A Laser Training Manual

by Dr John R Anderson

CONTENTS

INTRODUCTION

This training manual has been produced to assist those intending to conduct training clinics for Lasers. There has been a concerted effort by the Australian Laser Association over the last few years to lift the standard of Laser sailing by organizing and running instructional courses. They are to be commended in their efforts to foster and encourage the free exchange of ideas and mutual assistance within the class which is a feature of the one-design sailing in Lasers.

The people attending these courses have widely different backgrounds and experience in Laser sailing. Some may be rank beginners, perhaps in their first year of racing at club level. Others may regularly come in the 20's at State or National Championships, and may see the course as an opportunity to refine their techniques so that they can challenge for places in the top 10 positions. This large range of experience and expectation causes major problems for the organizers of training clinics because of the need to cover the basics without boring the experienced sailors, and the more detailed principles without moving too quickly for the beginners. This manual is intended to fulfil this need by providing the basic theoretical background information to Laser owners who may have only been racing at club level for one or two seasons. It is suggested that this manual be set as the text book which should be read by those enrolled in the course in the weeks prior to it taking place. Hopefully, all the participants would then understand the basic principles, and consequently, there would be a firm foundation of common knowledge upon which the clinic can build. In addition the manual may also may helpful to those attempting to improve the standard of their Laser sailing without participating in formal courses.

The notes were originally written for a Laser Training Clinic I conducted for a group of Canberra Laser owners who had been racing for one or two seasons. They were frustrated by their lack of improvement. None of them had benefited from observing how the experts rigged and sailed their Lasers by taking part in State or National Championships. Many of the ideas and hints included in these notes came from the first clinic conducted by the Australian Laser Association just prior to the 1982 Australian Laser Championships. My objective in conducting the clinic was to pass on this knowledge and thereby encourage the inexperienced sailors and hopefully improve the standard of Laser Sailing in Canberra to the benefit of all the Laser fleet.

I am indebted to the organizers and participants of this first National Laser Sailing Clinic for much of the information included in this manual. The remainder comes from my own experience in sailing in both State and National Laser Championships over the last four years.

The notes assume a certain amount of understanding of sailing terminology, which the beginner may find difficult without reference to a glossary. The manual is directed towards people who have had some experience in sailing Lasers, but it is not intended to provide a complete course on advanced Laser sailing. Nevertheless, the more experienced sailors may still find it useful in crystallising their own ideas and in stimulating discussion.

Two new sections have been added

- Section 2.1.1 Summarizes the new interpretations for Rule 42
- Section 3.6 briefly describes the rule changes allowing revised rigging for the cunningham, outhaul and vang.
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ENJOY ! SAIL FASTER AND ENJOY MORE !

CHAPTER 1

RIGGING A LASER FOR RACING

As supplied by the builder, the Laser is equipped for sailing but not for highly competitive racing. Although the one-design rules for a Laser are very strict, the sail adjustment methods can be refined by using appropriate techniques and ropes of the correct type and size. Certain other steps can be taken to ensure that the rudder, tiller, centreboard and hull are working optimally. Figure 1 shows the basic controls and rigging technique for a Laser. In this first chapter I will discuss some of the alternative methods for rigging a Laser and the function of the sail controls

1.1 Ropes

All rigging ropes should be replaced with 6-Smm diameter, pre-stretched rope of high quality. Rope that stretches, or is inflexible and stiff, is useless for control lines. Rope 6mm in diameter is ideal. It is easier to tighten than thicker rope and is still large enough so the lines will not slip in the cleats, provided all plastic cleats, including the one on the boom, have been replaced by metal ones of the same design. 6mm rope wears out reasonably quickly and so the lines need to be checked frequently and completely replaced before major championships. A complete re-rigging of your Laser will require 15-18m of rope; more or less depending on the specific rigging systems you decide to adopt for each of the controls. Apart from wearing out, and a tendency to slip in plastic cleats, the other major disadvantage of 6mm rope is that it is hard on your hands. Always wear good quality gloves when sailing. Also, each of the control lines should be terminated with double-thickness, bowline loops, about 14 cm in diameter. These loops provide convenient handles for gripping the rope and applying high tensions. These loops are especially required for the Vang, cunningham and Traveller control lines. See Section 3.6 for the rules changes and some ideas for creating extra purchase for these controls.

All lines should be made long enough so that they reach well into the cockpit so that you can apply maximum force by bracing your feet against the inside of the cockpit and using your body weight.

1.2 Clew Tie-Down

The clew-tie down is probably the most neglected piece of equipment on a Laser. If the clew tie-down is loose, as it is on most boats, the clew of the sail rides well above the boom and you will be sacrificing a vital few centimetres of leech tension and mast bending for depowering the sail. The clew tie-down should always be very tight; the grommet should almost be touching the boom. There are several ways of achieving this. The ideal system should be capable of achieving maximum tightness while being easy to attach and remove. The system should also produce minimum friction when the outhaul is being adjusted. The traditional system using the two metal fittings is hard to remove and does not produce the required tightness. There are two alternative methods in common use which fulfil the requirements (Fig. 2).

BASIC CONTROLS

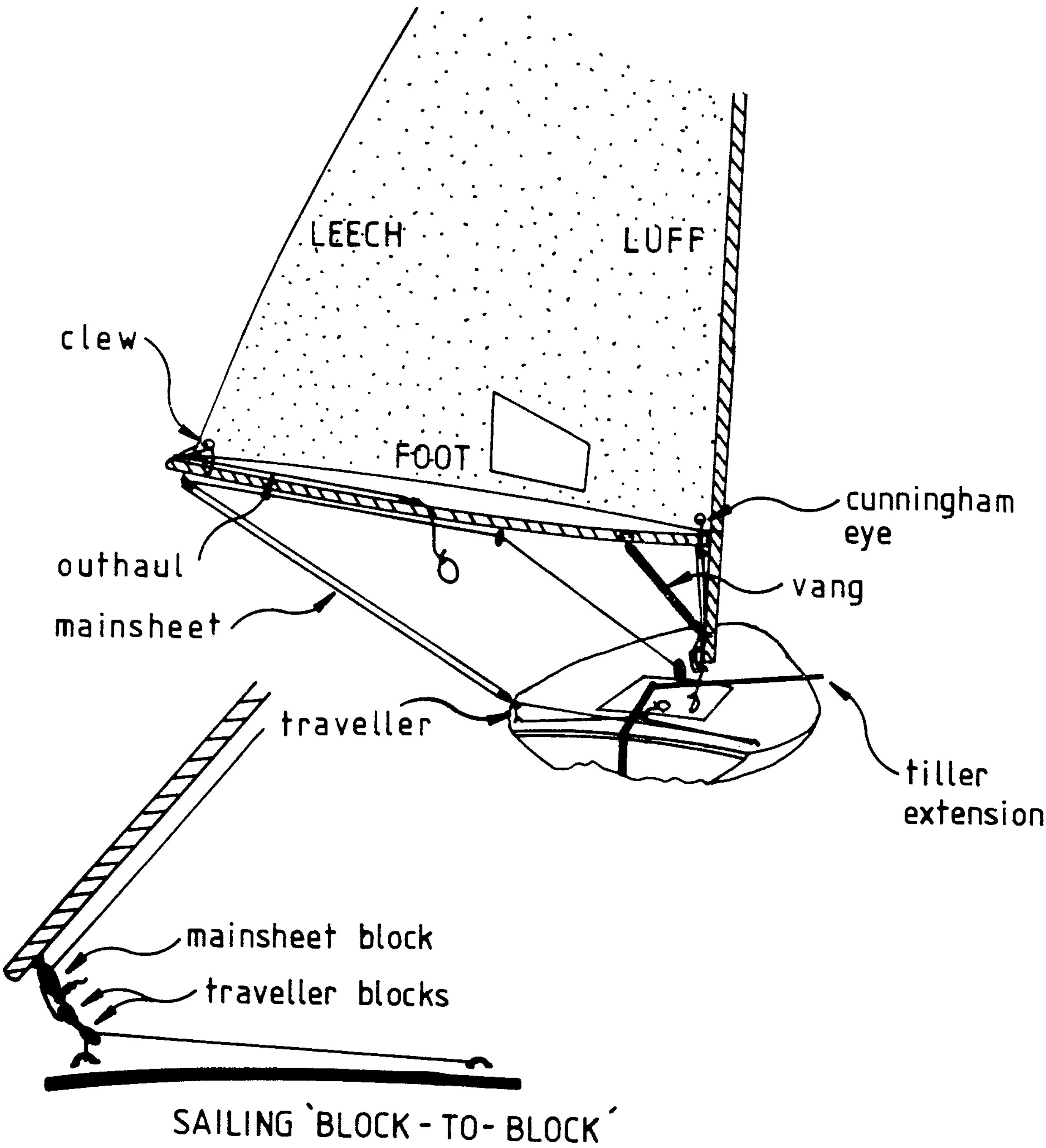
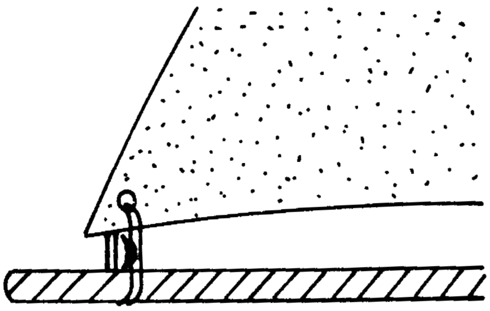
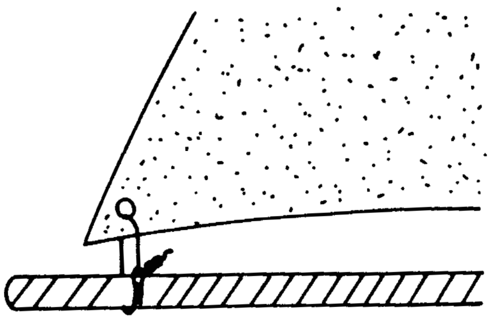


Fig. 1 Basic controls on a Laser. The lower part of the Figure shows what is meant by sailing 'block-to-block1. When the mainsheet is ended in a figure-of-eight knot, the mainsheet can be tightened so that the mainsheet and traveller blocks come together.

CLEW TIE-DOWN

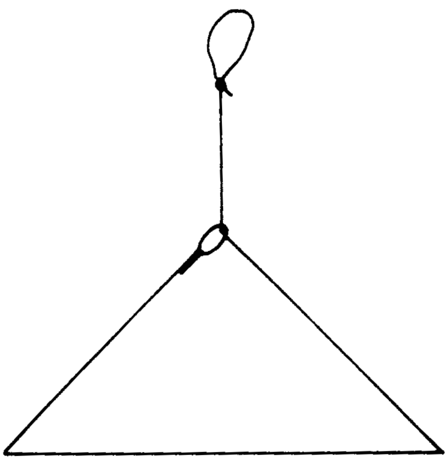


Method A

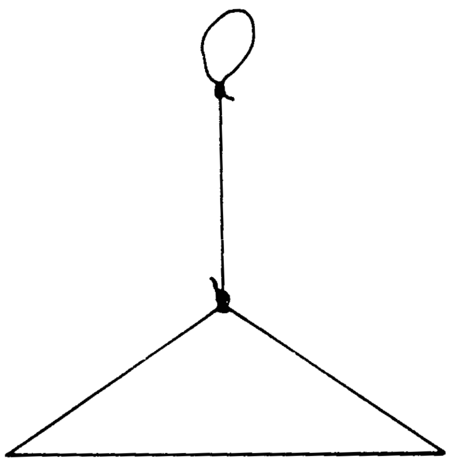


Method B

TRAVELLER



Loop Method



Bowline Method

Fig. 2. Alternative methods for tying the clew tie-down and traveller lines. The clew tie-down should be very tight. Both method A and B provide for easy tying and release.

<u>Clew Tie-Down</u>

Method A - This method requires about 50-60 cm of pre-stretched rope, 4-mm in diameter. The rope is twice passed through the grommet and around the boom and secured using a reef knot. Make sure that the clew tie-down is tied so that is lies inside the outhaul adjustment line. Also the knot should be tied on the opposite side from that of the outhaul line to ensure that the outhaul adjustment can be made without interference.

Method B - This method requires 30cm of pre-stretched rope, 6mm in diameter. Bind a loop in one end, with a diameter of about 20mm. Tie a figure-of-eight knot in the other end at a position appropriate for achieving the desired tightness of the clew tie-down.

The clew is attached to the boom by passing the knotted end of the line through the grommet, around the boom, and back through the bound loop. Once tension is applied, the knot will never slip out of the loop. This system is easy to use and leads to minimum friction in the outhaul adjustment.

Another couple of points may be worth considering. Firstly, adding a little silicone lubricant to the clew tie-down may also help to reduce friction and so assist in making the outhaul adjustment. Before leaving the beach, the clew tie-down rope should be angled in the direction you expect the outhaul will have to be adjusted during the course of the race. This will again make the outhaul adjustment easier.

Traveller

The bowline method of tying the traveller (Fig. 2) provides for a larger mechanical advantage and no slippage, and therefore ensures that the traveller is as tight as possible in moderate to strong winds.

1.3 Centreboard and Rudder

The rudder and centreboard should be carefully examined to ensure that all surfaces are smooth and the sections are symmetrical. Minor adjustments can be made to the centreboard and rudder within the rules by way of sharpening, or maintaining the trailing edge and repairing damage provided the thickness of profile are not changed. Vibration of either the rudder or centreboard when planning are signs that the blades need to be checked. The trailing edges should be kept true, without dings to produce a more efficient hydrofoil. The training edge of the centreboard cannot be sharpened as much because of the possibility of damage when the edge rubs against the back of the centreboard case. Tie a piece of shock cord from the front of the centreboard to the cunningham fairlead. This will ensure that the board will not be lost in a capsize, and it also helps to stop the board slipping up and down when the board is raised. Applying a little silicone glue to the front bottom edge of the centreboard case also helps to prevent the board from slipping.

1.4 Mainsheet

Use a figure-of-eight knot instead of a bowline when securing the mainsheet to the end of the boom. This will allow the boat to be sailed block-to-block, that is with the mainsheet and traveller blocks touching (Fig. 1). Incidentally, the two traveller blocks should be taped together to prevent them twisting and fouling on the traveller rope.

It is important to have a mainsheet which is of the right length and diameter. A general purpose mainsheet consists of about 13-15m of good quality, soft-ply rope, 10mm in diameter. You should choose rope which is supple and hopefully does not retain too much water when wet. Some people have two or more mainsheets for different conditions and use very fine rope (8mm) when conditions are very light. The thinner rope moves more easily through the blocks, especially when sailing on the reaching and running legs of the course. However, the thinner rope is harder on your hands so that

10mm is recommended as an all purpose mainsheet.

The mainsheet should be long enough to allow the boom to go slightly 'over-square' (beyond 90 degrees to the midline of the boat) when running in light winds. Doing this will help keep the boom out when the boat is heeled to windward and will also prevent the mainsheet from dipping in the water. Heeling the boat in this way provides a little extra speed. Another key point when selecting a mainsheet length is to allow an extra metre or so to permit the sheet to be passed through the mainsheet block at the front of the cockpit, and then secured with a bowline around the toe-strap adjustment line at the back of the cockpit. This is better than simply ending the mainsheet with a figure-of-eight knot at the mainsheet block. Eliminating the free end means that all those bothersome knots which seem to always form in the mainsheet, will be ' pull-through' knots!

When you are learning to sail a Laser the effective length of the mainsheet should be progressively shortened as the wind speed increases. This is done by tying the bowline so that there is a progressively longer free end at the back of the cockpit. Reducing the mainsheet length, reduces the maximum boom angle, and will help prevent a capsize, if you accidentally drop the mainsheet when running or gybing. The Laser is almost uncontrollable when the boom angle is 90, or beyond, while running in winds over about 15 knots! Under these conditions reduce the mainsheet so that the maximum boom angle is 70-80 degrees.

One additional point to remember is that an extra long mainsheet will be required if you are in the habit of gripping the mainsheet before it passes through the mainsheet block when sailing on the reaches and runs. This allows for more sensitive control of the mainsheet tension than gripping the mainsheet after it passes through the block. To accommodate all these requirements, you should purchase slightly more mainsheet than you think you will need and trim off the excess after you have sailed with it.

1.5 Traveller

The traveller should be rigged with about 3m of pre-stretched rope, 6mm in diameter. A bowline should be used to form the loop passing through the two traveller fairleads, rather than the system using a bound loop (Fig. 2). Using a fixed bowline considerably increases the mechanical advantage that can be applied to the traveller and eliminates slip. Making the loop as small as possible maximizes the mechanical advantage.

After passing the rope through the traveller cleat, another bowline loop should be tied to provide a handle.

There has been a considerable change in thinking about the traveller control on a Laser over the last couple of years. The main trend has been towards having a tight traveller under most conditions. Due to the simplicity of the traveller system, the only way of changing the lateral position of the traveller blocks, and the sheeting angle of the boom, is by increasing or decreasing the tension on the traveller rope (Fig. 3). The traveller is now carried tight, to very tight under almost all conditions, ensuring that the boom is carried at the greatest angle possible when sailing with the mainsheet tight. A wide boom angle leads to a reduced heeling component and an increased forward component of the total force produced by the action on the sail, compared with narrower boom angles. This means greater speed and less heeling when sailing to windward, but some loss of pointing ability. A tight traveller is essential in winds over 15 knots because easing the traveller is equivalent to easing the mainsheet causing loss of leech tension and ability to flattening the sail.

The most depowered sail can only be achieved when sailing block-to-block with high traveller tension, so that the boom is at the widest possible angle for the mainsheet tension. The traveller tensions required are such that the traveller will begin to saw through a wooden tiller. Consequently the tiller needs to be replaced with a metal one, or a protective metal or teflon strip added to the top of the tiller. A home-made tiller which has been designed to only just clear the traveller cleat when fitted to the rudder, means that the traveller can be tightened just a little bit more. Round-section tillers are preferred because of the reduced friction generated against the traveller rope.

Under what conditions should the traveller be eased? Essentially, the traveller adjustment provides a mean the draft of the sail without losing pointing ability. In winds of 5-10 knots, you will need a relatively full sail to maintain hull speed when sailing to windward, but you will also need to point as high as possible. Easing the traveller and continuing to sail block-to-block (with the boom higher off the deck) will the permit both a full sail and a narrow boom angle. Simply easing the mainsheet will produce a fuller sail, but the boom angle will be increased with loss of pointing ability. Moderate winds are the only conditions when you should consider easing the traveller. In winds over 10 knots a tight traveller is required for flat sails and wide boom angles.

Remember that under the rules no attachments, devices are permitted which would further assist or movement of the traveller block on the traveller line. However there is enough friction in the system, under mainsheet tension for the traveller blocks to be retained in a variety of positions, without changing the traveller tension. So it is important to ensure that the traveller blocks have gone completely outboard before applying mainsheet tension after a tack. This friction can be used to provide for a temporary adjustment to the boom angle when sailing. For example, if you require a higher pointing angle to lee-bow an opponent, or to squeeze up to the mark, you can achieve it by pulling the boom inboard a little. In moderate winds the traveller blocks will generally stay in this new position. The boom can be pushed outboard again after the manoeuvre by using your foot. This method of obtaining temporary traveller adjustment is far better, than adjusting the traveller tension itself, because the mainsheet will have to be released before the traveller can be tightened.

