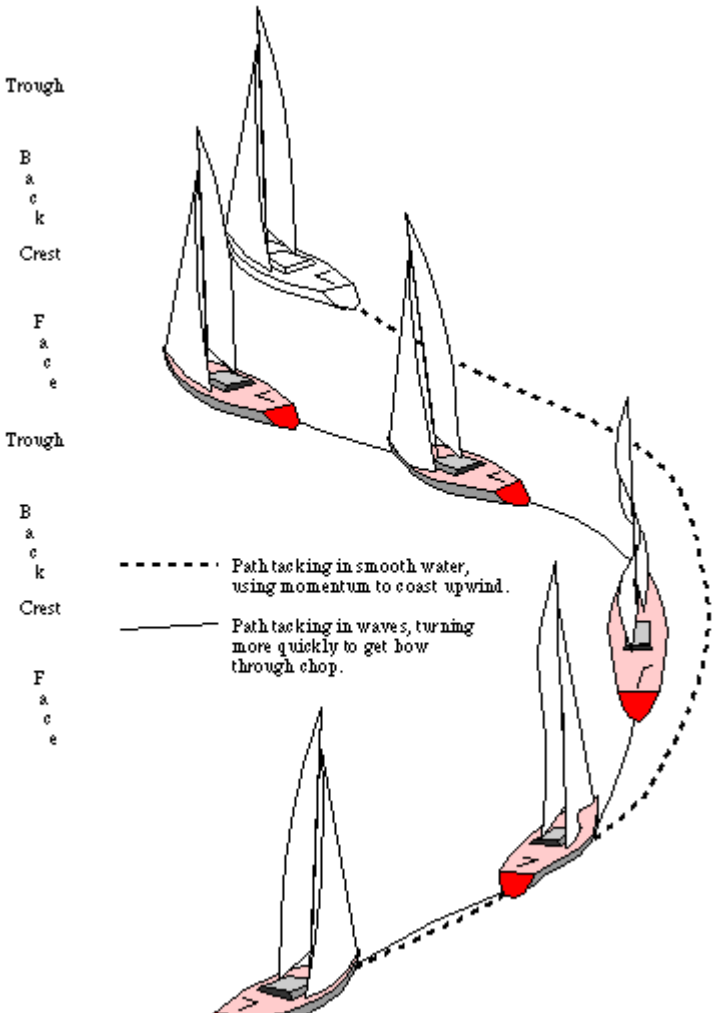


Fig. 2 - Tacking in waves requires a faster turn than a smooth water tack. Start your turn in the trough of a wave so the bow will pop free at the crest. Try to push the bow around quickly enough so that the next wave pushes your bow toward the new tack, not back to the old one.

Crew Movement

You should always be ready to tack. The lazy jib sheet should be loaded on the winch and the working jib sheet flaked at the completion of the previous tack. At "Ready about" the trimmer should make sure he is prepared to release and the tailer should check the new winch, take up

slack on the lazy sheet, and put the winch handle in place. No one else should move. You slow the boat if you get off the rail at "Ready about" and you telegraph your moves, letting your rivals know you are about to tack.

At "*Hard-a-Lee*" sit tight. The grinder should move into position as the boat stands up. There is nothing to grind until after the release anyway. The longer you hike the faster the boat will be going into the tack.

The Release

The release should not start until the genoa is backed half way across the foredeck. Then ease out one arm length before spinning the remaining wraps off the winch. The sheet should be flaked in advance. Make sure it runs.

Roll Tack

Every boat can Roll Tack, not just dinghies. In light and moderate winds a roll tack uses crew weight to help steer the boat and tack the sails. Here's how: First, heel the boat to leeward to generate weather helm and start the boat turning up into the wind. Next, as the boat passes through irons roll weight to the old windward / new leeward side. This will push the boat through the second half of the turn, and throw the sails across the boat. Finally, as the sails come over, the crew move up to the new windward side. This hikes the boat flat, and helps accelerate the flow of air across the sails, and thus helps the boat accelerate out of the tack.

Tail and Grind

The genoa should be trimmed hard from the moment it is released. The tailer should pull in long even strokes across his body. The grinder should grind full speed right from the start, even when there is no load. It is sometimes helpful to have another crew member help the sail around the rigging and drag the clew aft.

With the grinder spinning the winch full speed he can help the tailer bring the sail through the tough spots. By keeping the winch drum spinning he also prevents over-rides. This allows all the necessary wraps to be laid on the winch from the start of the tack. By laying all the wraps on in advance you don't have to stop to add wraps during the critical moments when the sail loads up.

Trim out of the Tack

Trim for extra power and better acceleration out of the tack. Pull the jib leads forward a few inches and trim three to six inches short of full trim initially. Grind to final trim as speed builds. If you want to adjust controls, such as the backstay, for acceleration out of the tack, do not wait until the turn is completed to make the adjustment. Do it just before you tack, or as you tack, so you can concentrate on building speed out of the tack.

Once the sail is nearly trimmed the grinder can move to the rail and the tailer can trim the last few inches as the boat accelerates. The trimmer should call out boatspeeds so the helmsman knows when the boat is approaching full speed.

Hike

If time allows, hike first. Don't set the pole, or clear halyards, or do housekeeping immediately after you tack. Hike out, settle the boat, and let the driver concentrate. Wait until you are up to full speed before you start moving around. This holds true in light air as well. Even when hiking weight is not needed, movement robs speed and disrupts concentration.

More Tacking Ideas

Tactically there will be times when you will not be able to execute the desired glide in and quick finish described here. When tacking in traffic you may need to execute a slam tack, where you slam the boat into a small opening. There will also be times - at starts for example - where an exaggerated coast in irons is called for to reach the desired location coming out of the tack.

Here's another idea: Tack through a wind shadow. If you are about to tack and there is a boat passing on the opposite tack downwind, tack through his wind shadow. There will be less drag and windage in reduced air of wind shadow. You may as well be tacking as you can't sail well in the shadow.

One more thing: Tactically, you should add a fake tack to your repertoire. Signal your crew with some clever code, like, "Ready about Wally?" to which they reply "Ready Beave." Put the helm down and turn to the point of the jib release. If your opponent falls for it, you can pull back. If your opponent doesn't tack, you can finish the turn as a normal tack. Hail either "tack" or "no" to signal your decision.

4.3 More Upwind Boat Handling

Straight Line Sailing

There are plenty of useful things for crew on the rail to do on a windward leg, aside from talking about their hangovers. Here are a few:

Find the windward mark (and the next mark).

Look ahead for changes in conditions.
Observe earlier fleets on the next leg (and plan strategy).
Plan ahead for the rounding - Bear away or jibe set?
Call immediate wind and waves.
Keep track of other boats.
Move to maintain proper heel.

These chores are, of course, in addition to badgering the driver to stop pinching.

Ducking

A proper duck is important to a successful reversal, as described in Performance Racing Tactics. To duck the sails must be eased as the helmsman bears off, and the sails retrimmed as the boat comes back on the wind. With a coordinated effort the loss from ducking a starboard tack boat can be minimized. The first trick, of course, is to look ahead so you see the other boat coming. The second trick is to keep greed from clouding your judgement about whether

you can cross or not. You can cross only if the bearing from your stern to the starboard boat's bow is increasing. The figure shows several ducking variations - only one of which is recommended technique. Fig. 3abcd.

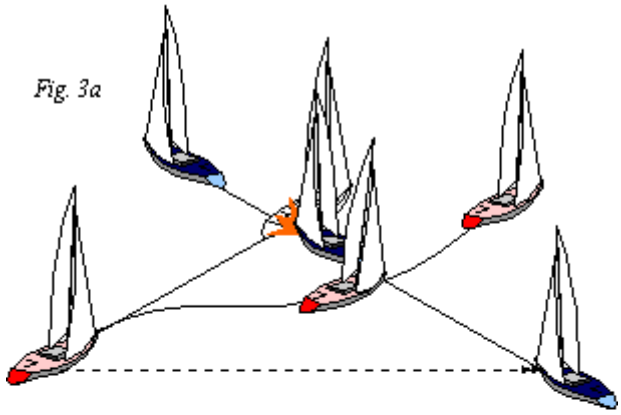
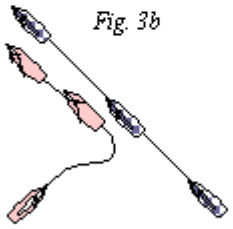
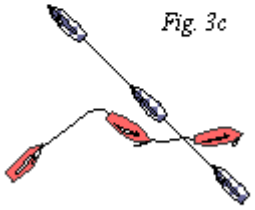


Fig. 3a - A proper duck involves a smooth turn, with sails eased to build speed. You gotta look ahead. You want to avoid the "crash tack" (3b), "Oh my god!" duck (3c) and the "ease the main, EASE THE MAIN" insurance incident report (3d).

Reefing





It is rare to take a reef during a round the buoys race. Usually we just flog the full main and hang on until the end of the leg. Once or twice a season a squall will roll across the course, and an immediate reef will be in order. If you can reef efficiently, you win. Those who are not practiced and prepared lose. And they beat the crap out of their sails as wellŠ

Taking a slab reef in the main should take less than 60 seconds. Here's how to do it:

Release the boom vang.
Lower the halyard to a preset mark.
Pull down the luff of the sail and secure the reef tack.
Grind the halyard to full tension.
With the sheet eased grind the reef line in.
Trim the main and reset the vang.

The key is to be organized for each step before you start. And divide the jobs. Keep as many crew as possible on the rail. All lines should be tailed from the rail, for example.

The genoa should be eased two inches and the helmsman should drive off slightly to keep power and speed while the reef is set; but be careful not to drive off too far as the rig is unbalanced while the main luffs.

If you tie in the reef, use brightly colored sail ties so you will not forget to take them out before shaking the reef. The reef points are only used for tieing up the loose sail - they are not strong enough to carry load.

Genoa Change

A genoa change is a major distraction, and should only be undertaken when absolutely necessary. Often, in a building breeze, it is possible to hang on with what you've got, rather than change down. In a squall change down for the sake of performance and for the life of your sail. In a dieing breeze it is more critical to change up to the appropriate sail.

There are three variations on genoa changes with a twin grooved headstay. The inside set, where the new sail is hoisted inside and the old sail dropped outside; the outside set, where the new sail goes up in the free groove outside the old one; and the tack set, where the new sail is hoisted inside, the boat is tacked, and the old sail is dropped inside.

Unless tactical considerations dictate otherwise the tack set is easiest and fastest, as the crew never has to work on the outside. Outside hoists and outside drops are difficult, as it is hard to get the outside sail under the foot of the inside one. Freeing the tack of the inside sail will create a gap under the sail, allowing the outside sail to pass more easily.

It is best to start the race with the genoa in the port groove so an inside set can be done on starboard tack, minimizing the chances of having to tack suddenly. One exception is a skewed beat heavily weighted to port tack.

Bring the new sail to the windward shrouds and prep it. Find the tack, check that the luff is straight, and attach the new halyard. Do all this before going forward to the bow. The new genoa lead should be set to a pre-marked position and a new sheet led. For a tack set simply use the lazy sheet from the old sail. The old halyard should be flaked so the old sail can come down as soon as the new sail is up.