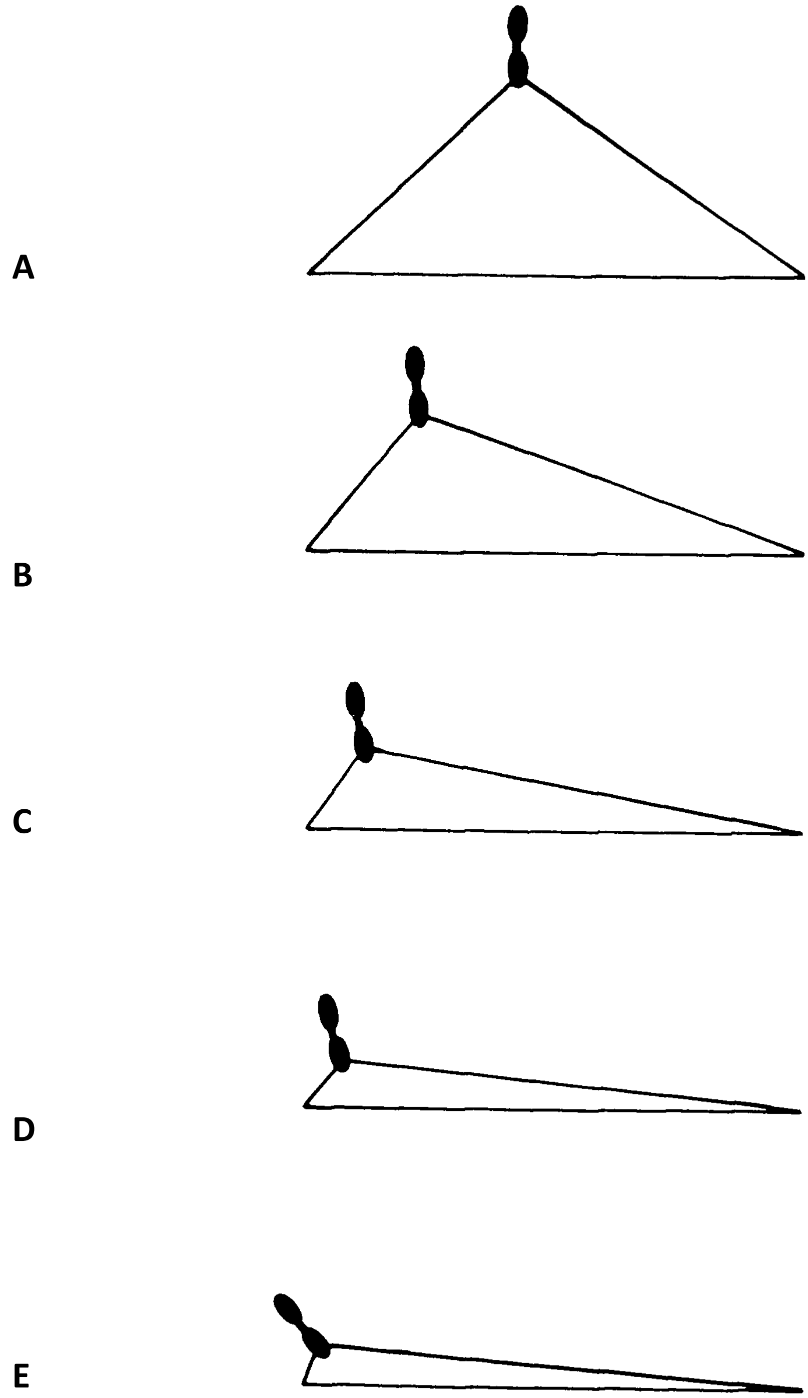


Fig. 3 Tightening the traveller shifts the position of the traveller blocks outboard and also reduces the height of the blocks above the deck. On a Laser the outboard position and height of the traveller blocks, and consequently maximum leech tension, are synchronized. The traveller should be tight (D and E) under most conditions.

1.6 Tiller and Tiller Extension

Make your own tiller and extension, or purchase one of the specially designed units supplied with the Laser Racing kits. This is the one and only chance (apart from the rope tricks for the cunningham, outhaul and vang) you have under the rules to express your individuality! The tiller and tiller extension are not restricted in any way, except that the tiller must be removable from the rudder head, and it also must be 'straight'. Under the rules, a tiller is 'straight' when there is no deviation from a straight edge placed along the topmost edge of the tiller between rudder head and the forward end of the tiller. This means that can not cut a groove in the tiller, or bend it, to reduce the friction caused by the tiller rubbing against the traveller, or to otherwise allow the traveller block to pass over the tiller more easily. However, this rule does not prevent an anti-wear strip, up to 20 cm long, being attached to the tiller, provided the strip is above or level with the upper surface of the tiller. The only other requirement is that the tiller should have a cleat of any design for securing rudder down-haul rope.

You should ensure that the tiller fits tightly into the rudder so that the rudder action is firm and direct. Wedges could be added to the aft end of the tiller so that the tiller is carried as low as possible over the deck and there is no lateral or horizontal play in the attachment to the rudder.

1.6.1 Tiller

The tiller should be made from square, or round section aluminum tubing. Generally the tiller should be slightly longer than the standard wooden on supplied with a new Laser. Many people use a tiller which only just extends into the cockpit when attached to the rudder, but I recommend a slightly longer one because it seems to make the steering easier (Fig. 4). The tiller should extend 15-23 cm (6-9 inches) into the cockpit. This length represents a compromise. The further into the cockpit the tiller extends, the greater the mechanical advantage for rudder movement, as the angle between the tiller and the extension approaches the optimum of 90 degrees when steering from a fully hiked position. A longer tiller also provides a handle for steering from the back of the cockpit on offwind legs in stronger breezes. It is better to grip the tiller directly, leaving the extension folded back aft, when trying to keep the Laser planing under these conditions. However a tiller that is too long will hinder steering and may interfere with tacking and gybing.

Place the cleat for the rudder down-haul as close to the rudder box as possible. This reduces the length of the down-haul rope and ensures maximum tension in the rope which reducing stretching. Most Laser sailors are extremely fussy about keeping the rudder fully down. Some people add extra purchase systems in the down-haul rope.

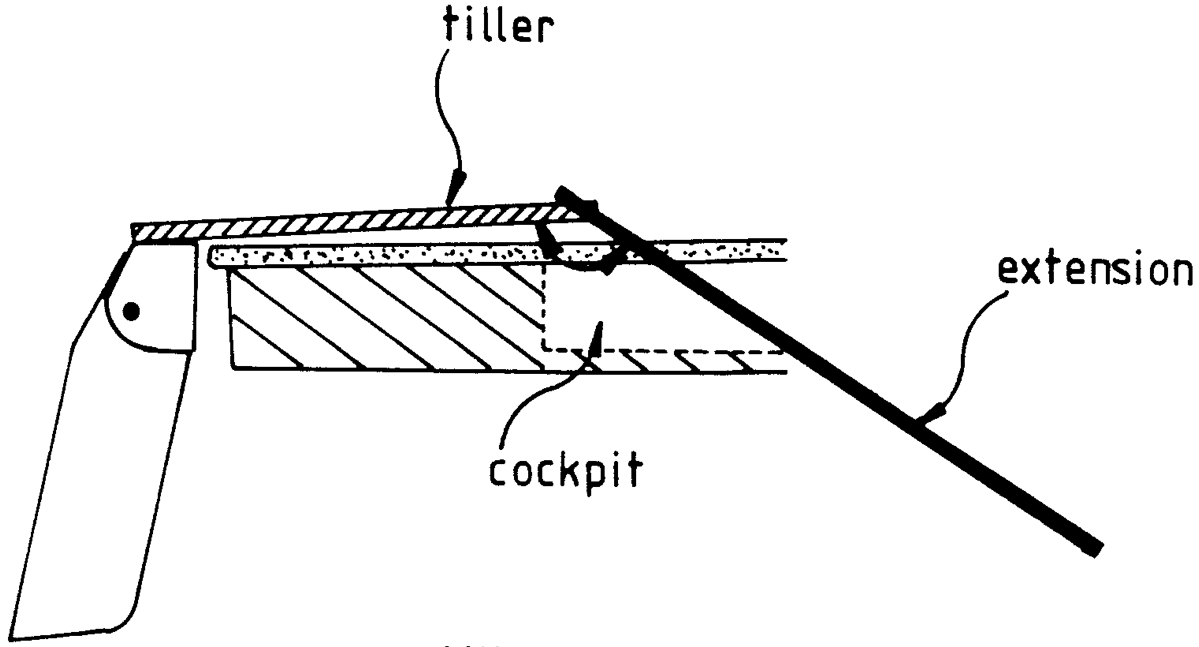
Ensure that the bolt through the rudder box is tight; it should require some force to rotate the rudder in the box. This will help to prevent the rudder from splitting, or the bolt from bending and eventually breaking. Tightening the bolt also ensures that the rudder action is firm.

1.6.2 Tiller Extension

Make your own tiller extension using aluminum or PVC tubing or purchase one of a suitable design. Adjustable or telescopic tiller extensions are not recommended as they have a habit of failing at the worst possible moment. Once you have selected the length you require, there is no need to change it during a race. Start with a tiller extension that is 30-40 cm longer than the total length of the tiller and then gradually trim it down to the size that is ideal for your particular height, body shape, and hiking style. Most people use an extension which is about 100-200 cm long (about 42-46 inches). The length of the tiller extension is determined by the need to steer correctly when fully hiked and sailing upwind. The tiller extension should rest on your shoulder when you are fully hiking from the front of the cockpit with your torso angled at about 120 degrees to your straight legs. Avoid having the tiller extension so long that it is awkward for tacking or gybing. Ensure that the extension is large enough to provide a firm grip, or add tape or some other covering to prevent the extension from slipping in your wet hand when steering.

TILLER AND EXTENSION

A



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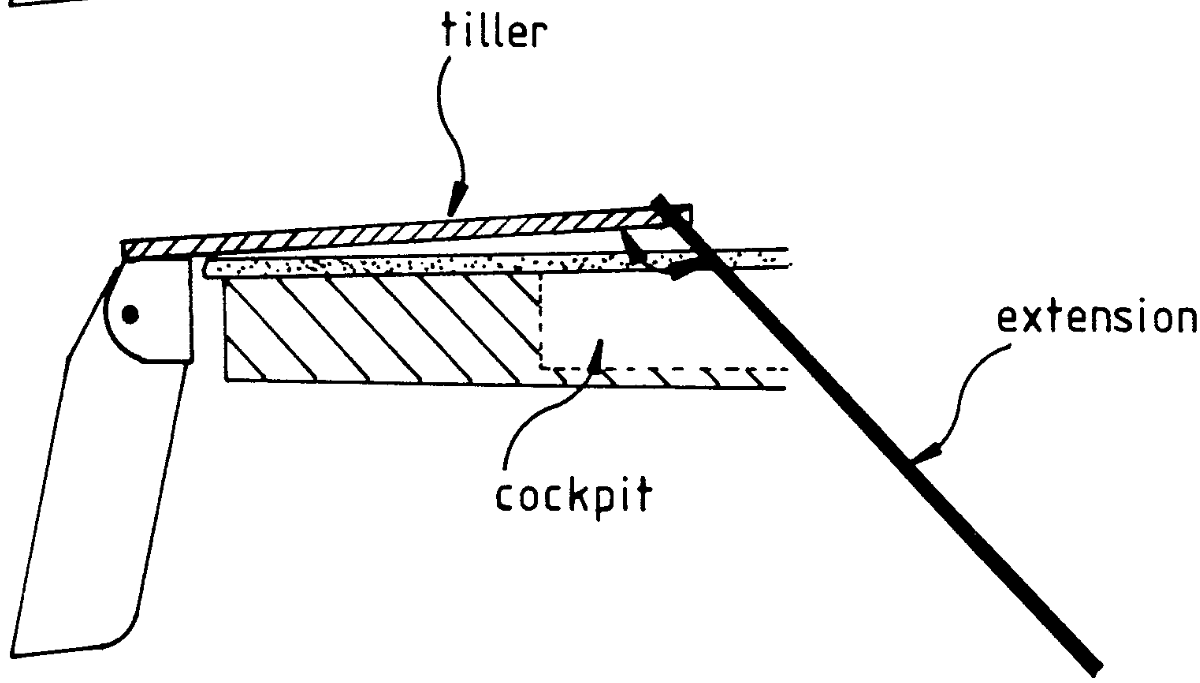


Fig. 4 Increasing the length of the tiller so that it extends about 20 cm into the cockpit decreases the angle between the tiller and extension when steering from a fully hiked position. This increases the mechanical advantage of the tiller movement and so reduces the fatigue when steering.

CHAPTER 2

STEERING AND HIKING TECHNIQUES

2.1 Steering Techniques

Steering is probably the most critical aspect of Laser sailing techniques. Beginners find it most difficult to master and this has a detrimental effect on their upwind performance, especially in waves. Lasers are renowned for their sensitivity to wind velocity changes which is compounded by the flexibility in the rig. The heading of the boat needs to be constantly changed to maximize performance. Part of this sensitivity arises from the fact that the helmsman may weigh almost as much as the Laser itself, and so body movements are extremely important and critical to the development of a good steering technique.

There are two stages in learning to steer a Laser. Initially you will have to compensate for small changes in the heading of the boat by, what may seem to be exaggerated rudder movements. As you become more experienced you will learn to be able to use body movements and subtle changes in the heel of the boat to steer with minimal rudder movements.

Efficient steering is impossible if the rudder and tiller connections are not firm, or the extension is too short. It is impossible to steer a Laser properly upwind if you have to grip the tiller extension, with your arm straight, at a point level with your knees. The rudder on a Laser is probably too small for the boat (the designer has virtually admitted this). Consequently, frequent and rather exaggerated, but controlled, rudder movements will be required to keep the Laser heading in just the right direction with the power developed by the sail maintained within the range that can be handled by the helmsman. Too many rudder movements are probably better than too few, especially when you are learning, but avoid sculling in light winds. Ensure your action complies with Rule 42 (2.1.1).

When sailing upwind, steer the Laser with a bent arm, wrist almost touching your shoulder, and grip the tiller extension as you would a dagger. This is the only way you can effectively produce the push or 'stabbing ' action on the tiller which is a vital component of a good steering technique through waves. The rudder movements should be rhythmical, but fairly quick, and oscillate about a slight weather helm position. The action called for is a sharp stab away, or pull of the rudder towards you, followed almost immediately by a quick return of the rudder to the central position. This quick return needs to be emphasised otherwise the heading changes will be too exaggerated, and far greater than those required in response to the minor changes in apparent wind. So when sailing upwind in waves, the steering action should consist of regular frequent rudder movements of small magnitude, oscillating about a slight weather helm position.

After you have mastered the art of keeping a Laser 'tracking along the knife edge' with the sail perfectly aligned all the time using the exaggerated rudder movements, you can begin to think about the ways of steering just as effectively with minimum rudder movement. When sailing to windward the Laser can be steered by moving the body fore and aft, and by heeling the boat slightly to windward or leeward. Moving your upper body backwards when hiking steers the boat to windward, and rotating forwards steers to leeward. Similarly allowing the boat to heel slightly to leeward causes the boat to round up slowly, and heeling the boat to windward leads to a bearing away. Note that some people regard a forward movement of the body as a detriment to speed despite the saving in terms of rudder movement.

Now these body movements form part of a technique for sailing through waves that is referred to as ' torquing'. This is permitted in phase with waves, but not in flat water. Ensure your action does not breach Rule 42 (see 2.1.1). This involves a rhythmical circular movement of the upper body fore and aft, as well as inboard and outboard, whilst hiking in a straight-legged position. The action causes minor changes in boat speed, as well as boat heading, to produce extra power to accelerate up and through the face of waves and to respond to the changes in apparent wind associated with sailing in waves or chop.

The complete action is a little hard to describe but I will make some attempt. When the bow of the boat is about to run up the face of a wave, you 'stab' the tiller sharply away from you. At the same time you throw your body outboard, and back towards the stern, without changing the position of your legs. This movement has the effect of lifting the bow, and driving it forwards and to windward. The steeper the waves the quicker the tiller and body movements should be. The extra hiking has the effect of preventing the sail from luffing as the apparent wind changes, and the boat tends to slow down as it strikes the wave. The aft movement produces a little extra drive so that the boat can be powered up the wave face. As the bow passes over the peak of the wave, the rudder is pulled towards you, whilst you rotate your upper body forwards and assume a more upright position. This action helps the boat bear away down the back of the wave to adjust for the apparent wind changes and to accelerate up the next wave face. Only when there is a large swell running should you bear away to anything more than the average lay line course for the particular tack. When this 'torquing' action is performed smoothly, and in tune with the wave pattern (and it can be effective in even the smallest waves), it achieves three things.

1. It stops the boat slapping or banging into the face of each wave and slowing down. Therefore you will be able to maintain speed and sit further forward in the cockpit.
2. It means that the boat takes a little 'bite' to windward with each wave, and

this can amount to a great deal over the entire length of the windward leg.

3. It maximizes the speed of the boat at all times when moving through the waves and maintains the correct heading to compensate for the changes in apparent wind. The kinetic body movement produces small surges of speed and amount to something close to 'rocking upwind'! This action is a legal method of dealing with the waves when it is restricted to an acceptable level - It is also referred to as 'ooching upwind ' (See Section 2.1.1).

Try moving fore and aft in the cockpit when sailing to windward and see the effect it has on steering the Laser. Similarly, try the effect of moving the upper body suddenly aft and outboard and observe the acceleration it produces. The only way of developing this technique is to practice it. You will know when you are getting close when you feel the boat moving more smoothly up and over the waves rather than through them.

Sailing in confused seas and choppy conditions will require a slightly different technique. Fuller sails will be needed to ensure that there is sufficient power to plough through the chop. There may be insufficient distance between waves for the steering technique discussed previously to be effective. Look ahead and steer around the worst patches, if this is possible, without altering course too much. Looking ahead will also mean that you have sufficient time to accelerate before driving through the confused choppy areas.

Leaning a Laser to leeward or windward is a very efficient method of steering for the offwind legs as well. The rudder should be kept fixed, in a midline position, and only moved as a last resort. As mentioned before, heeling the boat to weather will cause the boat to bear away, and heeling it to leeward will cause it to head up. The heeling action to induce this change of direction should be smooth and controlled otherwise you will spill wind from the sail and loose momentum.

2.1.1 Make sure your action is not contrary to Rule 42!!!

(See http://www.sailing.org/tools/documents/42interprets2005book-%5B512%5D.pdf)

42.1 Basic Rule

Except when permitted in rule 42.3 or 45, a boat shall compete by using only the wind and water to increase, maintain or decrease her speed. Her crew may adjust the trim of sails and hull, and perform other acts of seamanship, but shall not otherwise move their bodies to propel the boat.

INTERPRETATIONS (Basic)

BASIC 1 An action that is not listed in rule 42.2 may be prohibited under rule 42.1.

BASIC 2 A kinetic technique not listed in rule 42.2 that propels the boat, and is not one of the permitted actions covered in rule 42.1, is prohibited.

BASIC 3 An action prohibited in rule 42.2 cannot be considered as permitted under rule 42.1.

BASIC 4 Except when permitted under rule 42.3, any single action of the body that propels the boat (in any direction) with the effect of one stroke of a paddle is prohibited.

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

INTERPRETATION

BASIC 5 An action listed in rule 42.2 is always prohibited, even if it fails to propel the boat.

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

(a) pumping: repeated fanning of any sail either by pulling in and releasing the sail or by vertical or athwartships body movement;

INTERPRETATIONS (Pumping)

PUMP 1 Fanning is moving a sail in and out not in response to wind shifts, gusts or waves.

PUMP 2 Pulling in and releasing a sail in response to wind shifts, gusts or waves is permitted, even if repeated (see rule 42.1).

PUMP 3 Except when permitted under rule 42.3(c), one pump may be prohibited under rule 42.1.

PUMP 4 A flick of a sail resulting from the sudden stopping of an eased sheet is permitted.

PUMP 5 One flick of a sail due to body pumping, or a pump not permitted by rule 42.3(c), is in the yellow light area. Body movement that does not result in a flick of a sail does not break rule 42.2(a), but may break other parts of rule 42.

PUMP 6 Repeated flicks of a sail due to body pumping are prohibited.

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

(b) rocking: repeated rolling of the boat, induced by

(1) body movement,

(2) repeated adjustment of the sails or centreboard, or

(3) steering;

INTERPRETATIONS (Rocking)

ROCK 1 A roll of the boat caused by a gust or a lull followed by corrective body movement to restore proper trim is permitted by rule 42.1.

ROCK 2 One roll that does not have the effect of a stroke of a paddle is permitted.

ROCK 3 Background rolling is permitted. A boat is not required to stop this type of rolling.

ROCK 4 Adopting any static crew position or any static setting of the sails or centreboard, even when stability is reduced, is permitted by rule 42.1 and is not prohibited by rule 42.2(b).

ROCK 5 A single body movement that is immediately followed by repeated rolling of the boat is prohibited.

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

(c) ooching: sudden forward body movement, stopped abruptly;
INTERPRETATIONS (Ooching)

OOCH 1 Torquing to change the fore and aft trim of the boat in phase with the waves is permitted, provided it does not result in pumping the sails.

OOCH 2 Torquing on flat water is prohibited.

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

(d) sculling: repeated movement of the helm that is either forceful or that propels the boat forward or prevents her from moving astern;

INTERPRETATIONS (Sculling)

See interpretations of rule 42.3(d).

42.2 Prohibited Actions

Without limiting the application of rule 42.1, these actions are prohibited:

(e) repeated tacks or gybes unrelated to changes in the wind or to tactical considerations.

INTERPRETATION (Tacking and Gybing)

TACK 1 In a steady wind and in the absence of tactical considerations, a boat that tacks or gybes more than twice in quick succession breaks rule 42.2(e). In light wind a boat is in the yellow light area if she tacks or gybes noticeably more frequently than nearby boats.

42.3 Exceptions

(a) A boat may be rolled to facilitate steering.

INTERPRETATIONS (Rolling to Facilitate Steering)

ROCK 6 Heeling to windward to facilitate bearing away and heeling to leeward to facilitate heading up are permitted.

ROCK 7 Repeated rolling not linked to wave patterns is rocking prohibited by rule 42.2(b), even if the boat changes course with each roll.

42.3 Exceptions

(b) A boat's crew may move their bodies to exaggerate the rolling that facilitates steering the boat through a tack or a gybe, provided that, just after the tack or gybe is completed, the boat's speed is not greater than it would have been in the absence of the tack or gybe.

INTERPRETATIONS (Rolling while Tacking or Gybing)

ROCK 8 Body movements that exaggerate rolling and cause a boat to sail out of a tack or a gybe at the same speed as she had just before the manoeuvre are permitted.

ROCK 9 It is permitted to move the mast to windward of vertical at the completion of a tack or a gybe.

BASIC 6 After a tack when a boat is on her new close-hauled course, movement propelling the boat like a stroke of a paddle is prohibited under rule 42.1.

BASIC 7 When the speed of a boat clearly drops after she accelerates out of a tack or a gybe, and there is no obvious change of wind speed or direction, the exception in rule 42.3(b) does not apply and the boat breaks rule 42.1

42.3 Exceptions

(c) Except on a beat to windward, when surfing (rapidly accelerating down the leeward side of a wave) or planing is possible, the boat's crew may pull the sheet and the guy controlling any sail in order to initiate surfing or planing, but only once for each wave or gust of wind.

INTERPRETATIONS (Surfing and Planing)

PUMP 7 A pull of the sheet and guy made to attempt to surf or plane when surfing or planing conditions are marginal is permitted even if the attempt is not successful.

PUMP 8 If a boat repeats an unsuccessful attempt to plane or surf, she is in the yellow light area.

PUMP 9 Each sail may be pulled at a different time, but only as permitted by rule 42.3(c).

PUMP 10 It is only necessary for surfing or planing conditions to exist at the position of a boat for her to be permitted to make one pull of the sheet or guy.

PUMP 11 Surfing or planing may be possible for some boats but not for others. This can be caused, for example, by local gusts or by waves from a motorboat. Also, lighter crews may be able surf or plane when heavier crews cannot.

42.3 Exceptions

(d) When a boat is above a close-hauled course and either stationary or moving

slowly, she may scull to turn to a close-hauled course.

INTERPRETATIONS (Sculling to Turn the Boat)

SCULL 1 Provided the boat's course is above close-hauled and she clearly changes direction towards a close-hauled course, repeated forceful movements of the helm are permitted, even if the boat gains speed. She may turn to a close-hauled course on either tack.

SCULL 2 After a boat has sculled in one direction, further connected sculling to offset the first sculling action is prohibited.

SCULL 3 Sculling to offset steering of the boat caused by backing a sail is prohibited.

42.3 Exceptions

(e) A boat may reduce speed by repeatedly moving her helm.

(f) Any means of propulsion may be used to help a person or another vessel in danger.

(g) To get clear after grounding or colliding with another boat or object, a boat may use force applied by the crew of either boat and any equipment other than a propulsion engine.

2.2 Hiking in a Laser

When sailing to windward hike with legs straight and close together, without twisting either the legs or body. Both hands should be near the chest, one holding the mainsheet and the other the tiller. Sail to windward with the mainsheet uncleated if you can. Gripping the mainsheet with the arm bent means that about 30 cm of mainsheet can be eased and retrieved without having to change your grip on the rope. Frequent mainsheet trimming is required when sailing a Laser upwind. In fact, you should be working the mainsheet in and out through the waves; the tiller and mainsheet being worked rhythmically in opposite directions without breaking Rule 42! Your arms should be working like pistons – pushing the tiller away with one arm and pulling in the sheet with the other, up and down the face of a wave, once per wave. Pull in the tiller and ease the sheet a little as the boat passes over the wave.

Hike from close to the front of the cockpit. A forward position means that the hiking force is applied as close as possible to the centreboard and to the centre of effort of the sail. Move aft in choppy conditions, just sufficient to prevent water coming over the bow. Lighter sailors tend to sit further back in the cockpit than the heavy-weights. They also move further back as the wind increases. This action forms part of the de-powering techniques discussed in Chapter 4. Sit well back when hiking on the reaches and runs to keep the Laser on a plane.

Use a piece of shock-cord to keep the hiking strap off the floor of the cockpit when tacking. This makes it easier to slip your legs under the hiking strap after tacking. Under the rules the shock cord can only be attached to the hiking strap support fittings at the back of the cockpit; not to the traveller cleat.

Sailing fast upwind depends on two things – you need to lean out as far as possible so as to generate a large and sustained hiking force, to balance the heeling forces produced by the sail. The other requirement when hiking is to keep your body from hitting the waves, which is difficult in a Laser because of its low free-board. These requirements dictate that hiking in a Laser should be done with absolutely straight legs. This will mean that your torso will be well above the waves even when the Laser is sailed absolutely flat, and the hiking force produced by your body weight will be greater than when hiking with bent legs.

How tight should the hiking strap be? The general guide is that when hiking straight-legged, there should be equal pressure (pain?) at two points: where the calf muscles contact the side of the cockpit, and where the thighs contact the gunwale. If is excessive pressure on the calf muscles, for example, the hiking strap should be eased. If you feel pain in the lower back when hiking, try tightening the strap a little. If the pain persists, then try working out in the gym three nights a week, or make your own hiking bench training unit! Obviously, hiking with straight legs will require a looser hiking strap than with bent legs. Also the strap will need to be looser if you are fit enough to lean right out and hike with your knees almost over the gunwale! Wriggling and squirming when fully hiked seems to help you sustain the position for longer periods (less painful). This movement eases the tension on the muscles and also helps the circulation. When you first try hiking with straight legs you will find it hard to sustain it for more than a couple of minutes. However, as you get fitter, either by sailing a lot or exercising in other ways, you will be able to hold the position for longer periods, eventually for the entire windward legs!

Another important point is that the best way of coping with the need to vary the hiking action, in response to gusts or waves, is by hiking with the upper torso vertical most of the time, and swiveling from the hips to produce the required changes in hiking force (but see 2.1.1). Under the average conditions for any combination of winds and waves, the upper body should be carried at between 90 and 120 degrees to the straight legs. Moving the body to a more horizontal position in the gusts, and hunching the upper body over the knees in the lulls, is a far better way of changing the hiking force than bending the knees and moving the entire upper body inboard and outboard. It is less tiring to bend at the waist. It can be done more smoothly and with greater control. It also reduces the abrasion on the upper thighs! Try to be in a straight-legged hiking position with your upper body hunched over the knees when luffing before the start. When the gun goes you can then quickly get fully hiked as you pull on the mainsheet and accelerate. The recommended hiking position also offers other advantages. Hiking in a semi-vertical position allows more leverage to be applied to the mainsheet and other control lines. It is less exhausting than attempting to sail the entire windward leg with the body in a flat horizontal hiking position, and finally it allows for the circular 'torquing' action described in the previous section.

CHAPTER 3

SAIL SHAPE CONTROLS

The shape of the Laser sail will need to be frequently adjusted for two quite different purposes:-

1. To ensure an optimum aerodynamic shape to maximize the power generated by the wind acting on the sail surfaces.
2. To make fine adjustments to the power output of the sail, either by increasing the draft to produce more power, or by decreasing it in stronger winds to produce less heeling force.

The most frequent adjustment of sail shape will be required when sailing upwind, with major changes being required when rounding marks at the end of the offwind legs to prepare for sailing close-hauled once again. Fuller and more powerful sails will be required on the reaches; flatter sails on the works and runs.

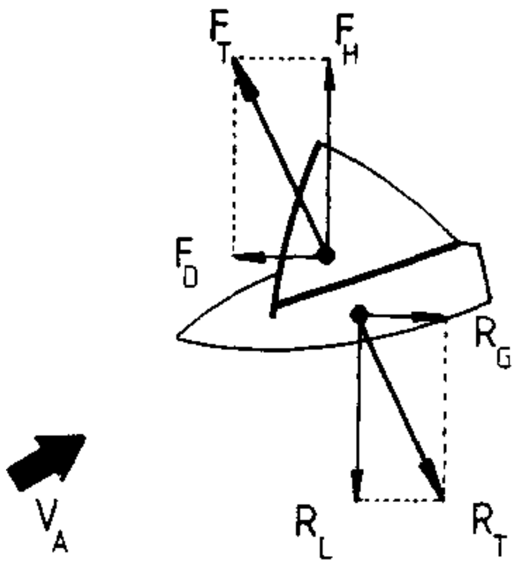
In this chapter I will discuss the rigging, function and adjustment of the four main sail shape controls on a Laser:-mainsheet tension, cunningham eye tension, outhaul and boom vang (See the rule and rigging changes in Section 3.6). Each of these controls will be discussed in turn introducing the elementary concepts for depowering the Laser sail. In the next chapter the sail controls will be discussed in a more integrated way as part of a more detailed account of the responses required for winds of different strength. Before considering each of the sail controls, it is worthwhile reviewing the various aerodynamic and hydrodynamic forces which apply to sailing boats.

3.1 Forces Acting on a Boat When Sailing Upwind

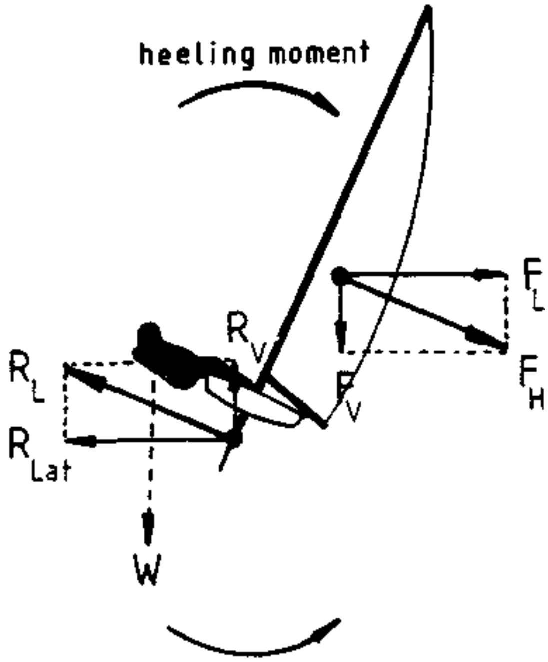
The diagram on the next page illustrates the balances of forces acting horizontally and vertically on a small yacht when sailing close-hauled. The force (**F**) produced by the sail acting as an aerofoil, and changing the speed and direction of the wind flowing over it, are balanced by the resistance of the hull and hydrofoils which produce forces acting in the opposite direction (**R**). Hence the total aerodynamic force ($\mathbf{F_T}$) is balanced by the total lateral resistance of the hull, centreboard and rudder ($\mathbf{R_T}$). Using vectors this total aerodynamic force and lateral resistance can be resolved into components that act along the centreline of the hull and at right angles to it. The forces can also be resolved into horizontal and vertical components.

Now, considering the horizontal components first, the total aerodynamic force ($\mathbf{F_T}$) can be resolved into the driving force ($\mathbf{F_D}$) acting to move the boat forwards, and a heeling force ($\mathbf{F_H}$) tending to push the boat sideways.

HORIZONTAL FORCES



VERTICAL FORCES



$\mathbf{V_A}$	apparent wind velocity
$\mathbf{F_T}$	total aerodynamic force
$\mathbf{F_H}$	heeling force
$\mathbf{F_D}$	driving force
$\mathbf{R_T}$	total lateral resistance and drag
$\mathbf{R_G}$	hull and hydrofoil drag
$\mathbf{R_L}$	lateral resistance
$\mathbf{F_L}$	horizontal heeling force
$\mathbf{F_V}$	vertical heeling force
$\mathbf{R_V}$	vertical component of lateral resistance
$\mathbf{R_{Lat}}$	horizontal component of lateral resistance
W	hiking force

When the boat is sailed steadily these two component forces are balanced by the hull drag ($\mathbf{R_G}$) resisting the forward movement, and the lateral resistance ($\mathbf{R_L}$) acting to prevent the boat from slipping sideways. The hydrodynamic action of the hull and centreboard moving through the water generate 'lift' and so actively help to drive the boat upwind. Sailing close-hauled would be impossible without a centreboard or keel.

When considering the vertical forces acting on the boat we have to take into account the vertical location of the centre of effort of the sail, and the centre of lateral resistance of the of the hull and hydrofoils. The heeling force acts through the centre of effort of the sail, which is located at a height about one third of the way between the deck and the top of the mast. The centre of effort lies near the maximum draft point of the sail profile, generally between 30% and 50% of the way back from the mast, towards the leech. The centre of lateral resistance lies about one third, to one half, the depth of the centreboard. The forces acting through the centre of lateral resistance and centre of effort of the sail therefore produce moments tending to rotate the boat and sail in a vertical plane along the centreline of the boat. The heeling force ($\mathbf{F_H}$), as the name implies, acts to heel the boat to leeward. This heeling moment is counterbalanced by the righting moment produced by the hydrofoils, the hull and the hiking force of the helmsman leaning outboard.

The sail controls provide a means of altering this balance of forces either by changing the total size of the forces generated, altering the relationship between the lateral and driving force components, or shifting the location about which the various forces act, i.e. moving the centre of effort or lateral resistance forwards, backwards or laterally.

When sailing to windward the sail controls are used to ensure that the power produced by the sail is within the limits of comfortable hiking. Under the average conditions for the windward leg, sailing close-hauled should require no more than about three quarters of your maximum hiking effort, i.e. with the upper body almost vertical. The sail controls can be used to achieve this power balance for maximum wind strength of about 15-20 knots. In very strong winds you will have to resort to other methods of depowering the forces produced by the sail. These methods include ways of lessening the aerodynamic efficiency of the sail, either by 'feathering' or by allowing the top part of the sail to twist and spill wind over the leech. The term 'feathering' refers to the technique of allowing the front part of the sail to luff by pointing slightly too high for the conditions. Allowing the upper part of the sail to twist also has the effect of reducing the working area of the sail.