When everyone is ready take the new sail forward and put the head in the luff groove. Start the hoist, and hook up the tack as the sail goes up. Don't overhoist if the tack is not secure as you near full hoist. Once the new sail is up [tack if you are doing a tack change and] drop the old sail.

Once down the old sail should be pulled aft along the weather rail and flaked. Before devoting crew attention to this house keeping chore first make sure you are properly trimmed and up to speed with the new sail. Then take care of the old one. At a minimum flake the luff and secure it with a sail tie so the sail is immediately available if needed. If the sail can be flaked and turtled so much the better. A fast genoa change will cost several boat lengths. A bad oneŠ

Incidentally, all sails should be stowed systematically so they can be found immediately as needed. Before the race put them in position where the weight will be least harmful - usually on the cabin sole. Once in place you cannot rearrange them during the race. They absolutely must not be left in the bow. Weight in the bow is a speed robber. Get your sails (and everything else) out of the bow.

A Few Words on Flaking

We'll take a moment here to rant about flaking genoas properly so they hoist easily. Simply put, the luff must be flaked straight. Since the luff is longer than the leech folds in the luff will need to be wider than those in the leech. Initially, to get the luff straight, take two or three full folds in the luff with small folds in the leech. The luff flaker leads, the leech flaker follows. The luff flaker should keep moving, taking wide folds which stack one on top of the other. It doesn't matter if the leech flaker falls several folds behind.

Note: If you are a foredeck crew inspect to make sure sails are flaked to your satisfaction. Or suffer the consequencesŠ

4.4 Conclusion

It is true: There aren't very many races where skippers cite superior upwind boat handling as the reason for their victory. But snafus - such as winch overrides, tangled sheets, jammed jib luffs, and the like - can snatch defeat from the jaws of victory. Fig. 4. Upwind boat handling is just one small block in the pyramid of power. Don't stumble over it.

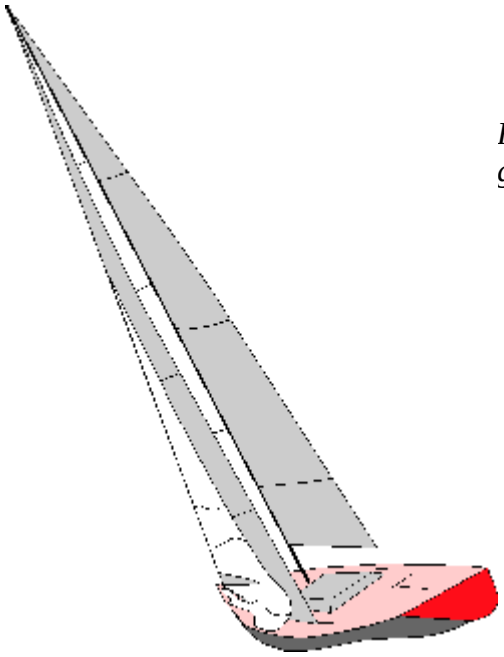


Fig. 4 - Snafus - such as a jammed luff tape during a genoa change - can ruin a race

Chapter 5 - Genoa Trim & Controls

5.1 Introduction
5.2 The Genoa Trimmer
5.3 Genoa Power
5.4 Sail Selection
5.6 Reaching Trim
5.7 Conclusion

Introduction

Genoa trim is a never ending process; the genoa sheet and other controls require constant attention to maintain optimum shape and performance. Every fluctuation in conditions requires a corresponding change in trim. Don't expect huge leaps in speed. Work for a boat length here, and a few feet there. Great trim is the sum of many small adjustments. It adds up.

This chapter will start with a look at the role of the jib trimmer in upwind performance. From there we will consider the sources of genoa power and proper sail selection. Next, we will look at each genoa control. We will start from the initial set of each control, and then move on to refined sail trim, matching genoa shape to sailing conditions.

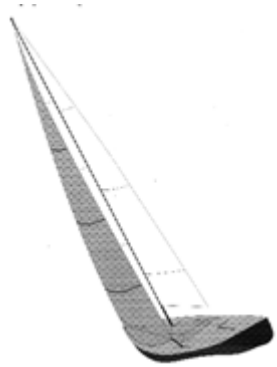


Fig. 1. Genoa trim is a never ending process of trim and fine tuning to match sail shape to the prevailing conditions and performance goals.

In subsequent chapters we will explore mainsail trim and helming. Later, in Chapter 8, we will also explore upwind performance problems and suggest methods for resolving them.

The Genoa Trimmer

The genoa trimmer guides the boat upwind. Through sail trim, and through communications with the driver, the genoa trimmer guides the boat to the optimum balance of speed and pointing.

The genoa trimmer monitors performance moment to moment, using one or all of the following:

- Comparison to other boats.
- A target boat speed standard.
- Immediate past performance (i.e.: How are we doing now compared with a moment ago?).
- The boats feel. A good trimmer will be able to feel a loss of power before it shows up as a loss of speed.

Based on current performance the trimmer directs adjustments to improve (or maintain) performance. Changes include adjustments in genoa trim, changes in mainsail trim, and

changes in driving style. It is critical for the trimmer to communicate the current state of performance, to suggest the means to improve, and then to report on progress as adjustments take hold. As we explore genoa trim further we will look at the specific adjustments which might be called for in a variety of conditions.

Genoa Power

There are three sources of sail power: Angle of attack, shape, and twist.

Angle of Attack

The genoa derives power first through angle of attack. Trim the sail in, and you add power. Let the sail out and you reduce power. Heading up also reduces angle of attack and power.

Angle of attack is increased by trimming the sheet or by falling off.

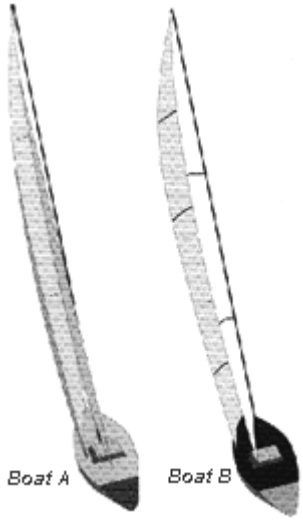
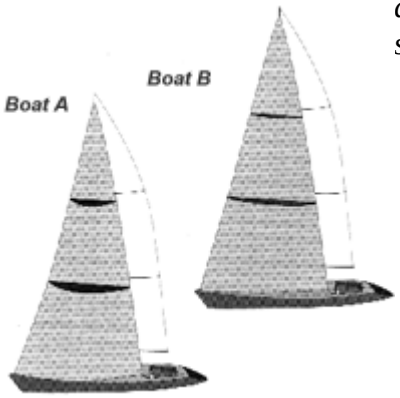


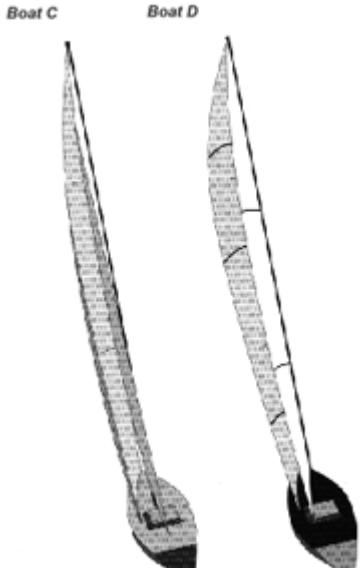
Fig 3.
Angle of attack changes with trim and steering angle. Here Boat A is trimmed to a narrow angle of attack, while Boat B, with the lead outboard and sheet eased, is trimmed to a wider angle of attack.

Shape

Deeper sails generate more power. Flat sail shapes generate less power (and less drag). Genoa depth is adjusted through a variety of controls, including headstay sage, lead position, and sheet trim.

Fig 4. Sail Shape: Boat A has deep genoa shape, for extra power. Boat B has a flat genoa shape, preferred for smooth water and heavy winds.





Twist: -

A closed leech generates more power. A twisted, or open leech, spills power. Genoa twist is controlled through lead position and sheet trim.

Fig 5. Twist: Boat C is trimmed for power, with little twist. Boat D's genoa is twisted open, spilling power.

Initially the sheet's primary impact is angle of attack, pulling the sail in. As the sail nears full trim the sheet increasingly pulls the sail down (not in). At this point the primary impact of trim is a change in twist.

Total Power, Mix of Power
The trimmers job is to achieve the correct total power in the sail, and also the correct mix of power from each source. **Sail Selection and Sail Controls**
Each genoa control impacts sail power in a number of ways. Of course, the biggest impact on power is the choice of which genoa to fly. The next section will look at sail selection. The subsequent section will cover sail controls one by one.

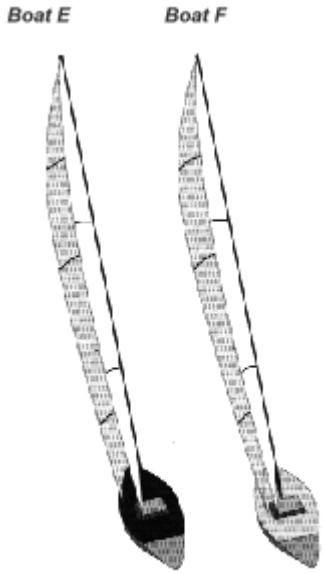


Fig 6. Twist versus Angle of Attack: Boat E has a wide angle of attack. - the entire sail is open, while Boat F has twist - the upper leech is open, but the lower part of the sail is trimmed inboard.

Sail Selection

The first step in genoa trim is to choose a sail based on conditions. Each sail has a designed strength and performance range. The optimal safe wind range for a given sail is available from the sailmaker, though with modern materials sail strength is less an issue than size and shape. The sail will be wrong from a performance standpoint before you threaten its strength. [This statement is not a warranty. Do not blow out your sails.] At the crossover between two sails several secondary factors influence the decision.

Sea State

Generally, in waves or chop use the bigger sail for extra power. In smoother water a smaller sail with a shorter overlap is preferred for close sheeting and high pointing ability. In big waves some skippers prefer a smaller jib which allows them to steer around big waves; while others rely on a big jib for power.

Trend of Conditions

No surprises here: If the breeze is building then use the smaller sail. In a dying breeze use the larger sail. Notes that sea state and breeze trend factors tend to coincide. In a building breeze seas will not have built up. In a dying breeze there will be left over seas.

Beware. Do not start with a smaller sail because you anticipate the wind building into its range. Use the smaller sail only if the wind is already in its range and you expect it to continue to build.

Performance Records

The band of uncertainty will become narrower as you become more familiar with your boat. Good record keeping can accelerate this process.

Two notes here: 1) Good record keeping can also help you in subsequent sail purchases. If you find you want to carry one sail up into the range where the next sail would supposedly be better then report this finding to your sailmaker. This information will help in the design of future sails.

Note 2) Once you know the exact crossover wind speed for each sail in your inventory, it is time to get a new boat. Sometimes you can delay this by changing your sail inventory.

Testing

Prior to a race test your options before making a decision. Head out to the starting area an hour early to test out different headsails. Tuning up with both sails against another boat is particularly valuable.

Better still, do your testing in practice against a well sailed sistership. You should sail with different sails, and then both switch. When you find which sail is faster do further testing to optimize performance with both boats using the same sail.

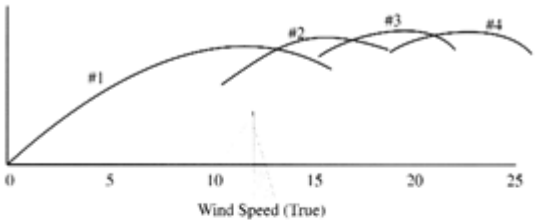


Fig. 7 Sail selection is based on wind strength, sea state, and the trend in conditions. Careful record keeping can help us know the proper sail selection.

Halyard

The halyard is used to position the draft. Working from our initial trim settings, this is a two part process.

Initial Trim

Set the halyard to remove wrinkles from the luff of the jib. In light to moderate conditions it is better to leave the halyard too loose - leave a few wrinkles. In heavier air a firmer halyard is needed - remove the wrinkles.

Draft Maintenance

As wind strength changes halyard tension is adjusted to keep the draft in position. As the draft blows aft halyard tension is increased to hold the draft forward. As the breeze dies the halyard is eased to match the reduced loads in the sail. Our goal in this first stage is simply to keep the draft in its designed position.

Draft Tuning

Once we have finished draft maintenance we can fine tune our sail shape to suit conditions. More halyard tension will pull the draft forward. This creates a rounder entry shape which makes steering easier, particularly in waves.

Easing the halyard will allow the draft to move aft, resulting in a flatter, or "finer" entry. This fine entry will result in a closer pointing shape, but with a narrow steering groove. In easy steering smooth water conditions this softer halyard will allow for better pointing.

To achieve proper halyard tension we must balance pointing ability with groove width. A flat entry which we cannot steer to will be slow; a round easy-to-steer entry will not allow us to point.

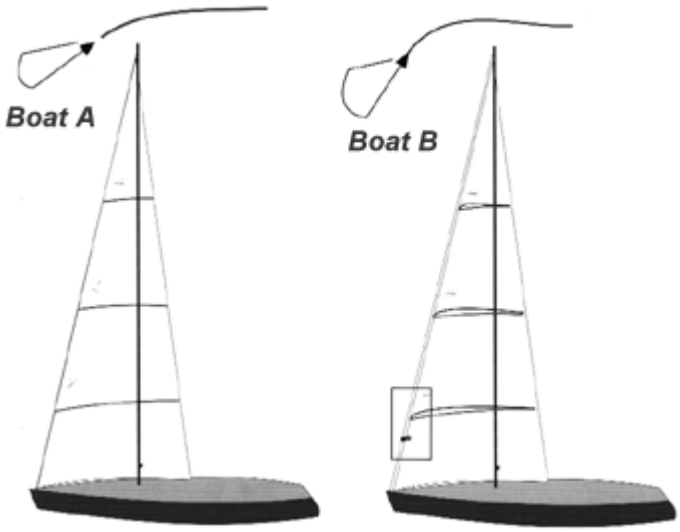


Fig. 9 Boat A - Draft aft creates narrow angle of attack. Boat B - Draft forward and wide angle of attack.

Measuring and Duplicating Halyard Settings

The best way to measure halyard settings is with a mark on your headstay and corresponding marks on your sails. This is easier and more accurate than number strips on deck matched to marks on the halyard. It also encourages pit crew to keep their heads up, looking forward during the hoist, which is good.

First, put a one inch wide mark on your headfoil six or more feet above the deck - as high as you can reach conveniently. (Your headfoil should be fixed in place. If properly installed it should not move up and down on your headstay.) Next, set each jib (in appropriate conditions) and set the halyard tension properly. Mark the jib luff to match the mark on the headstay. At the sail's upper end you may need to pull a little above the mark, and at the low end you will want the halyard slightly eased from this setting.

Fig. 10 Use marks on the sail and foil to set halyard tension.

These marks are particularly valuable when setting the jib prior to a spinnaker takedown. It is very hard to judge appropriate upwind halyard tension with the sail loosely sheeted on a reach.

One more trick: Overhoist the sail slightly and ease down to the mark. This helps assure even cloth tension over the length of the luff.

Headstay Sag

Headstay sag controls depth of draft, particularly in the forward part of the sail. As with halyard tension and draft position, controlling depth is a two stage process.

Initial Trim

Set the headstay sag with backstay or running backstay. Set at one quarter max tension in light air; progressively more for stronger breeze.

Depth Maintenance

As the wind strength changes loads in the sail change, and sag changes. As the wind builds we must add headstay tension to keep the same sail shape. Similarly, as the wind dies the headstay must be eased.

Depth Tuning

More sag adds depth and power; for extra speed in waves, and better acceleration. A tight headstay creates a flat shape. The flat shape will be faster and higher pointing in smooth water.

Fig.

Fig 11a - A tight headstay creates a flat closewinded, low drag shape best for heavy air and smooth water.

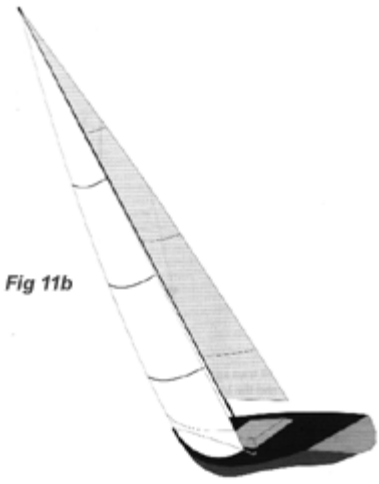
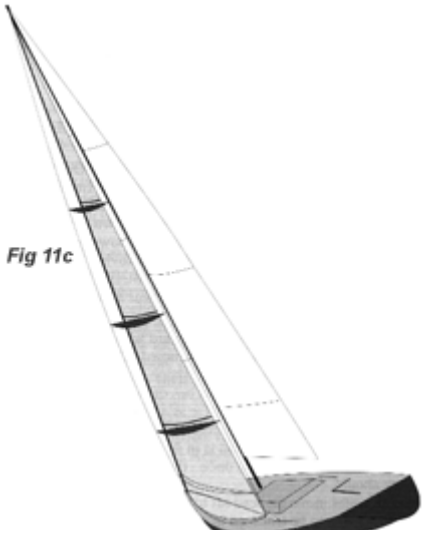


Fig 11b - A sagged or loose headstay produces a deeper, more powerful shape, best suited for light to moderate winds and chop.

Fig 11c - This figure shows a deep sail shape silhouetted over a flat shape. As the breeze changes the headstay sag will change due to changing sail load. Adjustments will first be needed simply to maintain shape. From there sail shape can be fine tuned to the conditions.



A secondary affect of headstay sag is a change in entry shape, similar to halyard control. More sag creates a

rounder entry; a tighter headstay creates a flatter entry. Consequently any adjustment in sag should be followed by a check of halyard tension to be sure entry shape is proper.

Tightening the headstay flattens the entry; and the halyard may need to be snugged to put some shape into the front of the sail. Sagging the headstay rounds the entry. A matching ease on the halyard can prevent the entry from becoming too round.

Genoa Leads

Moving the fairlead changes genoa shape and power. The goal of initial trim is to achieve the designed shape. We'll fine tune from there

Initial Trim

Set the jib fairleads so the sail has a fair curve and even shape from top to bottom. When the sheet is trimmed the jib telltales should break evenly from top to bottom. (As you pinch up above closed hauled the upper telltales will luff before the lower ones.) The leech of the jib should match the shape of the main.

NO, the telltales will not all break together. The upper telltales will luff first, and the break will spread down.

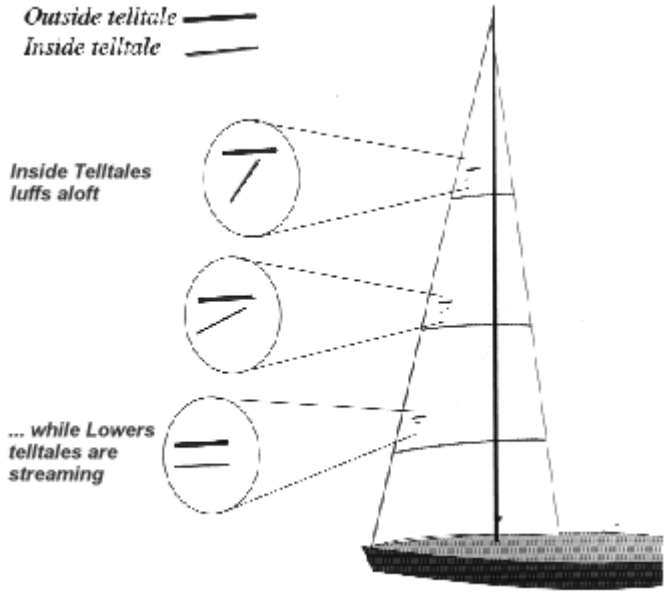


Fig. 12 - The jib telltales will NOT all break at the same time. The upper part of the sail will break first. and the luff will spread down form there.

Balance of Power

The jib leads balance high and low shape in the sail. Our goal is to set the lead so the sail shape matches the wind from top to bottom. When the lead is set properly the inside telltales will break smoothly, starting from top and moving down.

Moving the lead forward makes the sheet pull down more on the upper part of the sail, trimming in the top. Moving the lead aft will cause the sheet to pull back on the foot, like an outhaul, without trimming the upper part of the sail as much.

Tuning to Conditions

In waves and chop pulling the lead forward adds power throughout the sail. The top of the sail is trimmed fully, and the foot of the sail takes on a round, powerful shape. In moderate winds the leech will trim within a few inches of the top spreader, while in light air it may be as far as a foot off. The foot of the sail will carry perhaps two feet of depth over a ten foot chord

length. Only when the lead is in its forward most position will the entire luff break at once - the way basic sailing texts say they should.

In smooth water move the lead aft to open up the sail. This allows the genoa to be trimmed in closer to the main without clogging up the slot. The foot is stretched flat. Overlapping genoas will trim against the shroud base. The telltales break first aloft, and the lower telltales may even be partially stalled while the uppers spin. This flatter shape allows harder trim and thus higher pointing.

In over powering conditions move the lead aft to flatten the foot of the sail and spill open the top; reducing power throughout.

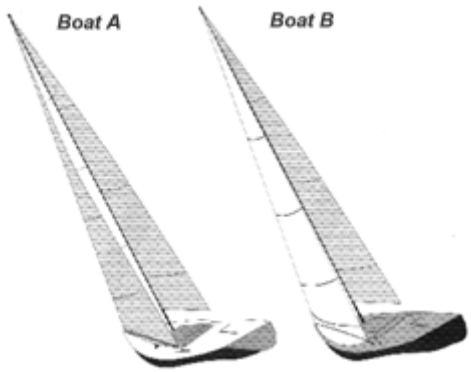


Fig 13 - moving the genoa leads changes the shape and power of the foot and leech of the genoa. Boat A - Moving the lea aft flattens the foot and opens the leech, reducing power. Move the lead aft to reduce heeling when overpowered and for closer pointing in smooth water. Boat B - Moving the lead forward adds shape and power in the foot and up the leech. Move the lead forward for extra punch in waves.