I will now consider each of the main sail control methods in turn

3.2 Mainsheet

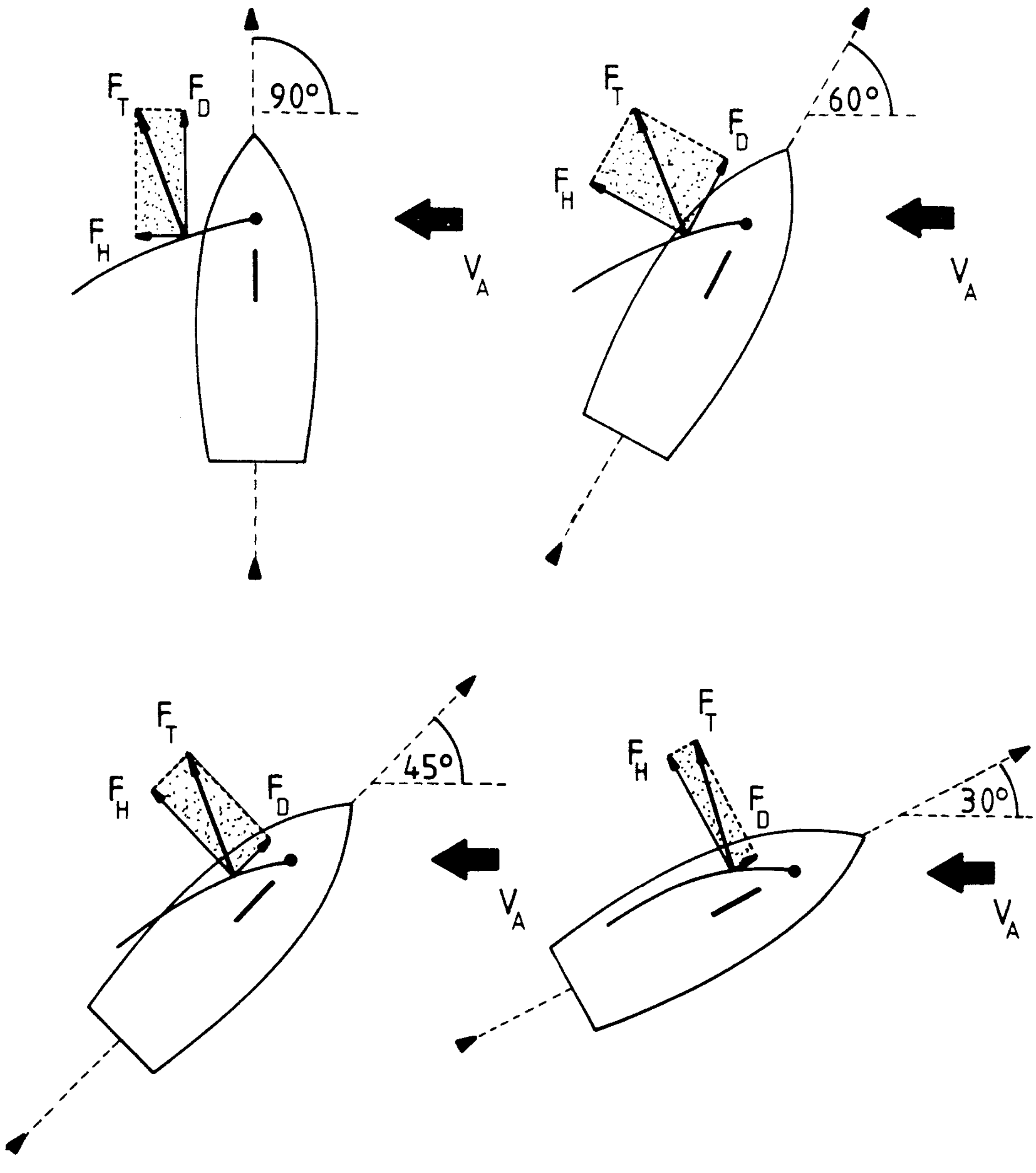
The main function of the mainsheet is to alter the boom angle and so the entry of the sail into the wind, it is used to ensure the sail is correctly orientated for each heading of the boat and wind angle. On a Laser the mainsheet also provides an important means of changing the leech tension, bending the mast and altering the draft of the sail when close-hauled.

3.2.1 Rigging

The rigging of the mainsheet and the choice of the right type, and length, of rope were discussed in Chapter 1. Secure the mainsheet to the boom block by using a figure-of-eight knot rather than a bowline. This will permit the Laser to be sailed block-to-block, with boom and traveller block touching (Fig. 1).

3.2.2 Function and Adjustment of Mainsheet Tension

The function of the mainsheet in controlling the angle of the boom and optimizing the aerodynamic efficiency of the sail by maintaining a correct orientation to the apparent wind is obvious. However, there are some less obvious consequences of changing the boom angle which relate to the way the balance between driving force and heeling force shifts, as the boom angle is reduced. This is illustrated below.

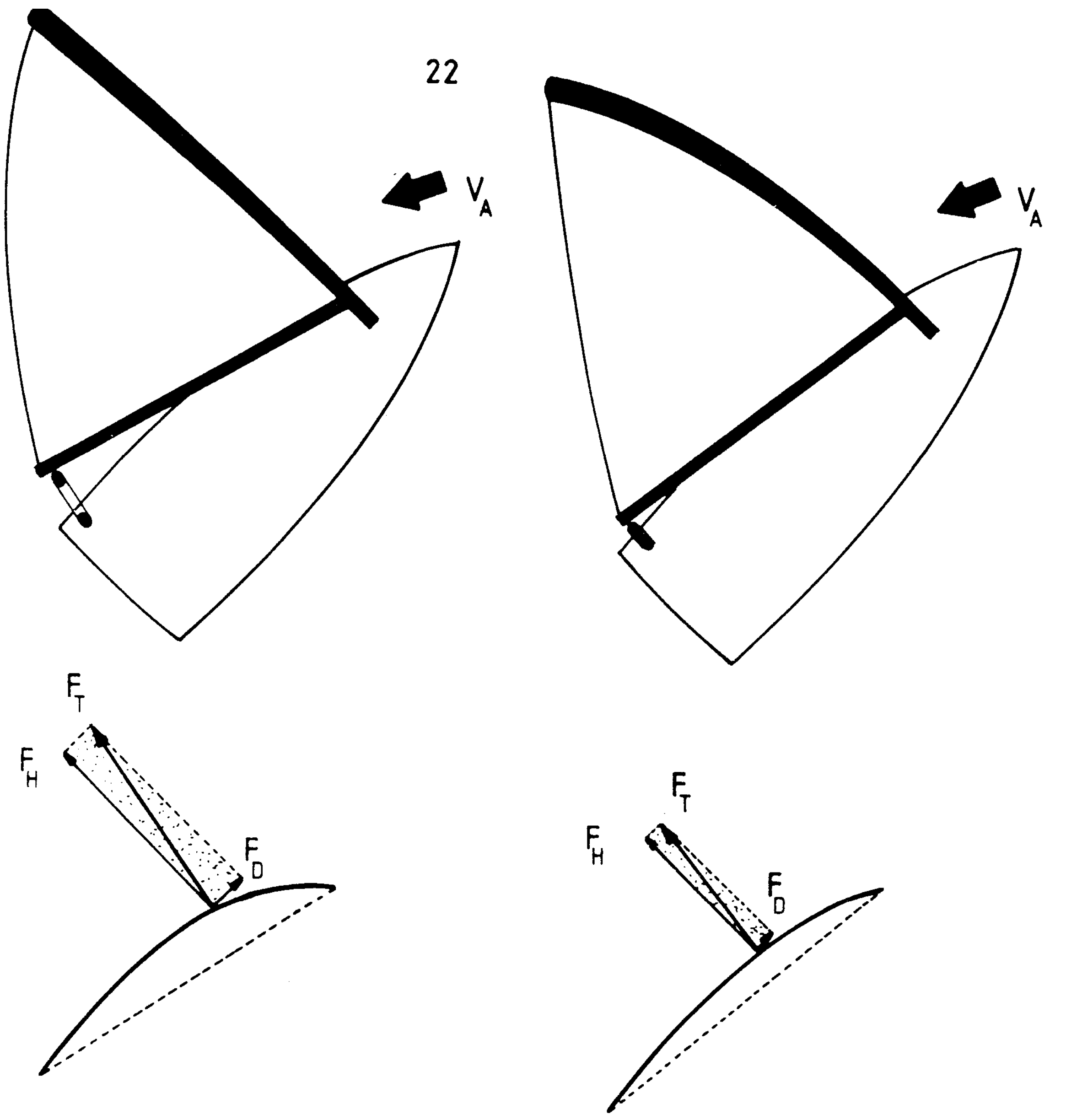


When sailing on a broad reach with the boat heeling at about 90 degrees to the apparent wind, more than 60% of the total aerodynamic force (**F_T**) is directed forwards as a driving force (**F_D**). The heeling force (**F_H**) is small so that little hiking will be required to keep the Laser sailing upright. Maximum boat speeds occur when reaching because of the large relative size of the driving force. As the sailing angle is reduced, and the boom is brought forward to sail higher into the wind, the total aerodynamic force is directed more laterally. Consequently, the relative size of the driving force decreases and the heeling force increases. When close-hauled with the Laser sailing at about 45 degrees to the apparent wind, the driving force may only be one quarter to one third of the size of the heeling force! At still smaller angles to the apparent wind, the driving force is so small, and the heeling force so large, that there is insufficient speed for the hydrofoils to work and the boat will drift to leeward.

Now we come to the effects of the mainsheet tension in bending the mast and producing a flatter sail. The diagram below compares the balance of forces when sailing ‘block-to-block’, with that found when sailing with the same boom angle, but without bending the mast. Pulling out the last 30-60 cm of mainsheet bends the mast and flattens the sail. As expected, this flattening of the sail angles the total aerodynamic force more laterally shifting the balance between the heeling force and driving force still further towards heeling. At first sight this may seem to be undesirable. However, notice that bending the mast and flattening the sail reduces the total aerodynamic force produced by the sail so that the heeling force component when sailing 'block-to-block' is actually less than when the mainsheet is eased slightly. This is a very important point as it illustrates the major method of depowering a Laser rig when sailing close-hauled in strong winds. Bending the mast flattens the sail and sacrifices some driving force in order to reduce the heeling force to a level that can be counterbalanced by hiking.

Other types of sailing boats have many different methods of bending the mast and flattening the sail using the stays or changing the position of the mast-step. However, with the free standing Laser rig, the only way of inducing mast bend is by exerting a downward force on the boom, and this can only be done using the mainsheet or boom vang.

More details of the techniques required to efficiently sail a Laser 'block-to-block' in moderate to strong winds are provided in Chapter 4.



MAINSHEET EASED

30cm between blocks

MAINSHEET TIGHT

'block-to -block'

3.3 Cunningham Eye

3.3.1 Function

The cunningham eye control is probably the least effective means of controlling sail shape, but its value is elevated on a Laser because it is easier to adjust than the other sail controls. It is the most frequently adjusted control apart from the mainsheet tension, and it should be attended to as the wind conditions change (see 3.6 for rule and rigging changes).

Increasing the downward pressure on the cunningham eye, tensions the luff of the sail and tends to shift the maximum draft point further forward. In stronger winds the sail cloth stretches. This stretch moves the maximum draft point backwards and creates a bulge in the sail profile just in front of the battens. Increasing the luff tension, using the cunningham eye control, acts to offset these changes and return the sail to an ideal shape (Fig. 5).

Stronger winds will also require flatter sails induced by increasing the mainsheet tension and bending the mast. When the mast is bent, the draft is reduced more in the luff of the sail, than in the leech, and this adds to the aft movement of the maximum draft point caused by simply flattening the sail.

Consequently the cunningham adjustment is linked to wind strength and the draft of the sail. Like the other sail controls, the cunningham is progressively tightened as the wind speed increases, initially to retain optimum sail shape and finally as a depowering technique. Tightening the cunningham in very strong winds acts to open up the leech allowing the top part of the sail to twist and spill wind.

3.3.2 Rigging

The best method of rigging the cunningham is illustrated in Fig 5, and for the new rules in Section 3.6. You will need bout 3.5 m of 6 mm diameter, prestretched rope. The rules stipulate that the cunningham control line must be a single piece of rope and that it is fastened at the goose-neck or at any other fitting. The line can now be extended back to the clew and cockpit. Additional loops can be used to obtain extra purchase. The suggested method gives a recommended method gives a mechanical advantage of 4:1. To rig the cunningham, take hold of the line at a point one third of the way between the ends and fasten it around the vang-tang on the mast, leaving two free ends (Fig. 5). Pass the shorter end (about 1 m long) up and through the cunningham eye. Tie a bowline so that the loop hangs just below the level f the boom. The other end is then fed through the bowline loop, back down to the fairlead and on to the cleat (Fig. 5). The control line should be terminated with a large diameter bowline loop to provide a handle. Ensure that this bowline is securely tied because the cunningham control line is the only thing holding the mast in the mast step when a Laser capsizes. The mast must be secured to prevent it falling out after a capsize!

This method of rigging the cunningham is better than others with greater purchase (see the new options in Section 3.6), because it allows the cunningham to readily be eased when the line is released. Other systems have too much friction and the control will not 'go off' when the line is pulled out of the cleat.

3.3.3 Adjustment for Various Conditions

The essential principle for adjusting the cunningham is to apply virtually no tension until you begin to be overpowered. Do not worry if your new sail shows large wrinkles near the joint in the mast, the sail will be fast with the cunningham eased, even though it looks ugly. Do not be tempted to pull on the cunningham simply to make the sail look nice. A tight vang in light conditions will mean the loss of speed and pointing ability.

In very light winds the cunningham should be slack. Some competitors even go to the extent of creasing the mast sleeve by-crumpling the entire sleeve in a bunch on the mast top section. This is done to ensure that the luff is as loose as possible when the cunningham is eased for the reaches.

Minimal cunningham tension is required for winds below about 10 knots. Thereafter, the cunningham should be tightened progressively, just pulling out some of the wrinkles near the mast joint, as the sail is flattened by increasing mainsheet and vang tension. In winds above 15 knots the cunningham should be very tight; with a new sail the bottom of the sail should be starting to crumple against the boom and goose-neck fitting, with an old sail the cunningham e\e grommet should almost be level with the boom! This high tension requires a good rigging system. Extra force can be applied by bracing your feet against the front of the cockpit!

Ease the cunningham for the offwind legs, especially the reaches. Less cunningham tension will be needed for the fuller sail shapes that can be accommodated off the wind. The best time to release the cunningham is just before you reach the windward mark. You will then have completed the adjustment before becoming involved in the complex manoeuvres required for rounding the buoy and preparing for toe next leg of the course. Pull the cunningham on again before you reach the leeward mark. The amount by which the cunningham should be eased for the reaches depends on the wind speed and the angle of the rhumb line to the wind. Usually the cunningham should be tensioned so that the luff wrinkles are just eliminated. Place a series of reference marks on either side of the mast, just above the goose-neck. These marks can be used to make quick and accurate adjustment of the cunningham tension just before rounding the marks.

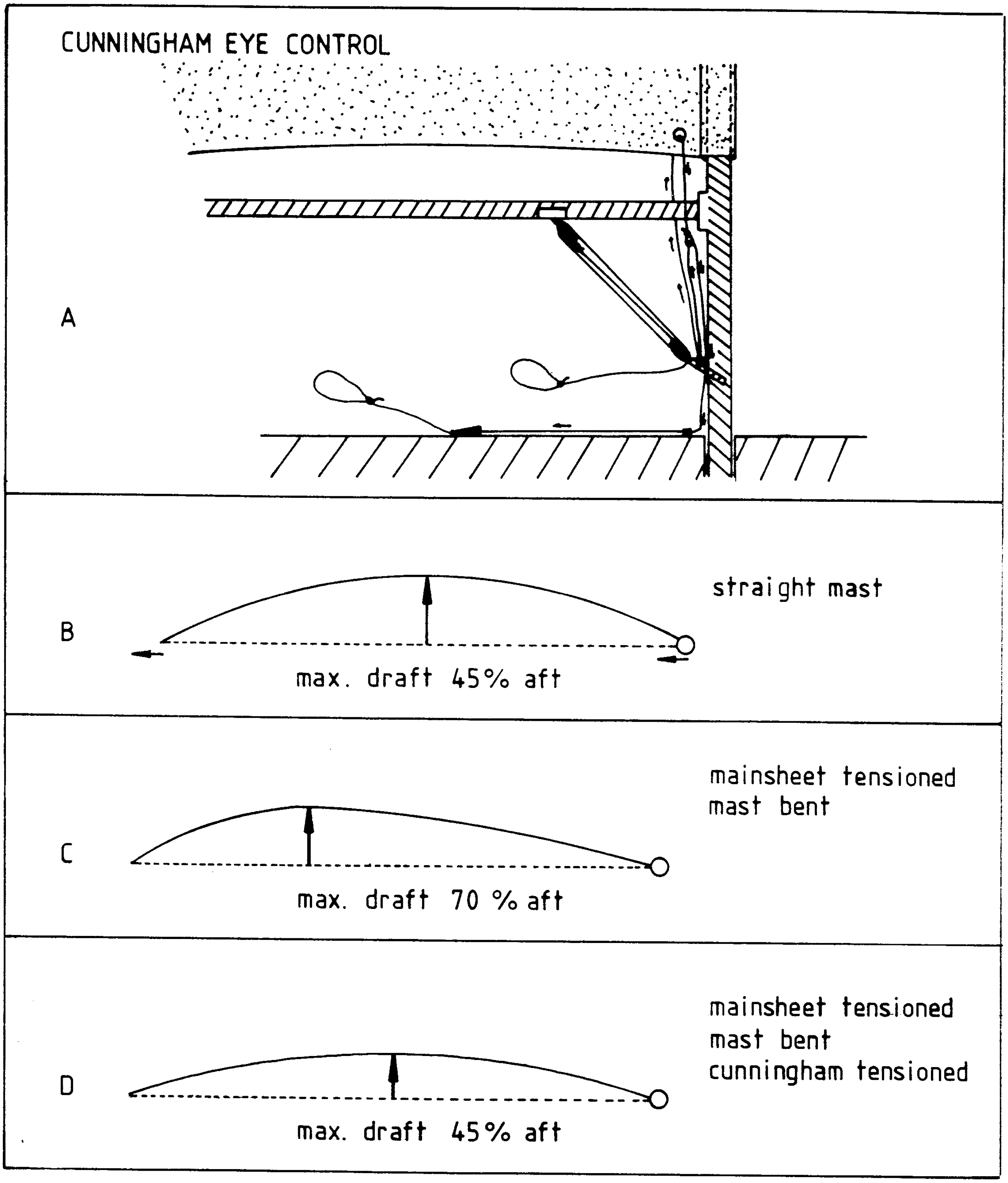


Fig. 5 Rigging and adjustment of the cunningham eye line. 'A' shows the recommended method of rigging. 'B to D' shows the effect of increasing cunningham tension on the position of the maximum draft on the sail. Bending the mast shifts the maximum draft point further back flattening the entry of the sail and producing excessive curve in the exit at the leech. Increasing the cunningham tension shifts the draft forward and returns the sail to its ideal shape.

3.4 Boom Vang

3.4.1 Function

The boom vang was initially added to boats to maintain leech tension when the mainsheet is eased for the offwind legs. The vang control stops the boom 'kicking-up' and letting the sail twist excessively and spill wind. While it still functions in this way on a Laser, it also represents a method of controlling the power output of the sail when sailing upwind. When discussing the function of the mainsheet it was shown how bending the mast provides a means of flattening the sail and depowering the heeling forces. The boom vang control provides a means of maintaining a flat and depowered sail when the mainsheet has to be eased slightly to sail upwind in strong winds without heeling (Fig. 6).

The boom vang affects the sail shape in three ways simultaneously:

1. The vang controls the general draft of the sail and the position of the centre of effort. High vang tensions mean flatter sails.

2. The vang controls the leech tension. A tight vang, like a tight mainsheet, increases the leech tension and will therefore reduce the twist of the sail. A tight vang therefore increases pointing ability. Conversely, easing the vang in strong winds will allow the leech to open up and let the top part of the sail twist. On the reaches, easing the vang and allowing a little twist with a full sail will maximize boat speed.

3. The vang controls the angle of entry of the sail. Combined with a tight traveller, tightening the vang tends to increase the outboard position of the boom (Fig. 3). The difference in boom angle produced by increasing the vang from tight, to very tight, may only be a few centimetres, but this may be extremely valuable in assisting fast sailing upwind in strong and overpowering winds. This lateral movement of the boom slightly reduces the heeling component of the force generated by the sail, with the same leech tension, and acts to sacrifice pointing angle for speed.

Next is the discussion about the function of the vang when sailing upwind. Sailing a Laser close-hauled in winds above 15 knots presents a problem for most sailors, especially inexperienced ones. A sail kept at 'block-to-block' tension is a depowered sail; however, such a sail has a tight leech and generates a large heeling force component. A flat sail has a very narrow working angle and it can quickly generate very large heeling forces if the wind shifts to blow more directly against the sail, i.e. the heading of the Laser to too low for the new heading. Therefore in winds over 15 knots it will be impossible to sail a Laser 'block-to-block' all the time. In winds over about 20 knots the mainsheet will have to be eased slightly, most of the time, with about 30 cm between the boom and the traveller blocks. In addition the mainsheet has to be eased through each tack. When sailing upwind, the vang control is used to retain a flat sail independent of the mainsheet tension. In effect, when sailing with a tight vang, the mainsheet is used to adjust the performance of the sail by acting as an extension of the traveller control –

i.e. altering the boom angle!

If the vang tensions are insufficient, easing the mainsheet will increase the boom angle, and increase the power generated by the sail as its draft increases (Fig. 6).

Inexperienced Laser sailors generally make several mistakes when sailing upwind in strong breezes. They fail to realise that a flat sail is a depowered sail, and they sail with insufficient vang tension. The situation is made worse by the inexperienced sailor who lacks the helm technique and 'feel' required to keep a ‘block-to-block ' sail working efficiently without being overpowering and inducing excessive heeling.

The typical response of a beginner to a gust that begins to heel the boat is to release the mainsheet. If there is insufficient vang tension, the sail will become fuller, more powerful, and still more difficult to handle. With the increased fullness in the sail the beginner has begun to fight a rig which is beyond his ability to control. The Laser continues the heel despite his superhuman efforts to hike. He staggers along alternatively luffing and accelerating close to capsizing.

The solution to these problems lies in recognising that flat and tight-leeched sails, are depowered sails on a Laser and that the fastest way to windward in strong winds is with the mainsheet as close as possible to 'block-to-block ' and with high, to very high, vang tensions.

The vang tensions required for sailing upwind in strong winds are referred to as 'over-vanging ' or ' supervangs '. These terms refer to vang tensions that are beyond that which can be achieved by pulling the mainsheet 'block-to-block’ and cleating the vang. The methods for producing this extra vang tension when sailing are described below. The upper limit to the vang tension is determined by the need for the end of the boom to clear the deck! Unless you are very small, and can squeeze into the cockpit when tacking, the tightest practical vangs produce a minimum deck clearance of 29-3Ocm when the mainsheet is released.

3.4.2 Rigging

It is essential that the vang control is rigged with prestretched rope. See Section 3.6 for the new vang rigging rules and systems which allow higher mechanical advantages. It is also important to tie a figure-of-eight knot in the vang rope so that you can apply some pressure to slide the vang into the fitting on the boom when rigging the boat. This will ensure that the vang will not slip off the boom when you are making adjustments to the vang tension! Tying additional knots, or marking the vang line in some way, will make it easier to consistently adjust the vang tension around the course.

The boom vang can be rigged in two fundamentally different ways (Fig. 6) and see Section 3.6:-

Method A. This method has the vang block with the cleat fitted to the boom. It requires about 3.5m of 6mm diameter, pre-stretched rope. The vang is tightened by applying a downward force. 'Supervang' tensions can be achieved by standing up in the Laser and leaning on boom with one hand over the attachment point on the boom, and the other pulling down and cleating the vang rope.

Method B. This method has the vang block with the cleat attached to a swivel at the base of the mast. The vang is then rigged in the normal way, but with an extra long piece of rope so that the control leads right back into the cockpit (about 4.5m of rope is required). In some respects this system provides an easier method for adjusting the vang. The main force required to tension the vang is directed backwards rather than downwards, and the vang can be adjusted without having to stand up and leave the cockpit. The vang is tensioned by bracing your feet against the front of the cockpit and applying a sharp backwards movement.

3.4.3 Adjustment for Various Conditions

The first principle for adjusting the vang is to ensure that there is some vang tension all the time. The absolutely minimum vang tension is that required to ensure that the angle between the boom and mast is never more than 90 degrees. This initial tension removes the small amount of luff that has been built into the Laser sail and will provide for a smooth entry. It will ensure optimum power for reaching and running in light winds.

Reaching - The maximum vang tension for the reaching legs is 'block-to-block' tension. Less tension will give greater speed in moderate winds. In the strongest conditions it may be safer to leave the vang adjustment at the tension used for the upwind legs.

Upwind - The minimum vang tension for upwind sailing is block-to-block tension. 'Supervang' tensions will have to be applied once the winds exceed 10 or 15 knots, the exact point being determined by your body weight, fitness and skill. The tension required is linked to the degree to which you are overpowered and the mainsheet tension that can be sustained. Try using a little extra vang tension (beyond block-to-block) in the lighter winds. This maintains a flat sail -the wind flow over the sail will not remain attached to a full sail, in light winds. A little extra vang tension may also help in moderate winds when there are waves or chop. In waves you will have to continually change the heading of the boat to steer through and around the waves. A flatter sail may offer some advantage because the wind flow will remain attached to a flatter sail through a wider range of entry angles than a fuller sail.

It should be clear from this discussion that the vang needs to be adjusted frequently, either as the conditions vary when sailing upwind, or when moving from a work to a reach, or vice versa. This presents a problem, because while it is relatively easy to rig the vang with supervang tension on the beach by getting someone to lean on the end of the boom, you will lose speed if the vang can not be adjusted through the race. The new rigging systems described in Section 3.6 should help. Easing the vang is generally no problem. You simply set the mainsheet tension at the desired position, say block-to-block, or perhaps with 20cm between blocks, and then quickly jerk the rope out of the cleat and then re-cleat it ready for the reach. Outlined below are some of the methods which can be used to obtain supervang tensions when sailing.

Incidentally, the correct time to ease the vang for the offwind legs is just before you reach the windward mark, and the correct time to retighten it for the works is just after you round the leeward mark.

Methods for tightening the vang when sailing

1. The 'swift kick' method

This is probably the method most frequently used. Sail block-to-block, luffing slightly. Cleat the mainsheet or otherwise re it, and then grip the vang rope. Remove one leg from under toe-strap and quickly kick against the mainsheet at a point about half way down between the boom and the deck. Straighten the leg and pull out the slack in the vang control and re-cleat it. One 'swift kick' is generally sufficient for winds of about 15 knot. In stronger winds the procedure should be repeated once or twice more to achieve the desired vang tension. If you use this method, mainsheet cleats certainly help, but they are not essential.

2. The 'incredible hulk' method

Sheet block-to-block, take a firm hold of the vang control rope and pull backwards with all your might, preferably with your feet braced against the front of the cockpit.

3. The 'incredible balance' method

This is the method recommended for those who prefer to have the block with the cleat on the boom. Sail block-to-block, luffing slightly, and cleat the mainsheet. Stand up in the cockpit, take hold of the vang rope in one hand, and push down hard on top of the boom near to the boom vang fitting with the other hand. Pull down hard on the vang rope and cleat it.

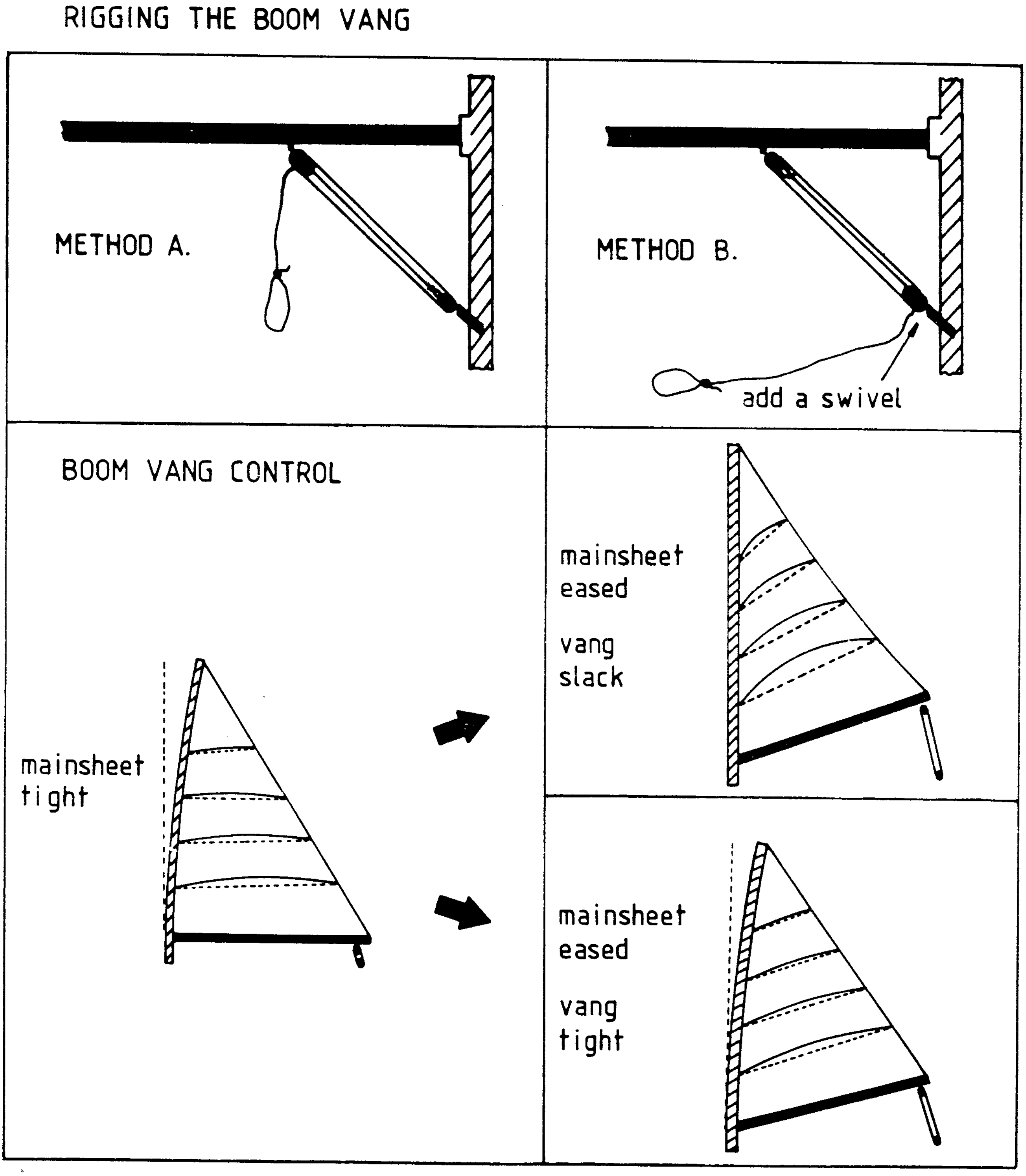


Fig. 6 Rigging and control of the boom vang. The figure shows two rigging methods and the importance of maintaining boom vang tension when sailing upwind. Easing the mainsheet in response to being overpowered produces a fuller, more powerful sail when there is too little vang tension. In winds from 15-25 knots (10-25knots if you are a light-weight) the vang should be greater than block-to-block when sailing upwind. In stronger winds the vang should be eased to allow the top third of the sail to twist off and feather.

How to Tell if the Boom Vang is Tight Enough

There is some variation between Lasers in terms of mast-rake, and the flexibility of the boom and mast top-section. Therefore, aim for getting the leech tension correct, rather than adjusting using the height of the boom above the deck. If you use boom height, then determine the appropriate height for your Laser rig. One general method which works is to observe the angle made by the traveller blocks when sailing close-hauled. As the vang tension is increased the angle between the traveller blocks and the deck will decrease from 80-90 degrees to about 30-40 degrees (Fig. 3).

Vang Tension Control in Extreme Winds

When the wind speed increases to 'survival conditions', that is 25 knots and above, it pays to reduce the vang tension back to block-to-block and not tighten it any further for the works. Easing the vang allows the upper leech to lay-off and spill wind when the mainsheet is eased. On the reaches the reduced vang tension will assist in keeping the boom from dipping as the boat heels. This may be important if you are struggling to keep the Laser upright on the reaches. If the boom immerses in the water you will almost certainly capsize and this is definitely slow! Gybing may be a little easier with an eased vang, for similar reasons. Also there will be less pressure on the spars and so chance of them breaking, which is not only slow but expensive One disadvantage of less vang tension is that there may be a greater tendency for the Laser to 'death-roll' on the runs, however there will be less chance of bending a top-section, when you do capsize.

3.5 Outhaul

3.5.1 Function

The general function of the outhaul adjustment is to control the fullness of the lower part of the sail by controlling the distance between the boom and the loose foot of the Laser sail. It allows you to compensate for stretch and retain the ideal sail shape under varying conditions. It represents a means of varying the power of the sail, either to increase the power to drive through waves without reducing mainsheet tension, or to depower the sail by completely eliminating the gap between the foot and the boom.

3.5.2 Rigging

There are three common methods of tying the outhaul (Fig. 7) – also see Section 3.6. The choice of methods really depends on how often you want to change the outhaul adjustment. For example, the outhaul should be eased for the reaches. In common with the other sail controls the ideal method represents a compromise between obtaining sufficient purchase for ease of adjustment, while minimizing friction so that the control will 'go-off' when the control line is released. The outhaul should be tied with 6mm diameter, pre-stretched rope. Each of the rigging methods begins by securing one end of the line to the fairlead- on the boom with a small bowline, passing the rope through the grommet and back through the fairlead (Fig. 7).

Method A. - With this method the rope is simply passed through the cleat and ended in a bowline loop. This system gives a purchase of about 2:1. The outhaul is tightened by grabbing the line about midway between the cleat and the end of the boom, and pulling it towards you. The slack is then taken up through the cleat with the other hand.

Method B. - This method is easier to adjust. The method is identical with method 1, but an extra purchase is added after the line passes through the cleat. The line is passed forwards along the boom and a small bowline loop is tied near the boom vang. The line is continued around the mast and a second bowline loop is tied near the mast. The line is then fed through the first loop and then the other, and finally terminated with a bowline loop for a handle (Fig. 7). Using this rigging method the outhaul is tightened by pulling backwards. Tie a figure-of-eight knot in the line at a pre-determined point giving the desired outhaul adjustment for the reaches. The outhaul is released by flicking the line out of the cleat.

Method C. - With this method the extra purchase is added to the line before it passes through the cleat (Fig. 7). After the line has been passed through the fairlead for the second time a small bowline loop is tied about half way between the fairlead and the cleat. The line is then passed forwards, through the cleat and back over the bridge piece of the cleat. The line is then fed through the bowline loop and on through the cleat. This method is a neat and tidy with enough purchase to enable the outhaul to be easily tensioned when sailing close-hauled.

3.5.3 Adjustment for Various Conditions

Smaller outhaul tension is needed when sailing in winds of 5-10 knots (Fig. 7), when full sails are used. The wind flow will remain attached to full sails in moderate wind conditions. Above and below this wind range, the flatter sails used will require less distance between the foot and the boom. Above 15 knots the outhaul should be pulled tight as a depowering device, even to the extent of having creases along the foot of the sail.

Mostly the trend has been away from the very foot widths that were used initially in Lasers. The main reasons for this are that the excessive distance between the foot and the boom reduces pointing ability, and destroys the vertical symmetry of the sail shape and most importantly induces weather helm. The maximum distance between the foot and the boom should not exceed 20 cm in the wind range from 10-15 knots. Generally, the outhaul should be reduced so as to minimize weather helm. However, some Laser sailors still advocate having a slightly eased outhaul when trying to develop power to sail through steep chop and waves.

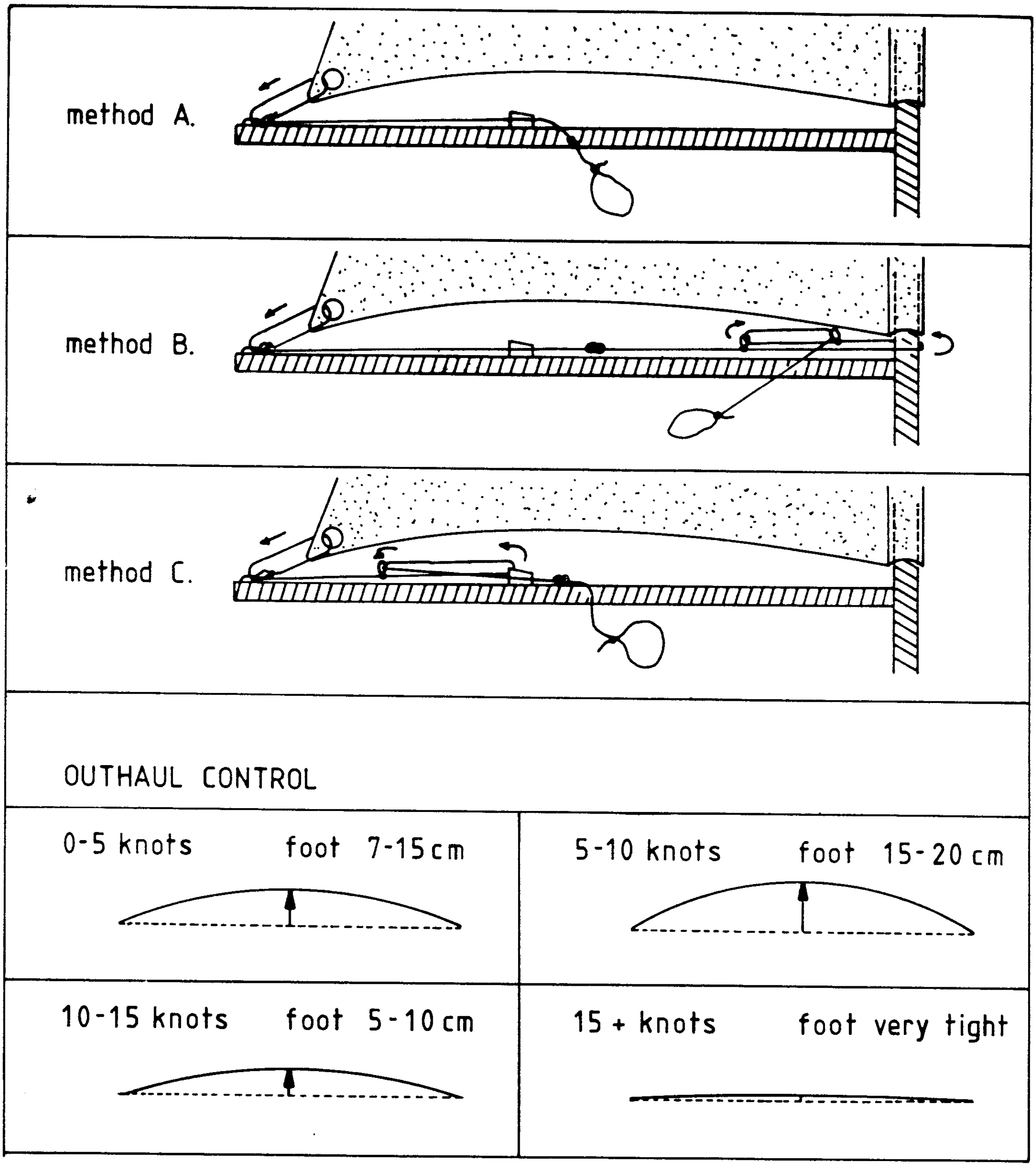


Fig. 7 Rigging and control of the outhaul. There are three main methods of rigging the outhaul which controls the distance between the foot of the sail and the boom. The outhaul controls the power developed by the lower part of the sail and the leech tension. The outhaul should be eased in moderate winds and tensioned in light and strong winds. The narrower foot is required in light winds to assist in maintaining attached flow over the surface of the sail. In stronger winds the outhaul is progressively tightened in response to the need to reduce the heeling force and to minimize weather helm.