Adjustable Jib Leads

Adjustable jib lead systems allow you to adjust the lead position on a loaded jib lead. This allows the lead to be adjusted to changing conditions and situations. For example, the lead can be pulled forward for extra acceleration out of a tack. As speed builds the lead is eased to its normal position. Similarly, the lead can be pulled forward to add power when approaching a tough set of waves, or the lead can be eased aft to spill power in a puff.

Inboard and Outboard Leads

An inboard lead position allows for closer pointing in ideal smooth water moderate air conditions. With the main and jib both trimmed flat move the lead inboard a few inches. (Drag it inboard with a hook around the sheet.) Your goal is to improve pointing without any sacrifice in speed. Be prepared to ease out immediately if (when) you lose speed. Speed first - pointing second. Keep speed, then try to squeeze up. On many boats it is difficult to improve pointing due to limitations of the keel.

In heavy air an outboard lead de-powers the slot. With an overlapping genoa and the main traveler down the slot will be clogged. Move the lead outboard to open the slot for speed and to reduce heeling. The danger here is a loss of pointing ability. Before moving the lead outboard try first to de power by easing the sheet a few inches while leaving the lead in its regular (aft) heavy air position. Only in extreme conditions - when you ought to have a smaller sail - is an outboard lead effective.

In very light air an outboard lead prevents the slot from being clogged and eases flow. Hold the lead outboard and reach off to build speed. Once you have speed then try pointing (back to the harbor). Repeat from above: Speed first.

From our initial set we can fine tune shape to suit conditions. Each control can be fine tuned; and as we adjust one we will need to check the impact on others. As stated above, genoa trimming is a never ending process.

Genoa Sheet

Sheet trim is the primary control of jib shape. The sheet effects the depth, power, angle of attack, and the shape of the slot. When the sheet is properly trimmed the genoa will have smooth even shape, parallel to the main. The main may show the first signs of backwinding.

Initial trim

Initial trim will put the upper genoa leech a few inches off the top spreader as the foot nears the shroud. (Obviously this is a rough approximation - yours may vary.) You will find you point higher and lose speed as you trim. When additional trim does not improve pointing the sail is overtrimmed. Ease slightly and continue the search for the best mix of pointing and boat speed. Play the sheet constantly to keep optimum speed and pointing.

One or Two Inches

The difference between fair trim and good trim is only an inch or two of sheet. About right does not cut it. Two inches too tight and you will be slow. Too loose, and your pointing will suffer.

The difference between good trim and great trim is effort. Get good speed and test extra trim. Try for extra pointing without sacrificing speed. If speed suffers ease for a moment to build speed, and try again.

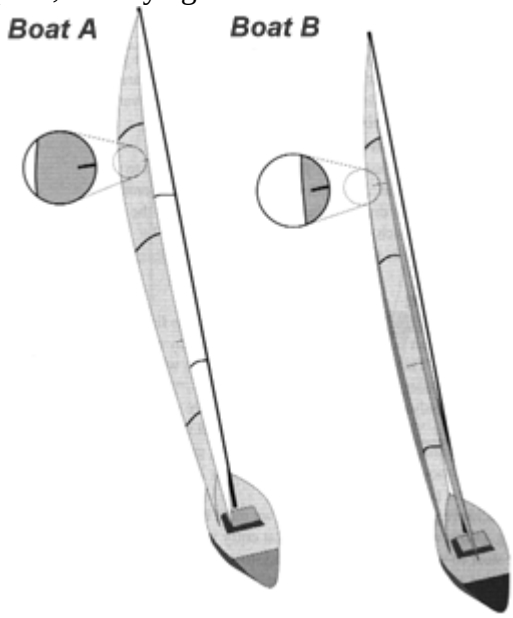


Fig. 8. The genoa sheet is the primary control. the sheet affects power, shape, and angle of attack. Trim the sheet so the genoa shape balances speed and pointing, and play the sheet with each change in conditions or performance - easing to build speed and trimming to point higher when speed is good. Be prepared to check the sheet trim with every change in secondary controls. Any change in the halyard, headstay, or lead will affect the sheet.

In final trim the difference between fast and slow is only a couple of inches. Here, Boat A is eased for acceleration. Boat B is fully trimmed for high pointing.

The genoa sheet must be played with each fluctuation in conditions or performance. In a lull, or when the boat is slow, the sheet should be eased. As a puff hits the sheet may need an initial ease, and then trim as the boat accelerates.
Keep working, and remember - speed first, then pointing.

Secondary Affects

Sheet trim must be checked after every other adjustment or change.

Raising the halyard raises the head of the genoa, and increases the distance from the clew to the head of the sail. To keep the same leech shape the sheet would have to be eased as the halyard is raised. The reverse would hold if the halyard were eased.

Tightening the headstay is similar to tightening the sheet, except the sail is pulled from the luff rather than the clew. To maintain trim as the headstay is tightened the sheet must be eased. If the sheet is not eased the entire sail will be trimmed in. (And vice versa for more headstay sag.)

Adjusting the sheet lead directly affects the sheeting angle. Any lead adjustment will require some sheet adjustment. As the lead is moved forward the sheet may need a slight ease; as the lead is moved aft the sheet generally needs trim.

Never Relent

Don't cleat the jib sheet, and don't hang out to leeward. The jib trimmer should be the last crew to the rail. As long as conditions allow, keep the jib trimmer to leeward, working on trim. Once the rest of the crew are fully hiked the jib trimmer should hike too. But don't cleat the sheet. Bring the tail along. That way the sail can be eased without delay, and without the trimmer moving off the rail.

Reaching Trim

A high clewed Reacher or Jib Top is designed for jib reaching, with extra roundness and power forward. Lacking such a specialty sail, you will have to make do with a standard genoa, trimming it as best you can for the reach.

Barber Hauling

Using a standard genoa on a jib reach the lead must be moved outboard and forward. You chase the clew of the sail with the lead. It also helps to keep the halyard firm to hold the draft forward and too prevent the back of the sail from becoming too round.

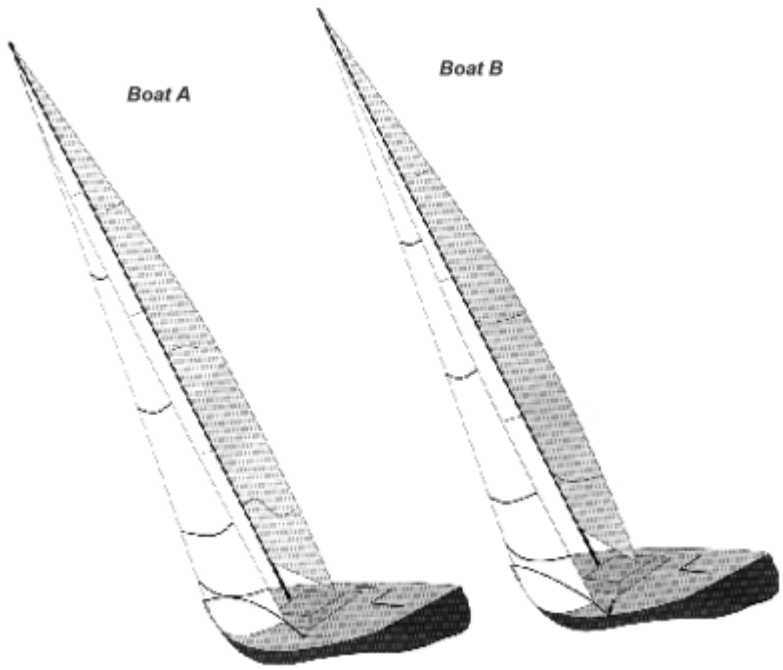


Fig. 14
As the genoa sheet is eased on a jib reach the genoa lead is must follow the sail outboard and forward. Boat A - If

the lead is not moved the jib foot will be too round, and the leech will spill.

If the lead is not moved as the sheet is eased, then the top of the sail will twist open, spilling power, and the bottom of the sail will hook in toward the boat, creating excess drag.

At the Cusp

There is a limit to how low you can reach effectively with a genoa. As you push the lead forward in an effort to keep the top of the sail trimmed you make the foot increasingly round.

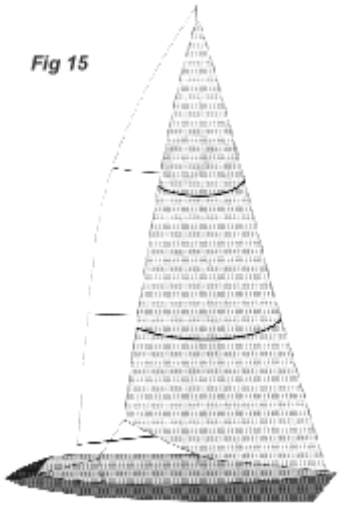
As you reach the lower limit of effective reaching trim you have two choices:

One is to set your spinnaker - particularly if you carry an asymmetrical spinnaker. If the angle is too close for a chute then the alternative is to head up slightly to keep the jib working effectively. As you gain height you will eventually be able to reach down and set a spinnaker. This is the only time a direct route is not fastest on a reach.

Reacher

If you carry a high clewed Reacher or Jib Top the exact lead position depends on the wind angle. Set the sheet lead well aft, and rig a choker to pull the sheet down. Adjust the choker so the sail luffs evenly from top to bottom. This arrangement is better than a fixed lead, as it allows easy adjustment as wind angle and wind speed change.

Fig. 15 A reacher is designed for reaching, with a hight clew and powerful shape. Sheet it aft, and choke the sheet to adjustable sheeting angle.



Genoa Staysails

Although they have gone out of fashion, some old IOR boats with huge J dimensions still carry genoa staysails.

The genoa staysail can be set between the jib and main, creating a double head rig. Tack it on the centerline at 40 - 50% of J aft, and sheet it evenly between the main and genoa. Try it. If you go faster keep it up; if it makes you slower take it down.

(WOW!) If you own one of these relics take care of it - you certainly don't want to have to replace it. It may also be time to think about a newer boat, where you don't need to carry so many sails to sail fast.

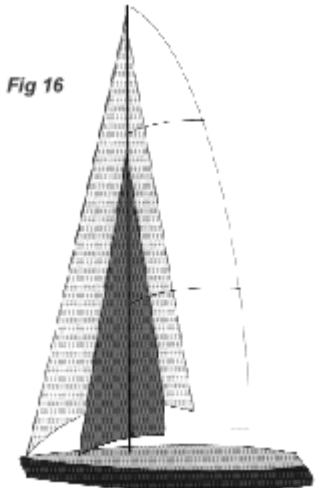


Fig 16 The genoa staysail depicted here may be the last one you see. Give it a close look...

Conclusion

Genoa trim is a never ending battle to match sail shape to the conditions of the moment. The genoa trimmer leads the

boat upwind, guiding the driver up or down, depending on performance.

Later, in Chapter 8, we will revisit genoa trim as we consider overall upwind trim solutions in a variety of sailing conditions.

Chapter 6

6.1 Introduction
6.2 The Mainsail Trimmer
6.3 Mainsail Power
6.4 Controls
Sidebar - Vang Sheeting
6.5 Reaching & Running
6.6 Conclusion
Addendum:
Fully Battened Mains

6.1 Introduction

The jib leads the boat upwind; the mainsail provides balance and control. Proper main shape is a shape which complements the jib, and balances the helm, while pushing the boat to the proper mix of pointing and speed.

We have more control over mainsail shape than we do genoa shape; and we are required to do more with it. After all, we have all those genoas, but only one main. Having so many controls is a double edged sword; sometimes it is hard to know what to use when. Fear not. If things don't work out, blame the tactician. Fig. 1.

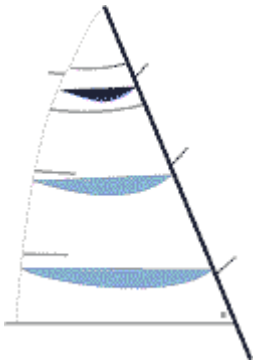


Fig 1. - A well trimmed main will provide speed, pointing, and balance to our upwind performance.

In this chapter we will look at the role of the mainsail trimmer in upwind performance, and the various sources of power for the main. Next, we will consider each mainsail control and how it impacts sail shape and power. We'll look at initial trim settings for upwind sailing, and refinements for varied conditions. Reaching and running trim will be covered in a separate section. Later, in Chapter 8 we will integrate main trim, jib trim and driving techniques in a variety of sailing conditions

6.2 The Mainsail Trimmer

The mainsail trimmer is responsible for monitoring the boat's upwind performance, trimming to keep the boat sailing fast, pointing high, and in balance. Fig. 2.

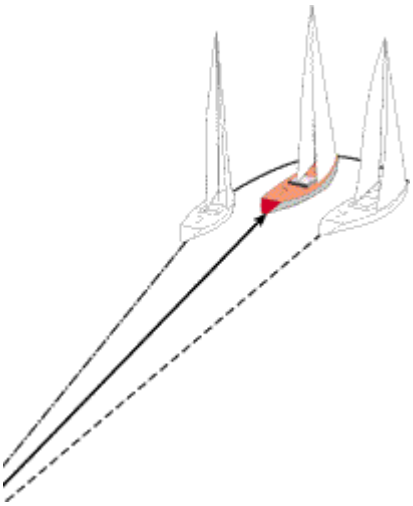


Fig. 2 - The mainsail trimmer works with the jib trimmer and driver to keep the boat sailing fast and pointing high.

Monitoring performance involves information from on and off the boat. Performance against adjacent boats is one key input. Boat speed and apparent wind angle provide additional information. Also important are the helm balance, heel, and path of the boat through water. For example, if the boat is pitching or the course unsteady the main trimmer can make adjustments to help.

The ability to make quick adjustments to the main in immediate response to changing conditions distinguishes it from the jib. Jib trim is trimmed to an average, with small, incremental adjustments to changing conditions. By virtue of the ease with which the main can be adjusted, and because of its effect on balance, the main is played much more aggressively. This is particularly true in puffy or wavy conditions.

The main trimmer has more control over shape and power than the headsail trimmer. In the next section we will take a look at each source of mainsail power. Following that we will look at each mainsail control.

6.3 Mainsail Power

There are three sources of mainsail power, as with any sail: Angle of attack, shape, and twist.

Power through angle of attack

The main derives power first through angle of attack. Trim the sail in, and you add power. Let the sail out and you reduce power. Heading up also reduces angle of attack and power.

Angle of attack is increased by trimming the sheet, raising the traveler, or falling off. Fig. 3.

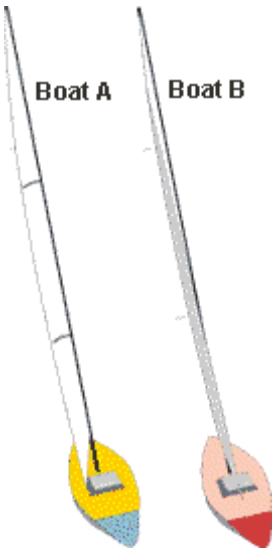
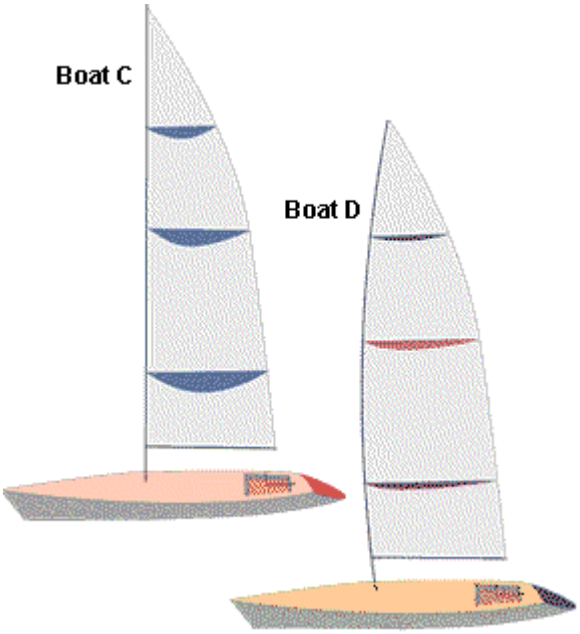


Fig. 3 - Angle of attack is the first source of mainsail power.
Boat A - Power is reduced by easing the sail out or by heading up.
Boat B - Angle of attack is increased by trimming the sail in, or by falling off.



Power through shape

Deeper sails generate more power. Flat sail shapes generate less power (and less drag). Sail shape is adjusted through a variety of controls. Mainsail shape is controlled by mast bend and outhaul tension. Fig. 4.

Fig 4. - Another source of mainsail power is sail depth.
Boat C has a deep, powerful mainsail.
Boat D has a flat sail, which generates less power (and less drag.)

Power through twist

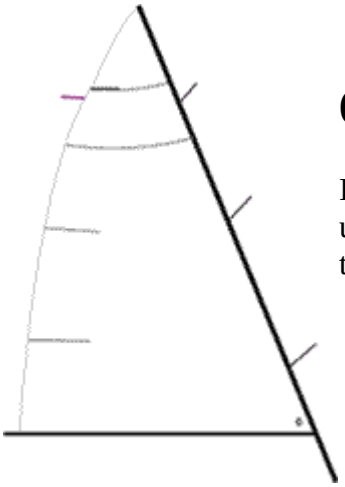
A closed leech generates more power. A twisted, or open leech, spills power. The mainsheet is the primary controller of main twist. Fig. 5.

Fig. 5 - Twist is the third control over sail power.
Boat E has an open, or twisted, mainsail, which spills power.
Boat F has a closed leech, with little twist, for maximum power.

Initially the sheet's primary impact is angle of attack, pulling the boom in. As the sail nears full trim the sheet increasingly pulls the boom down (not in). At this point the primary impact of trim is a change in twist.

Controls

The mainsail trimmer has an array of controls available to control each source of mainsail power. The next section will look at these controls one by one.



6.4 Mainsail Controls

In this section we will review each mainsail control, how it will be used to alter mainsail shape, and how it will impact the power of the sail.

Mainsheet

The mainsheet is the primary mainsail control. The sheet controls twist and leech tension; which affect power and pointing. Trimming the main also changes angle of attack and overall sail depth. The mainsheet should be trimmed so the leech end of top batten is parallel to the boom. Fig. 6. When the boom is on center line the end of the batten should point straight aft. Fig. 7.

Fig. 6 - Trim the mainsheet to put the upper leach parallel to the boom, and the telltale flying most of the time.

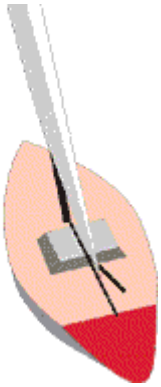


Fig. 7 - With the main at full trim the boom should be on the centerline.

Leech Telltales

From this initial setting the sheet can be fine tuned to keep the upper leech telltales flowing, with an occasional stall. Usually this telltale behavior achieves the best mix of speed and pointing.

There are conditions when performance will improve with the main slightly eased or trimmed compared to the settings described above. You never know until you try.

If the sheet is eased slightly, so the telltales never stall, then speed may increase without any loss of pointing ability. At other times, trimming to the point of stalling the telltales half the (or more) time may result in higher pointing, though the added drag will usually cause some sacrifice of speed.

Secondary Controls

As you make adjustments to the secondary controls described below you will need to check and recheck sheet trim.

Never relent. You can always go faster.

More on the Mainsheet

In light air over-trimming the sheet will stall the sail. We seek all the power the sail can generate. This means trimming just short of a stall. Fig. 8, Boat A.

In more moderate conditions, higher pointing is possible by trimming the main hard, to the point of a partial stall. There are of course limits on how hard you can trim without a sacrifice of

speed. The sheet should be eased to twist out the upper leech of the main when the boat is slow. Fig. 8, Boat B.

In heavy air over trimming the mainsheet will create excess weather helm. Some backwinding in the luff of the main is to be expected. Don't let a little backwinding trouble you - it is fast. . Fig. 8, Boat C.

Fig. 8 - Twist and power change with wind speed.
Boat A, in light air has a deep shape for power, with enough twist to ease flow.
Boat B is trimmed for moderate winds, with a tight leech and moderate depth.
Boat C is set up for heavy air with a flat sail shape and twist to spill excess power.

Boom Vang

The boom vang is primarily an offwind control. Upwind a very tight vang can add extra bend in the lower section of the mast. Snugging the vang upwind can also help control twist.

In light air a tight vang will close the leech, stall flow, and wreak havoc on performance.

We'll see more on the vang in the Reaching and Running section, below. At the end of this section we will also look at an alternative trim technique known as Vang Sheeting.

Mast Bend

After the mainsheet, mast bend is the second most powerful controller of mainsail shape. Mast bend is used to change the shape of the middle and upper portions of the sail. Mast bend is controlled by the back stay and/or baby stay and running back stays.

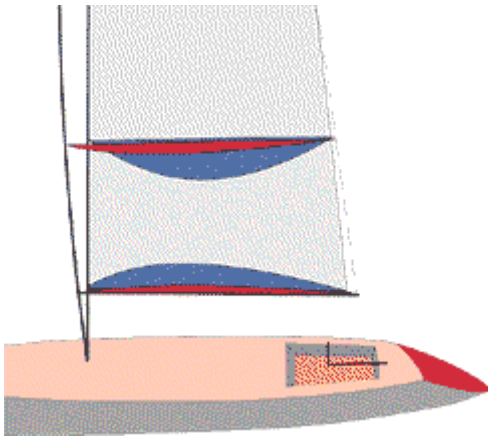
Mast bend flattens the sail by increasing the distance from luff to leech. Use bend to reduce power as the breeze builds, and for reduced drag and extra speed in smooth water. Use less bend (a straighter mast) for extra power in chop, or when sailing downwind. Fig. 9.

As secondary affects, mast bend also impacts twist and draft position. Concurrent to a change in bend the mainsheet should be adjusted to retrim leech tension; and luff tension must be checked as well.