3.6 UPDATE – RIGGING RULE CHANGES AND NEW SYSTEMS

(from http://www.laserinternational.org/rules/rulchovw.htm)

In January 1999 the Laser Class World Council set in motion a proposal to review the control line systems on the Laser with a view to making the control lines (boom vang, cunningham and Outhaul) easier to handle for lighter weight sailors and people joining the class. The final outcome was to give the following options: A builder supplied deck fitting to take two sailor supplied blocks that replaces the cunningham fairlead using the same fixing holes (photo A). A builder supplied cleat base to take two sailor supplied cam cleats that replaces the existing cunningham clam cleat using the same holes (photo B)

Photo A *Photo B*

Together with other changes this brings both the cunningham and outhaul controls to the centre of the deck (photo C also showing one of several prototype builder supplied vang fittings and a 4:1 cascade system for the cunningham).

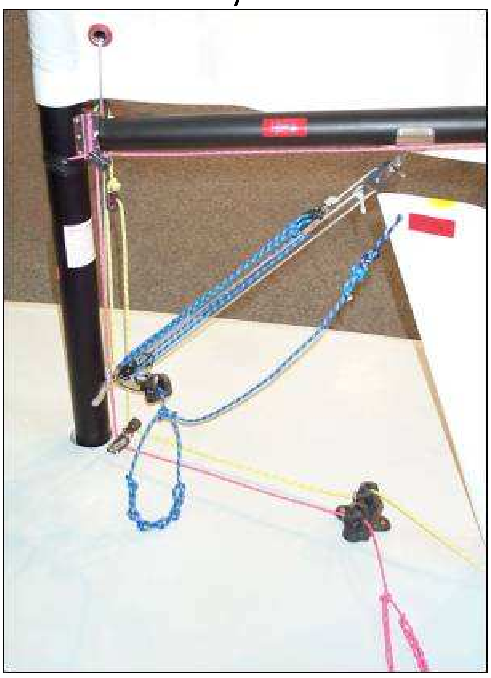


Photo C. NOTE: Centreboard retaining line required by rule 7(e)ii omitted from picture to give a clear view of control lines.

A builder supplied vang cleating fitting incorporating blocks and a swivel cam cleat as an integral fitting.

<u>Upgrading the existing vang fittings with additional blocks</u>

It was determined that leading the boom vang control to the deck was unnecessary, would add cost with little or benefit and the builders were concerned about increased loads on the deck fittings.

<u>Cunningham and Outhaul</u>

The remaining improvements to the cunningham and outhaul are the substitution of rope loops (with or without thimbles) with blocks (up to 4) and allow 3 separate lines in the cunningham and 2 separate lines in the outhaul to rig cascade systems. Various rigging options are available.

Examples shown below

cunningham

Outhaul

Boom Vang

The Working Party originally recommended to limit the boom vang options to avoid a proliferation of home made systems whilst still allowing improved control and similar flexibility to what we are currently used to. The Boom Vang rule has been revised. There are restrictions on the number of extra blocks allowed, the original small boom vang block may be replaced by a double pulley block, 1 or 2 blocks may be added to the original vang cleating block. The following photos 1, 2, 3 and 4 illustrate some examples of what is now allowed.

Photo 1 - The original 3:1 simple system   Photo 2 - Upgrade One

Sailor research indicated that many would be happy using existing systems and just substituting blocks or thimbles for rope loops in the line. This a simple upgrade, which on popular systems requires one additional small block and is a significant improvement.

Photo 3 - Upgrade 2

Photo 4 – Upgrade 3

A further modification is Upgrade 2 which remove a friction point in the system where one of the purchases runs over a rivet in at the bottom of the small alloy vang key block is illustrated in Photo 3.Both the systems in photo 2 and 3 use the same length of rope and provide an 8:1 system.

Upgrade 3 (photo 4) involves a completely new vang cleat fitting to be builder supplied. Several new fittings are currently being considered by the builders which offer 15:1 purchase and are specifically designed for lighter weight and younger sailors. Although not offering the advantages of an improved cleating system the Working Party felt it was desirable to allow a 15:1 system using the existing blocks with some limited additions. This option uses a single block either side of the existing large alloy cleat block and a floating double block with a becket.(photo 4).

Mast retention line

A new rule has been introduced for ALL Lasers requiring a simple mast retention line between the cunningham fairlead/deck fitting and either the gooseneck or vang mast fitting.

CHAPTER 4

FUNDAMENTALS OF SAILING UPWIND

In any race, sailing upwind separates the beginner from the champion, whereas sailing on the reaches separates the champion from the champion. These observations are particularly applicable to Lasers which are hard to sail fast upwind, especially in waves, Also, Lasers are easy to tack and therefore something can be gained from every small wind change. While the strict one-design rules for Lasers stresses the importance of strategy and tactics, achieving adequate boat speed is vital to the implementation of any strategic or tactical principles. I have already covered some of the sail adjustments which can be used to control the power produced by Laser sails when sailing to windward. In this chapter I will draw this information together and develop an integrated approach for varying the balance between boat speed and pointing under different conditions and for maintaining optimum speed without heeling.

4.1 Optimizing the Aerodynamic Efficiency of the Sail

The first principle for developing good speed to windward is learning to 'feel' how fast the boat is going and to 'read' the wind flow pattern over the surface of the sail. The beginner should seriously consider using all the aids at his disposal, such as wool tufts (or 'tell-tales'), leech ribbons and wind indicators. The champions do not need these aids because of their vast experience in knowing when the boat is sailing right 'in the slot' with optimum speed and heading for each set of conditions. The beginner requires these aids to develop these skills.

Choose a wind indicator which is sensitive, reliable and easy to read. It provides a general guide to the apparent wind direction and can be used as a coarse guide to setting the sail angle. It is vital on the reaching legs to maintain maximum speed by keeping the boat heading within the 'reaching sector' (Chapter 6). A wind indicator is indispensible when running, especially in preparing for a gybe by ensuring that the boat is sailing directly downwind (Chapter 7). It is also useful upwind to help correct the sailing angle when the wind changes beyond the operating range of the wool tufts.

Learn the correct angle between the apparent wind (the wind indicator direction) and the entry of the sail because in light winds and rain (!), the wool tufts may not work!

The aerodynamic efficiency of the sail depends on its shape and its orientation to the wind flow. Maximum aerodynamic force is generated by a sail that has an attached flow over the entire windward and leeward surfaces. When sailing on a steady course to windward, the ideal orientation of the sail is achieved by pulling in the mainsheet to the point where the front part of the sail is just not luffing. Try small adjustments to the mainsheet when sailing to windward and you will see that there is a narrow sector of about 2-5 degrees in which maximum power is developed, and that this sector occurs when the sail is just not luffing. The wool tufts provide a means of obtaining this optimum sail orientation with greater sensitivity, and avoid the need to luff occasionally to ensure that you are still in this ideal sector.

Attach a series of wool tufts to the front of the sail; one pair about half way between each of the seams, about 20cm (9-10 inches) aft of the mast sleeve. Do not place them any closer to the mast because of the interference caused by the mast, particularly to the wind flow over the windward surface. You may also add additional wool tufts further back on the sail and ribbons to the leech. They represent teaching aids which will help you to start thinking about sail shape and the effect of the different sail controls. However, the most important wool tufts for determining the ideal orientation of the sail are the lowest pair at the front of the sail. The sail will be working at maximum efficiency if the leeward tuft is continuously streaming (angled horizontally backwards) whilst the windward tuft is 'kicking', that is occasionally angling backwards, but mostly lying at an angle of about 45 degrees to the horizontal. The angle at which the windward tuft should be maintained depends on how close it is fixed to the mast sleeve. Less active streaming will indicate an optimum orientation for tufts placed nearer the mast; almost horizontal streaming for tufts placed further back.

4. 2 Depowering Techniques for Upwind Sailing

Lasers are slightly overpowered when sailing upwind in terms of their sail shape and hull design, and beginners quickly lose speed and begin to heel excessively if the correct depowering techniques are not applied in stronger winds. I have already discussed the ways in which the individual sail controls can be used to depower a Laser sail (Chapter 3), and the optimum hiking techniques (Chapter 2). In this section I will outline the correct sequence in which the depowering techniques should be implemented and also introduce some depowering techniques that do not directly involve changes in sail shape.

4.2.1 Sequential List of Depowering Techniques

- Cunningham tensioned
- Outhaul tensioned
- 'Supervang' tension
- 'Feathering' in the gusts
- Easing mainsheet with high vang tension
- Raising the centreboard
- Hiking from further back in the cockpit
- 'Feathering' most of the time
- Easing mainsheet with moderate vang tension
- Reefing the sail

4.2.2 Integrated Approach to Depowering

As the wind strength increases there are major changes in the desired objectives. For example, there is a shift in emphasis from ' pointing high ' to 'pointing high whenever you can'. Initially the depowering techniques involve the sacrifice of pointing ability in order to prevent heeling. As the wind speed increases still further, the major objective is maintaining as much speed as possible, at somewhat less that maximum speed, without inducing heeling. Consequently, most of the depowering techniques involve flattening the sail, and using wider sheeting angles.

'Feathering', refers to allowing the front part of the sail to luff slightly. It is used, initially as a means of dealing with the gusts, and finally in winds over about 15 knots, as a means of continuously reducing the effective working area of the sail. The entire sail area is only used in the lulls.

Raising the centreboard and hiking from further back in the cockpit have a depowering effect by virtue of their effect on the size, and centre of effort of the lateral resistance forces generated by the hull, centreboard and rudder. Raising the centreboard by 20-30cm (about 9 inches) when sailing upwind, decreases the lateral resistance of the centreboard and thereby reduces the heeling moment on the boat by allowing the Laser to slip slightly to leeward. Hiking from further back in the cockpit lifts the bow and effectively reduces the waterline length of the Laser, and hence, the lateral resistance of the hull itself. This backward movement also shifts the centre of lateral resistance further back and so reduces weather helm and helps to prevent the Laser rounding up in the gusts. Although both of these techniques mean a loss of pointing ability, they can be very effective, and the loss of pointing ability may be more than compensated by the extra speed and reduced heeling that can be achieved, especially when sailing upwind through waves.

Therefore, considering all the adjustments and techniques operating together in winds over 15-20 knots, the ultimately depowered Laser, with an unreefed sail, has

- all the sail controls pulled-on extremely tight;
- the centreboard has been lifted slightly and the helmsman is hiking from the middle or back of the cockpit;
- the sheet is eased so that there is 20-40 cm between the blocks, and the sail is being feathered slightly to maintain a heeling angle of between 0 and 5 degrees.
- Hike with all your might, but keep your cool.

The success of the lighter weight helmsmen in Australia over the last few years, in even the strongest winds, demonstrates how effective these techniques can be applied. Sailing in this way requires a high level of skill and fitness. The emphasis it places on maintaining speed all the time demonstrates the great value of balance and good steering techniques to Laser sailing. You have to be able to sail along what is equivalent to a knife edge in terms of the balance required to keep the boat sailing fast and upright, with the power output always within the range that can be controlled by hiking. The techniques require practice and a determined attitude to get out there when the wind blows and give it a try.

Reefing the sail is a last resort. Before you leave the shore reef the sail by wrapping the front part of the sail once or twice around the mast before attaching the boom and cunningham eye controls.

4.3 The Detrimental Effects of Heeling

Every effort should be made to prevent the boat heeling in all conditions other than very light winds when the boat may need to be deliberately heeled to let gravity assist in maintaining an optimum sail shape. The only other exception is in moderate winds when allowing a slight heel to develop seems to in driving the boat through the waves, but to sail the boat just the right excess amount of heel requires a lot of experience.

Heeling the boat in all other conditions is definitely slow. It is indicative of poor technique and it is demoralising because it leads to an exhausting fight with an overpowered rig. Excessive heeling is detrimental for the following reasons:-

1. The heeling moment rapidly increases as the angle of heel increases. It probably doubles between a heeling angle of 0 and 10 degrees. When the boat is allowed to heel the centre of effort of the sail is shifted outwards, and is directed more vertically. At the same time the centre of gravity of the skipper is moved inboard, reducing the moment produced by hiking. Therefore, as soon as the Laser starts to heel, the more it will want to heel, and the harder it will be to get it upright again.

2. A heeling Laser will tend to slip sideways and slow down, because of the shift in the vertical orientation of the centreboard. The reduction in boat speed adds to the inefficiency of the board angle. The lift, or lateral resistance force produced by the

board, is directly related to the speed of the water flow over it. A heeled Laser will therefore not point as high as one sailed upright.

3. Heeling immerses the leeward side of the hull. Due to the shape of the hill, this will cause the Laser to steer to windward and tend to 'round up'. Many people try to overcome this by pulling in the rudder; fighting an ever increasing weather helm with more and more rudder angle. The excessively angled rudder will induce drag and tend to slow the boat down. The reduction in speed will mean that both the rudder and centreboard will not work as efficiently. Therefore, there will be still more heeling, more weather helm and less speed. The end result of this is that the helmsman expends maximum effort sailing slowly, slipping sideways, pointing at a very low angle and staggering out of control on the verge of capsizing in the gusts!

4. Heeling Lasers often go all the way over and capsize!

So heeling is definitely slow - write "FLAT IS FAST" on your deck as a reminder. Flat means very flat, that is with less than 5 degrees of heel. The leeward gunwale should almost be at the same height as the windward one, and certainly not dipping in the water If you are sailing with straight legs and your rear end is still in the water when you are sailing the boat this flat, then the hiking strap is too loose.

Now having established that heeling is definitely slow, let’s look at some of the ways of preventing it. The first cause of excessive heeling is that the sail is not depowered enough for your weight, strength, and your ability to steer and balance the forces. Depower more than your competitors if it means you can sail the boat flat all the time. Many people are heelers (!!) because they lack the ability to sail 'block-to-block' most of the time. This requires a high degree of skill, but once mastered it provides the fastest passage to windward for the least effort!

Now, as mentioned before, the major objective when trying to prevent heeling is the maintenance of speed. It is wrong to attempt to immediately go block-to-block from an immobile position, for example, at the starting line, or when moving slowly straight after a tack. Leave the sheet eased a little to accelerate, Then hike hard and pull the mainsheet in when you reach the required speed and have the board working. Once sailing ‘block-to-block’ work hard to keep it that way. Use quick rudder movements, watch the tufts and vary your hiking effort to keep the boat flat.

If you 'lose it' when the wind changes, or the boat ploughs through waves and slows down, do not fight the extra heeling moment. Ease sheet slightly and work to accelerate again before resuming the block-to-block position and attempting to point high.

Prevention of heeling and the maintenance of good speed and a high pointing angle requires observation and anticipation as well as a good technique. Look ahead at the sailing angle of the other boats sailing to windward ahead of you. Look for changes in the appearance of the water surface. Is there a gust coming? How have the other boats responded to the new wind? Your pre-race preparation may have indicated that the gusts generally provide a lift on port tack. If so, and the response of the boats ahead confirms that this is the case, then it is better to tack early and get prepared for the gust, rather than be surprised by the gust and get caught out by having to tack in the middle of it.

It may be useful to end this section by providing a short summary of the techniques that can be employed to minimize heeling when sailing the windward.

1. The first response to an increase in the heeling moment is to hike a little harder. A fairly sudden jerk may be preferable to a gradual change. Remember that you want to stop the heeling action before it goes too far.

2. If the extra hiking is insufficient to prevent the heeling tendency, then push the tiller sharply to leeward. Allow the Laser to point about 5 degrees higher into the wind and then return the rudder to a slight weather helm position. If this is done quickly, with the push and return occurring within a second or so, it will cause a small luffing of the front part of the sail and a corresponding reduction in heeling force. While this may mean a slight loss of speed it is definitely preferable to heeling.

3. The final desperation action when hit with a gust is to ease the mainsheet suddenly. In the really heavy gusts that hit so suddenly - that there is no time for alternative measures - let about 40-80cm of mainsheet pass through your hand. Do not let the mainsheet go completely, but do it quickly. This will suddenly expel wind from the sail and relieve the excess pressure. Recover quickly and make the heading changes required for the new wind. Provided you keep the Laser flat, even this momentary easing of the mainsheet will not mean a great loss, and it is far better than having the boat heel and having to fight to get it upright again.

4.4 Changing Gears

As should be obvious by now, successful sailing to windward requires a dynamic, and ever changing compromise between the opposite objectives of maximizing boat speed and pointing. As the strength of the wind changes or you have to respond to the tactics of your opponents, you will need to respond by altering this balance. The emphasis will change from one aspect to the other at different times on the windward legs.

Sometimes you will be attempting to point very high, even to the extent of pinching a little. At other times you will need to accelerate rapidly to generate extra speed to overtake an opponent, or to develop power to blast through a bad set of waves. This extra speed or acceleration can only be achieved by sacrificing some pointing ability.

Major changes in gears will be required when sailing close-hauled in winds of different speed. An analogy of a car may help to explain the way the balance between speed and pointing ability has to be adjusted for different wind conditions. Imagine a car that has four gears with different power ratios, but the car is fitted with a governor. This means that the top speed is restricted, and, further that the top speed can be reached in each of the top three gears. Now further suppose that the aim is to maximize the speed and fuel economy of the car. The most economical way of travelling will then be to remain in top gear for as long as possible and only use the lower gears for the hills and to accelerate up to the maximum speed set by the governor. In terms of this analogy, the boat speed is equivalent to the car speed, and the fuel consumption to the pointing angle. Using too low a gear for the conditions will burn up pointing ability and reduce the speed-made-good towards the windward mark (equivalent to the performance of the car in kilometres per litre of petrol). Alternatively, trying to point too high (save fuel) by changing into top gear too early, will mean a serious loss of speed and efficiency.

Developing this analogy further, the different gears on a sailing boat are represented by changes in sail shape; <u>fuller sails</u> represent the low gears used for accelerating and producing extra power; <u>flatter sails</u> represent the higher ratio gears and are used for high speed economical sailing (high pointing angles).