Fig. 9 - Mast bend controls mainsail depth, particularly in the middle and upper portions of the sail. Increasing bend flattens the sail.

Outhaul

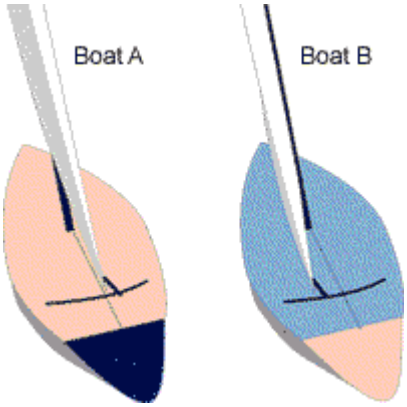
The outhaul controls depth in the lower portion of the main. The more we pull on the outhaul the flatter the foot of the sail becomes. On mains rigged with a flattening reef, think of the flattener as an extension of the outhaul, which takes over the outhaul function when the outhaul is at its limit.



The outhaul should be on part way whenever you are sailing upwind. As the breeze builds from light to moderate air the outhaul should come on all the way. The foot of the main should be stretched flat as the boat is over powered. In chop and waves the sail should be fuller for more power; in smooth water it can be set flatter for closer pointing. Fig. 10.

Fig. 10 - Use the outhaul to control shape in the lower portion of the main.

Traveler



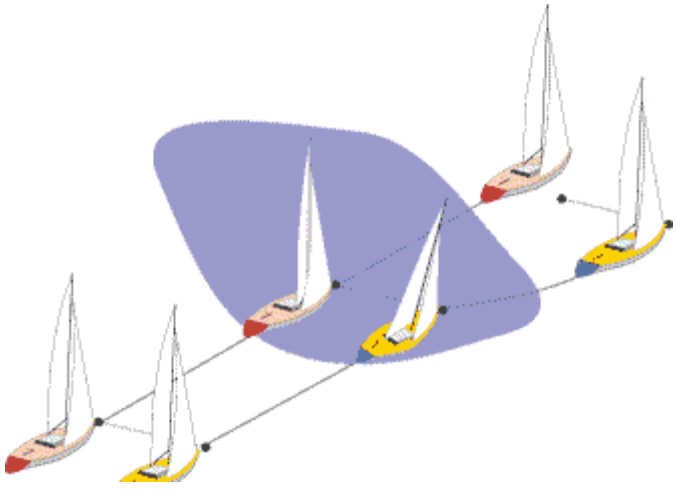
The traveler positions the boom, controlling angle of attack. Keep the boom centered (traveler to windward) until overpowered. Fig. 11.

Fig. 11 - The Traveler controls the angle of the mainsail.
Boat A - In the moderate conditions position the boom along the center line of the boat.
Boat B - On heavier air lower the traveler to control heel and reduce weather helm.

Gradually lower the traveler to leeward to control heeling as the wind builds. The boom should start centered with the #1 genoa. As you reach the upper end of the #1 the traveler may need to go down a foot or so. As the wind builds the range of play in the traveler increases. With a #3 the boom main be centered, or it may be eased to the quarter.

The traveler should be played constantly in puffy conditions to control heel and weather helm. Once the sail shape is set for the average conditions the traveler is used to make quick adjustments to overall power. Fig. 12.

There are times when it will be faster to leave the traveler set and play the mainsheet, adjusting twist, when overpowered. The preferred method depends on:



Sea State - In more waves playing twist is preferred, in puffy, smooth water

conditions the traveler is preferred.
Boat Design - Heavier, smaller keeled, smaller rigged boats respond well to traveler play. Lighter, deep keeled, over canvassed boats respond best to twist adjustments.
Ease of Use - If one is easier to adjust, and the other is a pain in the I mean difficult, then you'll probably go faster using the control that works - until you can fix the one that doesn't!
Testing - Try both techniques. Which provides better performance for you, today, in these conditions?

Luff Tension

Luff tension adjusts draft position. Adding tension pulls the draft forward. The main halyard and cunningham control luff tension. Use the halyard until you reach its legal limits, then use the cunningham. Fig. 13.

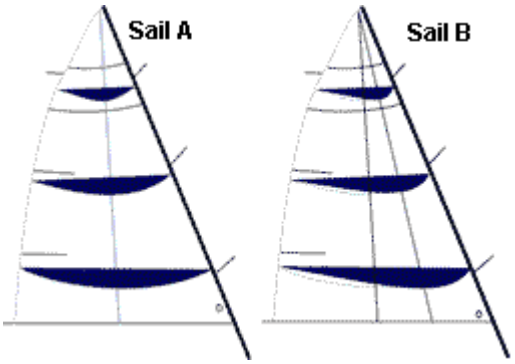


Fig. 13 - the main halyard and cunningham control luff tension and draft postition. More luff tension pulls the draft forward, less tension lets the draft move aft.
Sail A shows the draft where we want it - just forward of the middle of the sail.
Sail B shows the draft too far forward. This happens when the wind drops, or you turn down to a reach. To correct this the cunningham or halyard should be released.

Draft position is not so much a power control as it is a drag control. If the draft moves too far aft it creates too much drag. As the draft is pulled forward drag is reduced, with some loss of power.

The draft should be just forward of the middle of the sail, at 40-45%, most of the time. When overpowered try to pull the draft further forward with extra luff tension. In light air chop a more draft aft shape can help add power.

Mast bend pushes the draft aft. As you add bend add luff tension to compensate. Also, don't forget to ease luff tension when you straighten the mast. Fig. 14.

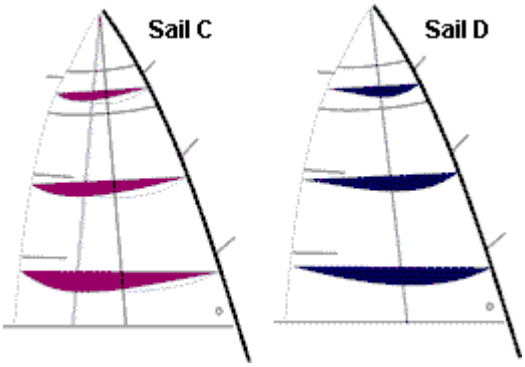


Fig 14. - The draft moves aft as we bend the mast and as the wind increases.
Sail C is a draft sail.
Sail D shows a sail with added luff tension to compensate for the impact of mast bend.

Full length battens also impact draft position. For

more on the relationship between draft position, luff tension, and battens, see the addendum to this chapter.

Mainsail Controls - Conclusion

Our goal in mainsail trim is the extract the appropriate power from the main - in balance with the jib. We also seek the optimum mix of power from the three sources of sail power - angle of attack, shape, and twist. With impact on all three facets, the mainsheet is the primary control of overall mainsail power. Fig 15.

Fig. 15 - Changing conditons call for changing mainsail shapes. The mainsheet remains our primary sail control.

Our secondary controls influence the depth, angle of attack, and overall power of the main. As adjustments are made to any one control they impact the settings of other controls.

In Chapter 8 we will look in detail at the balance between the sails and the balance among the various sources of sail power.

SIDEBAR - Vang Sheeting

Vang Sheeting is an alternative mainsail trimming method.

Conventional Trim

In conventional trim the mainsheet controls the angle of attack, and it controls twist. That is, the mainsheet pulls the boom **in** and **down**. As you near full trim the emphasis is on the down component - adjusting twist. The traveler takes over the in and out component - moving the boom to center line once the desired twist is achieved, or playing the main in and out in puffs. This technique does not rely on the boom vang as an upwind trim control.

Vang Sheeting

In *Vang Sheeting* the boom vang takes over the mainsheet's up / down control over the boom, and the mainsheet handles the in / out trim which is the traveler's domain in our conventional upwind arrangement. This technique does not require a traveler.

Vang Sheeting requires a very powerful boom vang, capable of handling the entire leech load. *Vang Sheeting* is particularly popular on two person dinghies and other boats without back

stays. When there is no back stay the vang controls mast bend as well as twist. (The vang pulls the boom down and thrusts it forward. The forward force of the boom bends the mast.)

We all Vang Sheet

On reaches we all vang sheet. On boats using conventional trim methods upwind the vang takes over control of twist once the sheet is eased, and the sheet moves the boom in and out. *Vang Sheeting* simply uses this trim method for upwind trim as well.

6.5 Reaching and Running Trim

Reaching

Upwind trim demands a balance of speed, power, and pointing. Reaching trim is simplified by eliminating concerns over pointing. Reaching trim calls for more power. Ease the outhaul and ease the back stay to add power. Don't get carried away easing the outhaul. Don't sacrifice area as you add shape.

Reduce luff tension for the lighter apparent winds and straighter mast relative to upwind sailing. Set the boom vang to control the leech of the sail. Keep the top batten parallel to the boom and try to keep flow off the leech telltales.

Most importantly, ease the sheet. Ease until the sail luffs, then trim to stop the luff; ease and trim. An overtrimmed main is slow.

In heavy air reaching dump the vang to spill the leech when overpowered, and be prepared to dump the sheet to prevent a broach. If the boom is close to the water ease the vang and keep it from hitting water. When the boom hits the water it can't be eased properly.

Running

On a run don't forget the main. While everyone fusses over the spinnaker the main is often neglected. Ease until the sail luffs or until it rests against the rig. There is no harm to the sail or rig - let it out. Since there is no flow on a run don't worry about the rig interfering with shape. Ease the back stay to straighten the mast for a powerful sail shape. Ease the outhaul to add shape without sacrificing area Set the vang to keep the top batten parallel to the boom. Ease the vang if the batten hooks in, tighten when the batten spills out. Fig. 16.

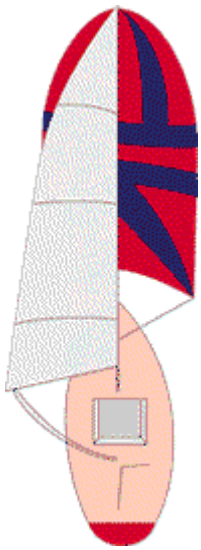


Fig. 16 - Reaching and Running
Don't neglect your main downwind. Let it out. Ease it 'til it luffs, and trim. On a run ease the sail out against the rig.
Outhaul: *Eased for power.*
Luff Tension: *Eased - draft at 50%.*
Traveler: *Down.*

Sheet Trim: *Ease to luff, then trim.*
Vang: *Top batten parallel to boom, try to keep flow.*

6.6 Conclusion

The mainsail is critical to the trim and balance of the boat. Use your mainsail to keep a balanced helm. When there is excess weather helm and heel de-power the main. When the helm is mushy and the boat lifeless power-up. The helmsman and mainsail trimmer must work together to optimize performance. The helmsman is at the mercy of the mainsail trimmer.

The next chapter covers helming. After that we'll look at trim solutions integrating the main, jib, and driver.

Addendum: Fully Battened Mains

Fully Battened Mains are Good

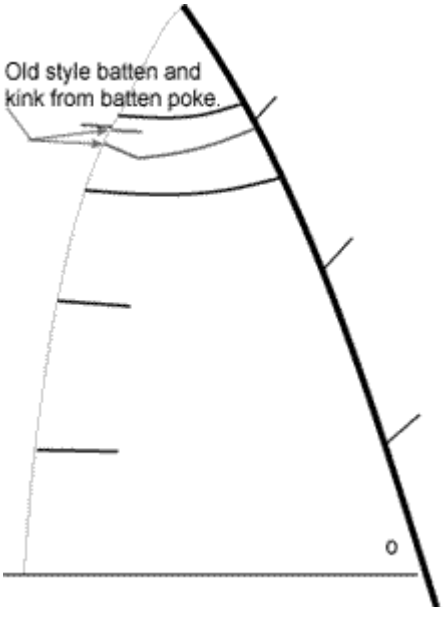
Full battens improve both the performance and the racing life of main sails. Full battens change some of our control and trim techniques, and they generally make mainsail trim easier.

Full battens eliminate some of our control over draft position. The battens' curve determines the draft position, and luff tension has little impact. At the same time, the battens prevent the draft from moving out of position, so our need for control is diminished. We can still pull the draft forward with extra luff tension, but the propensity for the draft to move aft with mast bend is reduced.

Tapered upper battens give us a sail with self correcting draft position. As the sail loads up and the draft starts to drift aft the battens soft forward section bends to hold the draft forward.

No More Poke!

The nagging problem in mainsail design and trim has been batten poke - the sharp crease and kink which develops at the inboard end of conventional battens - particularly the top batten. With full battens batten poke disappears. Kinked upper leeches are replaced by smooth even shapes. Fig. 17 - next page.



Full battens also provide a more stable platform for main sails and reduce wear from luffing and flogging. Since fully battened sails do not flog the life of a racing main will be extended enough to cover the cost of a proper set of tapered full length battens.

Fig. 17 - Full battened mains hold their own shape better than traditional mains, they are easier to trim, and they eliminate batten poke. Not only that, but they overcome the age old problem of batten poke, which gave mains a

kink at the inboard end of the upper battens. And not only that, they last longer too!

One or Two?

Not all your battens need be full length. Depending on the size and roach of your main only the top one or two battens need be full length. While you're at it, make sure they are tapered. It is worth the additional cost to get tapered battens.

Not Quite Full Length Option

An alternative to full length battens is longer but not quite full length battens. These avoid the compression and loading along the luff which full length battens create. These are an alternative to consider, particularly on boats which luff slugs or slides, although they do not provide all the benefits of true full length battens.

Keep It Loose

Some sailors complain of difficulty flattening their fully battened mains. This is most often due to putting the batten in too tight. The full length batten should be inserted with no compression. Better the batten be too loose than too tight.

Another cause of trimming difficulty is soft battens. Get stiff, tapered battens.

Conclusion

If rule makers are preventing the use of fully battened mains in your area or fleet, join the lobby in favor of full battens. They are better. Catamarans, dinghies, and windsurfers have known it for years.

Chapter 7 - Upwind Helmsmanship

7.1 Introduction
7.2 Garbage In...
7.3 Steering Upwind
7.4 Calling Trim From The Helm
7.5 Driving At Starts
7.6 Conclusion

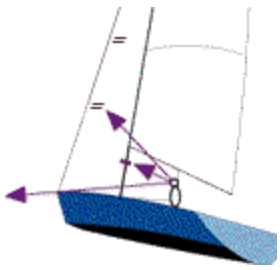
7.1 Introduction

Helmsmanship.* One of the most important and least tangible elements of boat speed. Experience and concentration are important performance factors. The ability to stay calm in situations which scream out for panic is another trait. The truly excellent helmsman not only drives fast, but is also able to call trim through the feel of the helm. The driver is often also the skipper. In that role the helmsman must surround himself with trusted crew. The helmsman must be confident in those around him so he can concentrate on sailing fast.

In this chapter we will discuss helmsmanship upwind in various conditions. We will also look at driving at starts. Chapter 13, later, covers Driving Downwind.

7.2 Garbage In...

To be a great driver you must first be able to feel how the boat is performing. Once you have that information you can respond to improve performance. There are many sources of information to draw from. The importance of each source varies with conditions. Fig. 1.



Driver info...

Boat speed

Our boat speed is the first critical piece of performance info. The best source is comparison to nearby sister ships. In mixed fleet racing this is not often available. We must make do with speed from our instruments, and comparisons to boats of similar design.

Obviously, if we are slow then we've got to do something about it. The first response at the helm is to foot off. We'll explore possible reasons for the slows in more detail below.

Fig. 1 - The driver uses the information from the seat of his pants, boat speed, jib telltales, and wind and waves ahead; along with information passed along by the trimmers and crew; to guide him in his steerings.

Pointing

If your speed is OK but pointing is a problem then changes in trim are called for. As driver you may be able to help decide what trim changes are needed based on the feel of the boat.

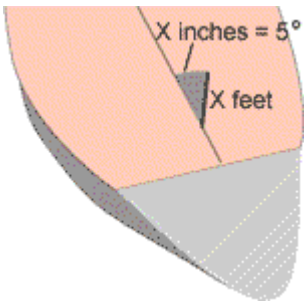
Seat of the pants "feel"

If the boat feels mushy, slow, or unresponsive you may be over trimmed. You should also be able to feel the boat lose power before it loses speed. You can respond and reestablish power. Ease the sails, and bear off if necessary.

Feel of the wind

As with seat of the pants feel, you can often feel changes in the wind before they show up as changes in performance. In a lull drive you can expect power and speed to drop. Retrim for lighter air while maintaining the best performance you can.

Feel of the helm



Weather helm is a key trim guide. If you are carrying more than 4° of helm, the boat is out of balance. (Note: On tiller boats 5° of helm is about 1" of helm per foot of tiller length. i.e. For a four foot tiller four inches of helm equals 5°. On wheel boats you will have to measure the ratio of wheel rotation and rudder turn.) Fig. 2.

Fig. 2 - When trim is properly balanced you will have less that 5° of weather helm. By coindidence, for a tiller X feet long X inches of weather helm is 5°

Angle of heel

Once you are fully powered angle of heel becomes a key performance guide. Steer and trim to maintain a constant angle of heel. Too much heel will mean too much helm and leeway.

Jib telltales

Jib telltales are a valuable trim and steering aid. You can use them a couple of different ways. The most common method is to correlate telltale behavior to performance gears, ranging from acceleration to speed, pointing, and pinching. We'll look at that in more detail in the next section.

A second way to use telltales is somewhat the reverse. When the boat is performing well look at the telltales. Steer to maintain that behavior, whatever it is.

If there is a problem with jib telltales it is that some drivers rely too heavily on them, while ignoring many of the other inputs described here.

Info from trimmers

Much of the information discussed here you gather yourself. Other information can be passed to you by your trimmers. For example, you should not be looking at other boats to compare performance - the crew should gather and pass along this information. Rather than take a barrage of info from all sides it is best to pass all the info through one or two people - the jib trimmer and either the main trimmer or the tactician, for example.

Comments from the rail

Rail crew can call incoming puffs and waves. They can also provide critical information about other boats. Of course, given the state of crew today, the information must be viewed with a high degree of skepticism.

7.3 Steering Upwind

As you tune in to the your performance information you should respond as necessary to anything which seems amiss. Your jib telltales can help you fine tune your steering to improve performance.

Using Jib Telltales to Advantage

One valuable tool for upwind performance is genoa telltales. Genoa telltales serve as a trim guide and as a steering guide. Once the trimmer has set the sail to proper shape the driver can fine tune his course to suit the boat's needs. There is more to it than simply keeping the telltales streaming. Fig. 3.

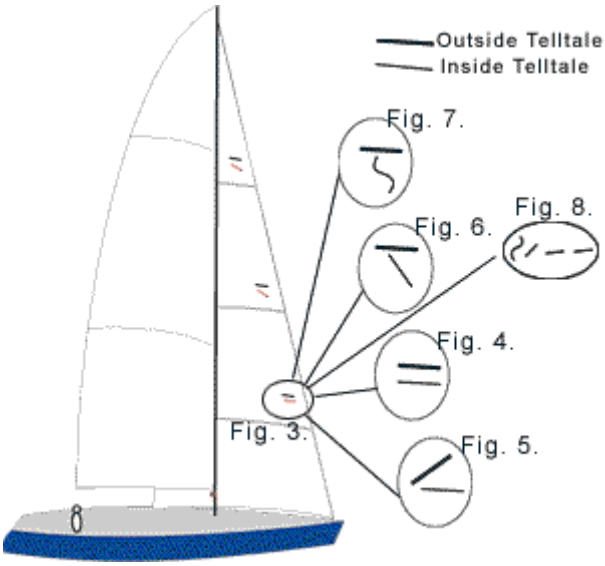


Fig. 3 - Once you are sailing in the groove with the telltales flowing you can fine tune as follows:
Fig. 4 - Sail with telltales flowing to maintain full speed and pointing.
Fig. 5 - Push down against the outside telltales for extra power and acceleration.
Fig. 6 - For extra pointing in smooth water let the telltales lift occassionally.
Fig. 7 - When overpowered feather up and let the telltales luff to help depower.
Fig. 8 - Gentry Tufts are a series of short telltales which can help more narrowly define the steering groove.

Full Speed Mode

The baseline is sailing at full speed, with the telltales streaming. This course will hold full speed. Fig. 4.

Acceleration Mode

Slightly lower than a full speed course, in Acceleration Mode the outside telltales will dance. By "pressing down" against the jib the boat will be fully powered. This extra power improves acceleration out of tacks and through chop. Fig. 5.

Point Mode

Slightly higher than Full Speed Mode is Point Mode. Here the inside telltales will rise (but not luff). The goal is to hold this slightly higher course without sacrificing speed. At the first sign of a loss of speed it is best to slide back down to Full Speed Mode. If you are slow to respond the bottom will fall out, and you'll need to fall all the way down to Acceleration Mode to rebuild speed. Fig. 6.

Pinching and Feathering

Higher than Point Mode is pinching, with the inside telltales luffing. You are pinching if you force the boat up and lose speed. More time and distance is lost through pinching than through any other single flaw in driving. Don't do it.

Feathering, on the other hand, is OK. The telltale behavior is the same as for pinching - the inside telltales luff. The difference is that you feather as a way to depower in heavy air. You are feathering if you don't lose speed. If you slow down you are pinching. Fig. 7.

Gentry Tufts

Gentry Tufts are a string of several short telltales used in the place of a single lower telltale. They provide more subtle information about where on the sail flow is becoming attached. Use them to more narrowly define your steering groove. If you find you have a great balance of speed and pointing when the front tufts are luffing, and the aft tufts are streaming then steer to maintain that behavior. Fig. 8.

Tacking

A slow smooth turn initially, coasting upwind to carry speed; with a faster turn through the second half. Settle immediately and drive off slightly to accelerate. Work with your trimmers to quickly get back up to speed. Keep it smooth.

In waves a sharper turn is needed to get the bow around. First look for a smooth spot. Start the turn heading into a wave trough. The bow will pop out as you hit the crest of the wave and (hopefully) cross the wind before the next wave hits. This way the next wave helps you complete the turn rather than pushing you back onto the old tack. (See figures in Chapter 4 - Upwind Boat Handling.)