The 'governor' on a yacht is the drag and wave making resistance of the hull, which together set an upper hull speed for each particular hull design. There is an exponential relationship between the speed of the hull through the water and the power required to increase its speed. This applies to power boats as well as to yachts. Initially the drag of the hull acts to slow the boat, and eventually a maximum speed is approached, with the hull lying in the trough between the bow and stern waves generated by its own motion. The speed is restricted by the inability of the boat to drive over its own bow wave!

A further increase in speed can be obtained by planing hulls, which are designed to partially lift out of the water at a certain speed. This lifting of the hull reduces the wetted surface area of the hull and so the hull drag and wave making resistance are reduced. However, after this further increase in speed, a new upper speed limit is approached for the planning hull which can not be exceeded. Owing to the exponential relationship between boat speed and the power required to achieve it, these upper speeds are very difficult to attain, especially on sailing boats.

To explain what is meant by <u>an exponential relationship</u> I will provide an example. Let’s say that it takes a force of F to increase the speed of a boat from 5 to 10 knots. Then, it my take a further increase in force of perhaps 2F to gain another 5 knots of speed, to reach 15 knots. It may require an extra 4F of force to reach 2 knots, and maybe 8F to reach 25 knots. Now, as shown in Chapter 3 the aerodynamic force generated by a sail acts at an angle to the centre line of the boat. This means that the driving force component acting to move the water through the water is always accompanied by a heeling force component. At any given heading of the Laser the size of the heeling force is <u>proportional to the driving force</u>. This heeling force is an additional factor which limits the practical speeds which can be achieved, especially when sailing upwind. The maximum hull speeds may not be attainable because the boat simply heels over!!

It should be clear from this discussion that you have to learn what are the maximum <u>sustainable</u> boat speeds for a Laser at each of the different sailing angles and different sets of wind and wave conditions. This knowledge will stop wasting energy and pointing ability in attempting to exceed this maximum speed you can sustain with your particular hiking force and boat handling skills.

Similarly, there is an optimum pointing angle and sail orientation (boom angle) for each set of condition. If you attempt to point too high for the conditions, you will lose out through the excessive loss of speed. The 'touch' and 'feel' required to know what gear to use, how high to point, how fast to sail, and the sail control needed to accelerate smoothly away from the start, will only come with experience. Watch how the experts do it at the major regattas. However, some initial guidelines about the needs to shift emphasis between speed and pointing in winds of different strength may be helpful. A summary of the basic principles is provided in Figure 8 and in the following sections.

4.4.1 Light Winds

The key point for light wind sailing is that maximum hull speeds can not be achieved. Obtaining speed becomes the major objective, and to ensure this you need clear wind and low pointing angles. You may only be able to sail block-to-block in the gusts. Too much mainsheet tension at other times will mean that the boat will almost stop and slip sideways excessively. Point low in the lulls to maintain a minimum speed at all times. Gains can be made in the gusts if you are first to accelerate and start pointing a little higher. Likewise, you can also gain by sustaining the higher pointing angles and speed for longer as the gust passes.

4.4.2 Moderate Winds

In moderate winds, close to maximum speeds can be achieved, but only by using full sail shapes. The full draft sails can be tolerated because the heeling forces are well within the range that can be balanced by hiking. Also, the smaller heeling forces mean that the sail can be carried close-hauled at small boom angles. Therefore, quite high pointing can also be achieved, provided there is reasonably clear wind. In winds over about 10 knots you will be able to sail fast when sheeted 'block-to-block' for almost the entire windward leg. Some 'feathering' may be required in the gusts, but generally the extra heeling forces should ne adequately dealt with by applying extra hiking force. Again the basic principle is to maintain speed and point high when you can.

4.4.3 Heavy Winds

In heavy winds power can be achieved easily, and the need for clear wind becomes of relatively minor importance. The emphasis shifts to balancing the heeling forces so as to prevent heeling. High pointing angles are no longer achievable because of the excessive heeling forces developed when the mainsheet is pulled in tight. Moderate speed is required to keep the centreboard working.

4.4.4 Accelerating

You will need to develop techniques for accelerating from the start and at other times when you are forced to slow down for some reason. Fuller sails and wider boom angles will be needed to generate this acceleration. Remember that it takes time for the wind flow pattern to reach a new equilibrium (perhaps requiring 3 or 4 seconds) with each change of sail shape. Also be aware of the large scale changes in both the speed and direction of the apparent wind caused by the change in boat speed. This will require changes in the heading of the boat or the sheeting angle, every time the boat accelerates or decelerates. A good technique for accelerating a Laser should be smooth and controlled, taking care to watch your wool tufts to maintain an optimum sail orientation as the boat speed changes.

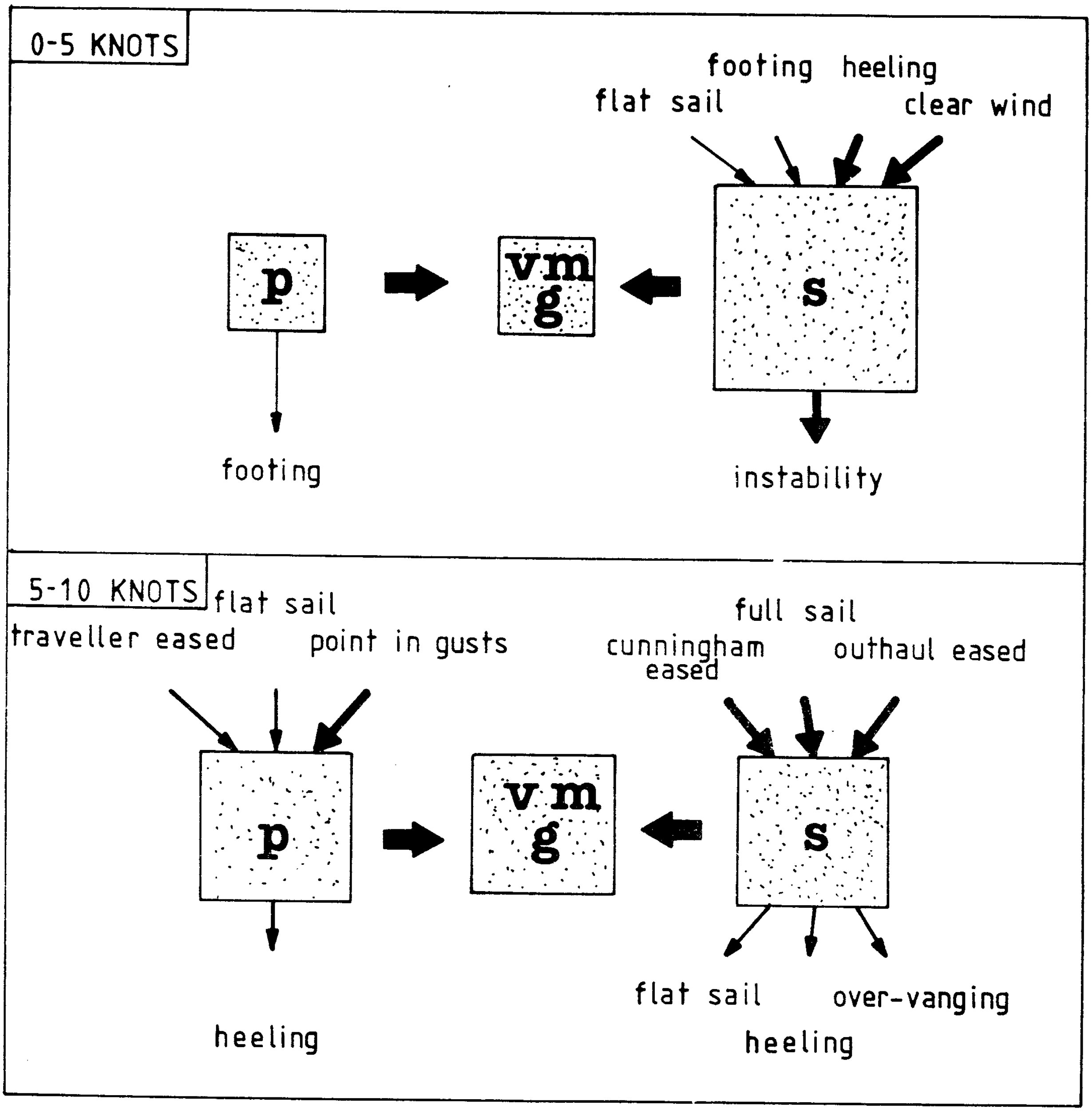


Fig. 8 Summary of the balance between speed (s) and pointing (p) required for sailing upwind under different conditions. The balance is assessed in terms of the velocity made good to windward (vmg). In the figure the size of the box is proportional to the relative importance of speed or pointing. The figure also includes a summary of the major factors which produce an increase (arrow towards the box) or decrease (arrow away from the box) in either speed or pointing. The width of the arrow indicates the relative importance of each of the contributing factors under each set of conditions. In light conditions (0-5 knots) the emphasis is on boat speed. Obtaining clear wind and deliberate heeling of the boat to leeward are the most important factors in producing maximum speed. In moderate winds (5-10 knots) there should be an equal emphasis on pointing as high as possible and obtaining optimum speed. This speed will require relatively full sails which can be accommodated because the heeling forces generated can easily be controlled by hiking. High pointing angles should only be attempted when the boat is moving at close to maximum speed.

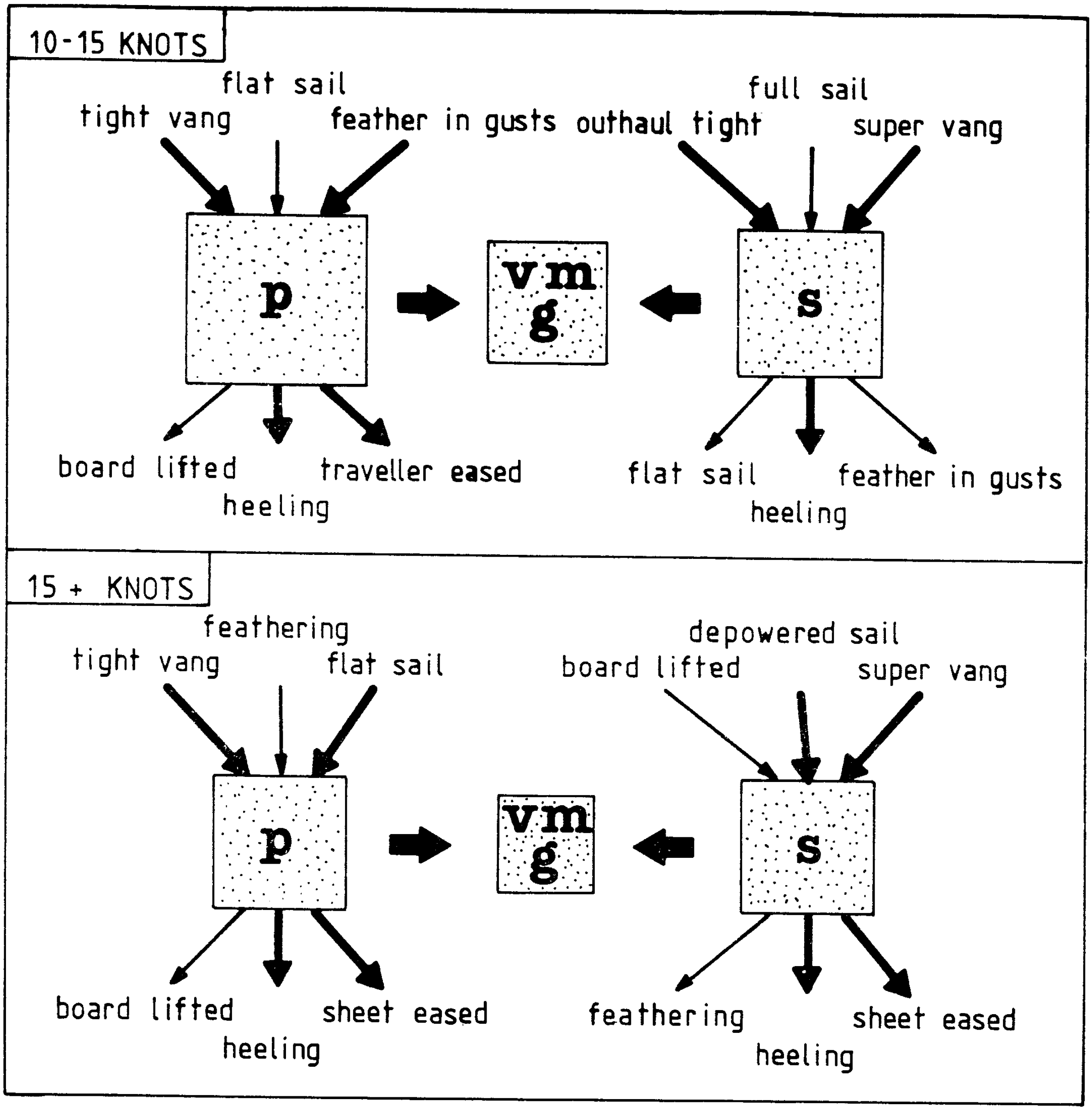


Fig. 8 (cont.) In winds greater than 10 knots the emphasis shifts from techniques adopted to obtain maximum hull speed at an angle of 45-50degrees to the apparent wind, to techniques which allow the maximum sustainable speed to be maintaining without heeling the boat. The speed which can be sustained will be dependent on the hiking force which you can develop. In winds of 10-15 knots there is a slightly greater emphasis on pointing between the gusts. When overpowered, speed can only be maintained by using the rigging controls to produce a flat sail, with a tight outhaul and a super-vang tension. Feathering in the gusts means some loss of speed, but this is compensated by a higher pointing angle and the prevention of heeling. When the winds increase to more than 15 knots, further adjustments are required to depower the sail and reduce the heeling forces. This involves lifting the centreboard slightly to reduce the lateral resistance, and ensuring that all the sail controls are very tight. The emphasis is on maintaining reasonable speed to keep moving through the waves and that the centreboard and rudder are working well. Feathering of the front part of the sail and easing the mainsheet will be needed most of the time to reduce heeling.

CHAPTER 5

STARTING

The first leg of any race is by far the most important. You must be up with the leaders at the windward mark for the first time if you hope to do well. It is therefore essential that maximum effort, both mental and physical, be applied to the first leg and its foundation at the start. A good first leg and start require adequate preparation. Try to be on the water 30 minutes before the start to allow sufficient time to develop a plan for the first leg and start. These plans are related because the selection of the favoured side of the course will often dictate the favoured end of the line and the tack for the start. For example, if the starboard side of the course is favoured then the starting plan may call for the freedom to tack onto port soon after the start.

You will also need to establish the wind pattern. What is the frequency and range of the wind shifts? Is a persistent shift- developing? Can you expect a consistent change in wind direction up the windward leg of the course because of the influence of the land surrounding the lake on which the race is sailed?

How large is the fleet and what is the standard of your opponents? Who are your nearest rivals and where are they starting? All these things need to be considered in devising a pre-race plan. It is impossible to do this adequately if you do not arrive on the course until 5 or 10 minutes before the start, so be prepared to get out on the water early.

Many magazine articles and books have been written on starting tactics and strategy and so I will not attempt to cover the entire subject in detail. I will concentrate on the major element required for starting successfully in large Laser fleet (100 +). Small fleet and club starts require a completely different approach and I will not cover these starts except in a very general way.

5.1 Elementary Steps for Starting

A good starting technique can be subdivided into a series of elementary steps:

- Prepare a plan for the first leg and the start.
- Work out the phase of the wind shifts at the time of the start so that you can adjust the starting plan to avoid being headed just after the start, and can quickly respond to the new wind.
- Accurately determine the position of the line in a way that avoids mistakes. Also determine which is the favoured end of the line, that is which end is further upwind, or is in a more favourable position in relation to the prevailing current or tide.

- Modify the starting plan using this added information and where you expect the majority of the fleet to start.
- Try a few practice starts from an appropriate staging point for the conditions. Accurately determine the time required to make the initial approach to the line from this point.
- If it is a club start or a mixed-class regatta, watch the other classes start. Get to know the best boats in the other classes. Watch where they start and where they sail in the initial stages of the first leg. Establish if their strategy is consistent with your own plans, and modify them accordingly. However, you should be reluctant to change your plans without having very good reasons.
- Just before the start (in the last 10-15 minutes), work to windward for a short distance to get warmed-up, to check-on the phase of the wind pattern and to make final adjustments to the sail trim.
- Move to the vicinity of the staging point and begin the count down to make your approach.
- At the appropriate time, begin the approach and choose the exact position on the line where you will try to start. Allow a few extra seconds in case you have to move up or down the line to find a less congested spot. Begin the tactical manoeuvres which will provide you with a small space to leeward of your position into which you can accelerate just before the gun goes.
- With about 10 seconds left before the gun, defend grimly against the boat immediately to windward of you and begin to head off and accelerate along the line into the space you have been diligently defending.
- When the gun goes steer sharply up wind and point as high as possible without losing speed. The objective is to 'pop out' from the line and be the first boat to get into the undeflected wind in front of the line.
- When you have clear wind and freedom to tack begin to implement the plan for the first leg.

I will now discuss some of these steps in more detail.

5.1.1 The Plan for the First Leg

It is far better to have a plan, and be proved wrong, than have no plan, and be right without knowing the reason. You can learn a great deal from these mistakes. Simply following the bunch or making haphazard decisions will teach you nothing.

However, it is important that your plan be soundly based on knowledge and observation, and have some in-built conservatism rather than be based on the expectation of miracles. We all have our miracle shifts but it is impossible to plan for them!

5.1.2 The Phase of the Windshifts

If there is a regular pattern to the shifts it is important that you can predict the phase of the cycle expected when the gun goes. If the shifts are large, and are sustained for 5 to 10 minutes, each end of the line may be alternately favoured and disfavoured, so that knowing the phase is very important. In the last few minutes before the start watch for signs of gusts on the surface of the water or in the responses of boats to windward and try to determine the favoured tack. Better still; work out the shift frequency by noting the wind direction changes over the last 10-20 minutes before the start.

In oscillating winds the critical factors are to ensure that you are on the correct tack just after the start, heading towards the new shift. It is also important that you have freedom to tack to the new wind change that may be expected just after the start. You need to know the approximate time interval between the wind shift cycles. For example the wind may swing through an angle of 10 degrees and return to the original heading every 3-5 minutes. Once this interval has been estimated, try to predict the probable shift at the start. For example, if the wind direction changes at the 5 minute-gun, and the phase interval is about 5 minutes, then it is reasonable to expect the wind to shift again before the start. However, if there is a change in the last 60 seconds, then it is reasonable to expect this wind direction to continue for several minutes after the start.