7.4 Calling Trim from the Helm

It is not enough to simply steer fast. A good driver will also provide feedback to the trimmers to assist in improving trim.

The helmsman has the most direct feel of how the boat is performing. He must help call trim by giving details of the feel of the boat. Is the groove to narrow or too wide? Do you have enough punch in the waves? Do you feel you should be pointing higher? Is the helm properly balanced?

For the trimmers to trim properly the helmsman and trimmers must communicate and understand the relationship between trim, helm, and performance.

Narrow or Forgiving

If the steering groove is narrow and the telltales won't settle down then the jib may be over trimmed or too flat for the conditions (or the helmsman). The easiest way to widen the steering groove is to ease the sheet an inch or two. You can also create a rounder, more forgiving entry shape by tightening the halyard, or sagging the headstay. Fig. 9.

Fig. 9 - With the halyard esed and the sheet trimmed hard the sail will have a narrow high pointing angle of attack.

Of course, if you are going fast and pointing high, who cares that the boat is hard to settle. Live with it.

If the steering groove is wide and the boat is not pointing well try a flatter entry shape and narrower slot. Trim the sheet, tighten the headstay, and/or ease the halyard. In smooth water you will be able to steer to a narrower groove than in wavy conditions. Fig. 10.

Fig. 10 - A tighter halyard (and eased sheet) will create a more forgiving angle of attack for easier steering in wavy conditions.

Proper Power

If the boat feels sluggish, and lacks punch in the chop, the driver must call for more power. Conversely, if the boat is overwhelming the helm you are overpowered.

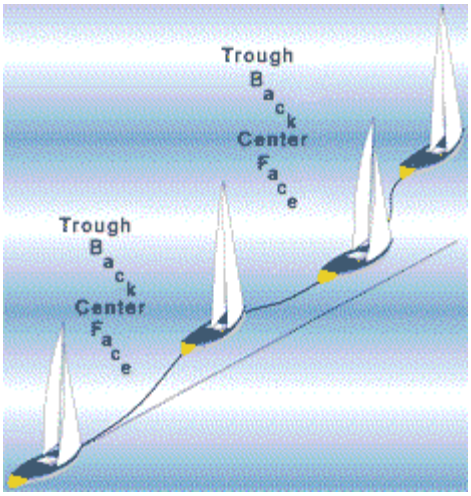
There are many ways to change the boat's power - through sail shape, twist, and angle of attack for each sail. In Chapter 8 we will look at how to balance each type of power.

Weather Helm

If you are carrying more than 4° of weather helm your trimmers need to know. To reduce weather helm flatten your sails, add twist, or reduce angle of attack by easing the traveler. (Which to do? - see Chapter 8, next for ideas)

Wind & Waves

In heavy air and waves we want to keep the boat in the water and prevent it from pounding through the seas. You do not really steer through the waves. Set the boat up with proper trim and it will find its own best path. Fig. 11.

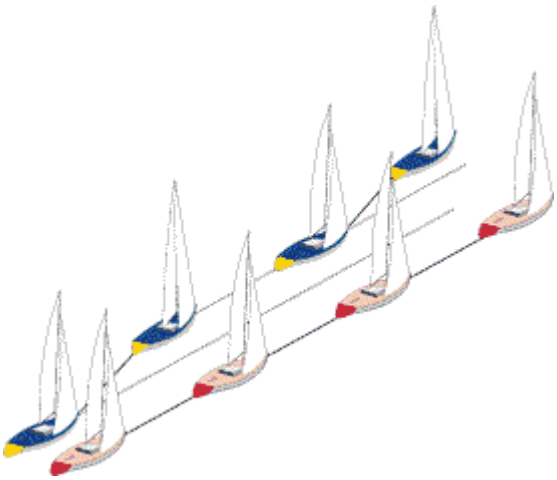


Weather helm can be used to head the boat up for each face. Rather than force the boat up with the helm the boat should be trimmed with enough weather helm that it heads itself up for each wave. In order to bear off the weather helm will have to be relieved for a moment by lowering the traveler or easing the sheet. To head up pull the traveler up, or trim the sheet. Steering with the sails and using the natural weather helm of the boat is much faster than pushing the boat around with the rudder.

Angle of heel is an excellent guide for steering in these conditions. The proper angle of heel will create appropriate weather helm to match the size and period of the waves.

Fig. 11 - A properly trimmed boat will almost steer itself through waves. Trim in enough weather helm to bring the bow up for each swell. In chop this won't work. Just crank up the power, put the bow down and, and crush the chop

In short chop it is not possible to get the bow up for each wave. Crank up the power, put the bow down, and crush the chop.



Turbo Sailing

Point higher without giving up any speed! Enjoy the rewards of Turbo Sailing!

In smooth water beating with the crew on the rail try forcing the boat to point higher. It will, without any loss of speed. Turbo Sailing works best in ideal sailing conditions - smooth water and enough breeze to get the crew fully hiked without being overpowered. Get your boat sailing at normal speed and angle, and then head up slightly. Turbo Sail until the first sign of diminished speed or power; then bear off immediately to power up and rebuild speed. Experiment with trim to find out if extra mainsheet tension or flatter shapes helps you hold the higher angle. And beware the first sign of a lull or chop. Nothing is as slow as trying to Turbo Sail in Non-Turbo conditions.

Turbo Sailing offers improved performance in special conditions. The next time you're racing upwind in smooth water with the crew on the rail give it a try. But don't try to force it when the conditions aren't right. Fig. 12.

Fig. 12 - Turbo sailing involves trimming hard and flat, and sailing slightly higher without any sacrifice in speed. It only works in ideal, smooth water, moderate air conditions.

7.5 Driving at Starts

Starts are chaos. Driving at starts requires that you focus on factors affecting your start. You should know which way you want to go after the start, and you should know which end of the line is favored. You need to anticipate and keep clear of crowds.

You need proper position against the boats closest to windward. You need to create a space to leeward. You need to keep clear air, and judge the time, speed, and distance to the line. Fig. 13.

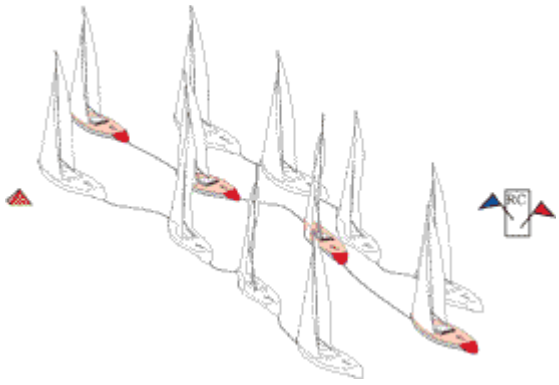


Fig. 13 - Driving at starts requires timing, judgement, and teamwork. It also requires focus. Sail your boat. Ignore the chaos around you.

Make a Plan

You need a starting plan, and your crew need to be ready to put the plan into play. You must pick a spot on the line, select an approach that will get you there.

Starts require free form boat handling - you never know what will happen next. A well organized and prepared crew will allow you to take advantage of opportunities as they present themselves.

Sail Your Boat

Don't be distracted by the madness around you. Sail your boat. Don't talk to other boats - assign that chore to someone else. Sail your boat. Don't be late, don't be timid, don't worry about the crowds. Work with your trimmers. Sail your boat.

Your tactician should look ahead and tell you where crowds are forming, and what to expect in the next 30 seconds or minute. He should also look behind, and warn you of following traffic.

Your foredeck crew should call the line, signalling distance to go. Trimmers should keep the boat at full speed, and avoid the common mistake of overtrimming in the confused seas and disturbed air of the start.

Practice Drills

Starts are hard to practice. It is tough to get enough boats out to get a realistic set up. There are several drills you can use to train for starts.

Stop and Go

From a close hauled course luff you sails and coast to a stop, then trim and accelerate to full speed. How long does it take? How much distance do you cover? Obviously that will vary with the wind and seas. Fig. 14.

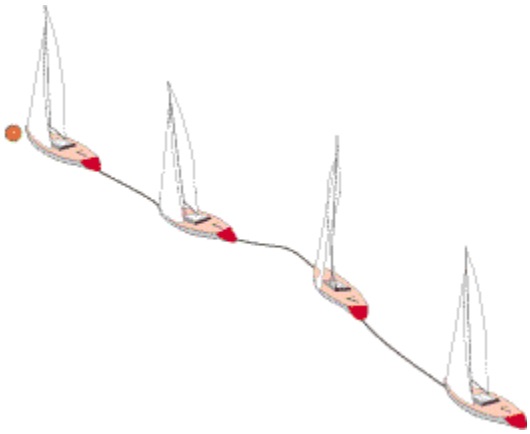


Fig. 14 - The Stop and Go drill is used to practice trimming and accelerating at starts. How long will it take to accelerate to full speed at a luff? How much distance will you cover? Practice to find out.

Trimming from a stop it is best to trim the jib first, and following with the main. If the main is trimmed first it tends to push the bow up into the wind, and you will need to pull the bow down with the rudder, which is slow. Trimming the jib first holds the bow down, for better acceleration.

Variations on Stop and Go

Once you are comfortable with the Stop and Go try these variations:

Try trimming while holding hard on the wind, as though there were a boat close to leeward. Also try the Go-Stop-Go. From full speed stop as quickly as you can - push out the main as an air brake - and then accelerate to full speed again. This can be a handy way to kill time, or to break an overlap so you can dive below a leeward boat.

Practice Approaches

Use a buoy as your chosen starting spot, and practice various approaches to it. From a distance try to guess how long it will take to get to it. With a little practice you can become quite good at this skill, and it is a great help at starts.

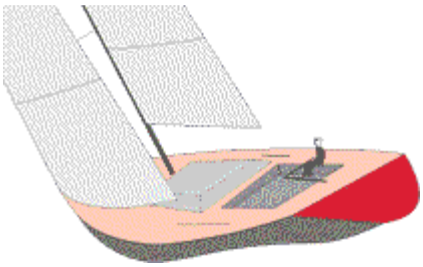
More Practice

Try a 360¡ turn, and see how long it takes. Do you end up where you started?

Also pretend you were over early, and circle back for a restart.

7.6 Upwind Helmsmanship - Conclusion

Helmsmanship is a subtle skill requiring practice and concentration. A relaxed yet acute awareness is needed to be able to sense what is going on with the boat. To build sensitivity practice steering with your eyes closed. Feel the boat through yours hands, seat, hair, feet, and inner ear. Go ahead and laugh, but try it.



The best helmsmen are those who have surrounded themselves with great crew, so they can focus their attention on driving. If you want to be driver, tactician, and sail trimmer then race single handed. If you really want to look around and do tactics, get off the helm. Fig. 15.

Fig. 15 - The best drivers focus their full attention on driving, and trust their crew to take care of everything else. Great drivers require great crew!

You can order this great book called Performance Racing Trim in it's entirety.

You can order on-line here or Contact:
Bill Gladstone
P.O. Box 1169
Evanston, IL 60204-1169
BGSailing@aol.com