The objective in planning a start in oscillating winds is to minimize the time you are forced (by other competitors) to remain headed on the wrong tack. If a veer (a shift in a clockwise direction favouring a starboard tack) is expected at the start then it will probably be better to start at the leeward end of the line. If you do this you will be ahead and to leeward of most of the fleet when the next phase change occurs, favouring port tack (a back in the wind direction - that is anticlockwise). If you start at the starboard end of the line under the same conditions, you would be lifted initially and have clear wind. However, you will suffer considerably in the all important first tack after the start, when the wind shifts to favour a port tack. You may have a large number of boats ahead and to windward blocking your wind when the fleet assumes a port tack.

On the other hand, if a back is expected at the start, which is to be followed by a veer, then you will need to be able to start on port tack, or be able to assume a port tack very soon after the start. These circumstances may favour a start at the starboard end so as to have freedom to tack, and be in the right position for the next shift.

5.1.3 Determining the Position of the Starting Line

A good start depends on you being able to determine exactly where the line is under all circumstances. If you are midway between the two starting buoys it is impossibly to accurately determine how close you are to the line, even if you can see both ends through the mass of sails assembling for the start. A sag often develops in the middle of the line because of this uncertainty. Often the Lasers in the middle of the fleet may unknowingly be 3 or 4 boat lengths behind the line when the gun goes. Knowing the location of the line is especially important in large fleets of more than 100 boats starting on a line that may be 300 m long!

The best way of determining the position of the starting line for your final approach is by taking transits (Fig. 9). If, for example, you intend to start on starboard tack, you should sight along the extension of the line to a landmark on the shore. Then use the port end buoy and the landmark to estimate how close you are to the line. The transit should be taken when luffing at a point on the extension of the line just to the right of the starboard mark. It often helps to pick a second landmark just in front of the extension of the line. This can be used to estimate where you are if your view of the first landmark is obscured. Taking transits in this way avoids the need to be continually looking up and down the line in the last few seconds before the start to judge your position between the two marks. There are too many other things to worry about just before the gun.

5.1.4 Determining the Favoured End

The major concern here is determining the end of the line which is further upwind. The end of the line which is closer to the windward mark is a secondary consideration on long courses. Below are three of the simplest methods of determining the upwind end. Another important point is that you should try to estimate how much one end is favoured as this will determine how much it will contribute to your plan for the start.

1. Sail down the line with the mainsheet set at an optimum angle. Quickly tack and head back along the line in the other direction without changing the mainsheet setting, and see whether you are footing or luffing on the return heading. The end to which you head with the sail luffing is the favoured end. Try this more than once to account for changes in wind direction (Fig. 9).
2. Luff head-to-wind on the line, adjacent to one of the marks. Use your wind indicator to ensure that the boat is heading directly into the wind. Sight across the boat using the traveller or back of the cockpit as a guide and see whether the mark at the other end is above or below the imaginary line of sight. If the mark is above this line taken at right angles to the wind direction, then it is further upwind. Again, this should be done more than once to allow for wind changes (Fig. 9).
3. Use the same method of sailing along the line and luffing directly into the wind, but use a compass to compare the headings (Fig. 9).

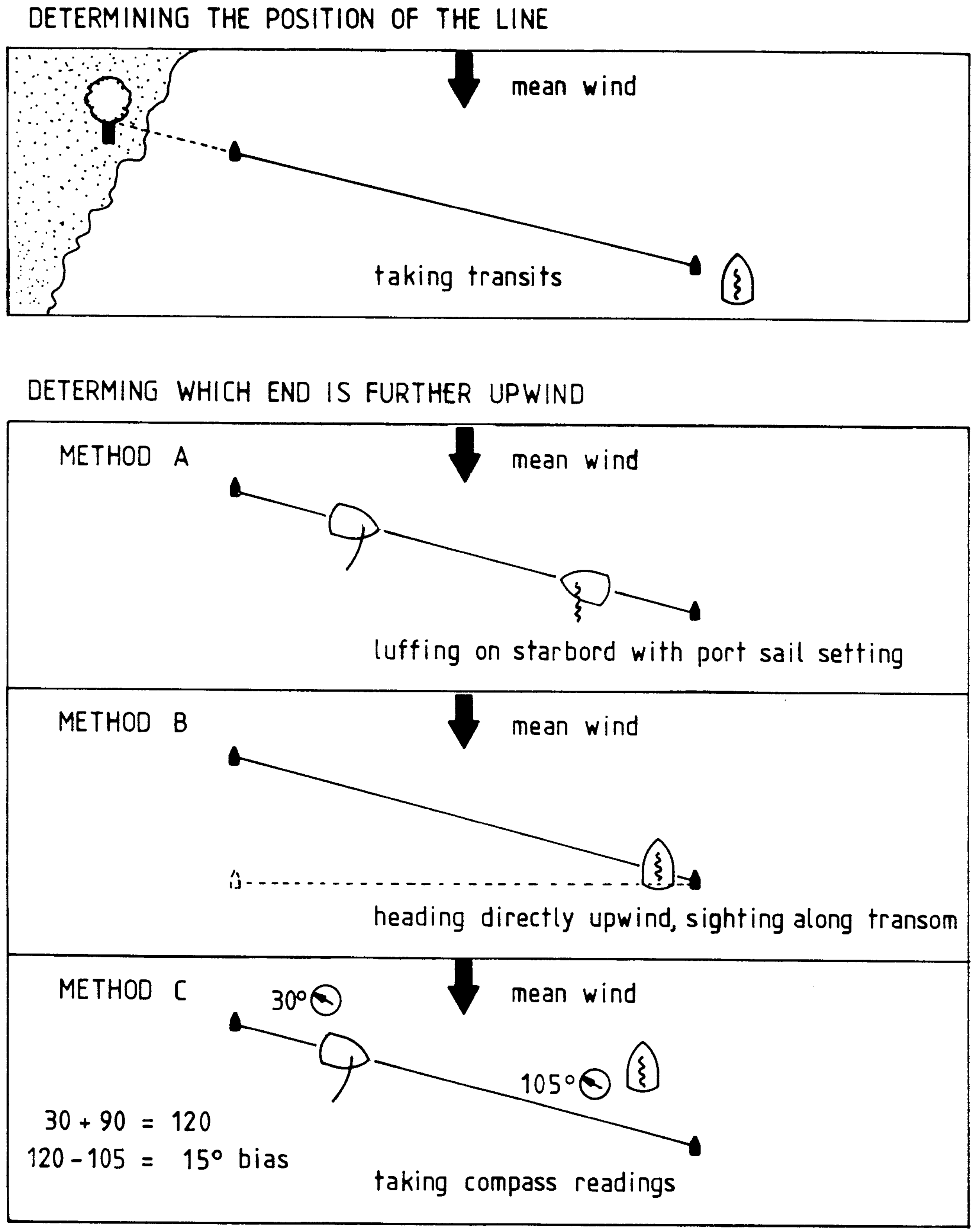


Fig. 9 Determining the location of the starting line by taking transits and also determining which end is favoured.

5.2 Starting Strategy

Having covered most of the basic points for obtaining a good start it is now time to consider the different strategies required for different wind conditions and for starting lines at different angles to the mean wind direction. The most important factors are:

- The preferred side of the course for the first leg governs the choice of ends, the desirable tack for the start and may mean selecting a start which will allow an early port tack.
- The approach to the line is governed by the choice of favoured end.
- The size of the fleet, the angle of the line, the wind speed and the presence of oscillating wind shifts determines the speed and angle of the approach tack.
- The wind speed provides an over-riding constraint, particularly in relation to the tactics and strategy involved in dealing with your immediate competitors on the line.

I would now like to consider the starting plan in more detail. Generally the main choice is between starting at the starboard or port end of the line, or in the middle. Rarely, you may also want to start on port tack. The following summary provides a guide to making these decisions.

5.2.1 Starting At, or Near the Starboard End

Starting near the starboard mark on starboard tack is a safe and conservative strategy that is less risky that starting at the port end. Starboard end starts require less precise information about the position of the line. They also require less skill and judgement for manoeuvring near the line. If you get a bad start, you can always tack onto port and look for clear wind, which may help you recover your position. When starting right next to the buoy, the approach should be made from a staging point about 5 boat lengths beyond the line extension (allow more distance in strong winds). The approach should therefore be made from well to windward of the starboard tack layline to the mark.

Staring at the starboard end is warranted if the line is square, you want a conservative start and if the starboard end is favoured. The exact starting position is determined by the following set of guidelines.

<u>Start next to the mark if</u>:

- Freedom to tack onto port soon after the start is essential. This early tack may be required because of the phase of wind shift pattern, or because the starboard side of the course offers some advantage.
- The winds are strong and oscillating without a clear pattern. This is a conservative measure retaining the option to tack onto port.
- You are reasonably confident of being able to win the fight for the ideal position right next to the mark. If you have the ability, you can control the fleet from this

position. However, if there are crowds of other boats attempting to get the ideal position it may be better to avoid trouble by starting a little further down the line away from the mark?

Start between the middle of the line and the starboard end if:

- The starboard tack is to be continued and there is no early need to tack onto port.
- The left side of the course is favoured.
- The wind is light and there is more chance of obtaining clear wind away from the starboard mark.

5.2.2 Starting At, or Near the Port End

Port end starts, on starboard tack, are more risky, and require better boat handling that starts at the starboard end. You must be aware of the position of the line and be confident that the port end is strongly favoured. If there is a wind shift, you may be in trouble through being held to the starboard tack by the mass of boats above you.

When starting at the port end, approach the line slowly keeping an eye on the other competitors. With about one and a half minutes to go you should be in a position from which you can reach the mark in less than a minute of full speed sailing. You should also be about 3 boat lengths behind the line. Watch what the other boats nearby are doing. If there is going to be a mass of boats at the buoy then hold back a bit. If there are fewer other boats then you can afford to go closer to the mark. Remember to be a little conservative. In large fleets you can not afford to make a major mistake trying for the absolutely ideal start. Try to be sailing fast when the gun goes and foot a little to get into the clear wind.

Start next to the mark if:

- Starboard tack is to be continued; no shifts favouring a port tack are expected.
- The left side of the course is strongly favoured.
- The air is light and there is clear wind only at the ends of the line.

Start between the middle of the line and the Port end if:

- Freedom to tack is essential.
- The right side of the course is favoured.
- The winds are strong and it is difficult to precisely time your approach to the mark.

5.2.3 Starting in the Middle

Starting in the middle offers relative freedom from the congestion that often occurs at the ends. It is more conservative, but offers greater flexibility. It is extremely important that you know exactly where the line is when starting in the middle. However, it often will provide freer winds and may be the preferred strategy in winds with an irregular shift pattern.

5.2.4 Port Tack Starts

Port tack starts should be attempted when the line is square and the port end lies further upwind. A port tack approach to the line is also very successful. If the conditions favour a port tack when the gun goes, and you can successfully start on port, you will gain an immediate advantage over the rest of the fleet on starboard. However, port tack starts are very hazardous in large fleets, particularly when the line is short.

5 .3 Starting Tactics

The starting tactics are the methods employed to gain an advantage over your fellow competitors. The ideal start is achieved when you

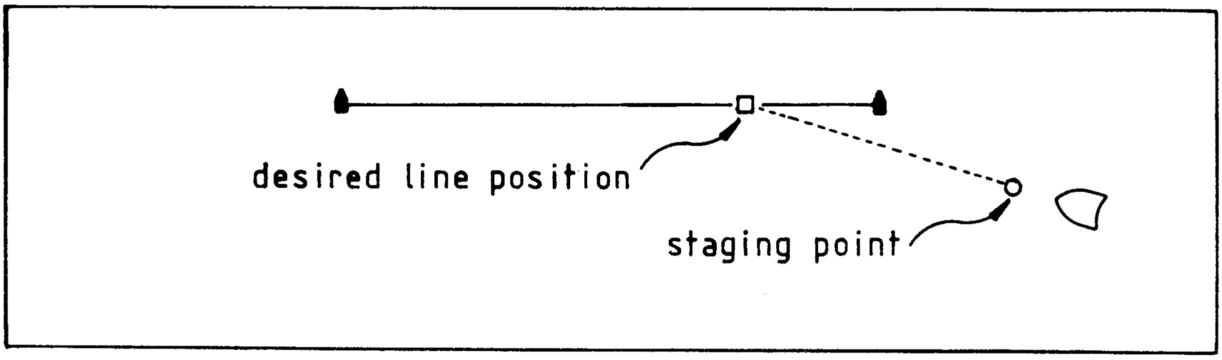
- cross the line right after the gun,
- you are heading in the favoured direction,
- you are in phase with the shifts,
- you have clear air,
- you have freedom to tack,
- and finally you win the battle with your immediate neighbours and the 100 other competitors all trying to obtain the ideal start.

I will begin discussion of starting tactics by giving a list of do’s and don't's.

- Don't get on the line too early so that you get cold waiting for the gun, but also avoid being late, otherwise you may miss out on the front rank position.
- Start with close to full speed when the gun goes.
- Start as close as possible to the boat immediately to windward of you, but as far away as possible from the boat to leeward. Whatever the approach you adopt, aim to come close to the lee-bow of a selected weather boat. You have right of way, and if you can maintain the position until the gun goes, your close position will force him to sail in the wind deflected ahead of your sail. This action will also prevent the windward boat from driving over the top of you, and helps to create a little free space to leeward (Fig. 10).
- Avoid going into the lee shadow of another starter in the final 10-20 seconds before the start.
- You can only afford to hang back when starting near the starboard mark. Otherwise be sure that you are on the line when the gun goes.
- Practise the techniques of manoeuvring a Laser while luffing and maintaining a stationary position near a buoy.
- Don't foot in the first few seconds after the gun goes unless you need the extra

speed to stop being overtaken by a windward boat. There is a considerable deflection of wind by the mass of sails lined up for the start. On the line the wind speed may only be three quarters of that occurring further upwind. There is also a sizeable veer in the wind direction on the line. Frank Bethwaite’s articles in 'Australian Sailing', have demonstrated this effect. The best way of breaking through this zone of slowed and deflected air is by pointing high for the first 10-20 seconds after the gun. Footing only takes you back into the slower deflected air. The effect of the fleet in deflecting the wind in the vicinity of the line is especially important in moderate winds. Remember also that the wind is slowed, and therefore you will need fuller sails at the start than later on the first leg.

THE APPROACH



DUELLING

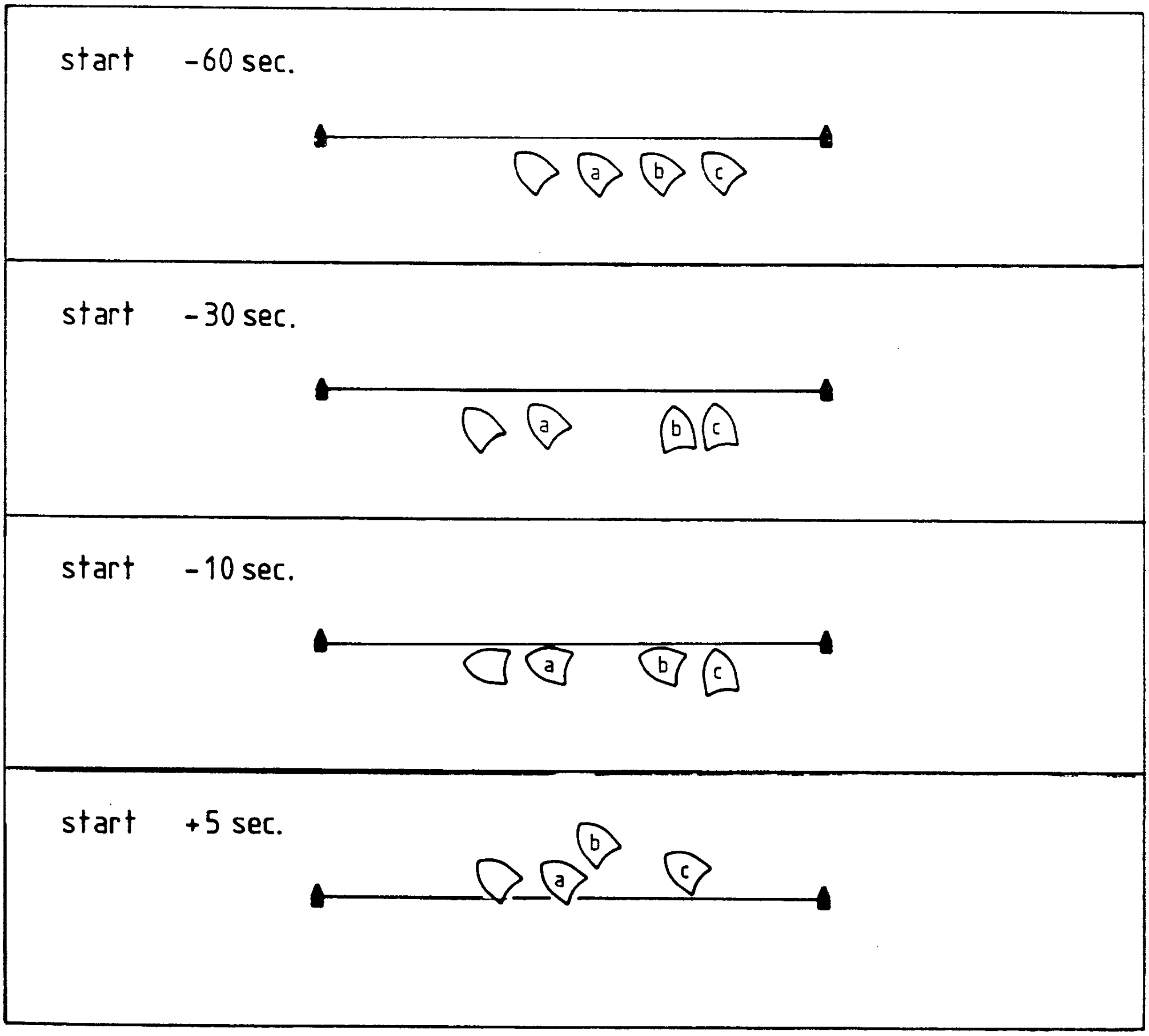


Fig. 10. The approach to the line and the close tactical manoeuvres required to obtain an advantage in the last few minutes before the start. The approach should be carefully timed and take place from a pre-determined staging point. In the last few seconds **'b'** obtains an advantage by luffing **'c '** and creating a small gap to leeward into which he can accelerate in the last few seconds.

5.3.1 The Tactical Duel

For all practical purposes, in the last 20-30 seconds the tactical battle becomes a duel between you and two other boats; the one immediately to windward of you on the line, and the one immediately to leeward. This duel consists of a fight for a small extra space to leeward of your bow (Fig. 10). You will need to luff the windward boat, attempt to make this boat stall, and keep it in a position where it cannot interfere with your wind. Meanwhile, you will also be attempting to maintain a fairly stationary position about 1-2 boat lengths from the leeward boat and protecting the space into which you can accelerate just before the gun, to gain an advantage over both your nearby opponents.

Now there are several ways in which you can protect this precious space.

- The first point is that you should carefully pick your two opponents. Select two inexperienced opponents for the duel and avoid the experts!
- Another key point is to remain observant and try to anticipate what your opponents are trying to do. Look around continuously. Especially watch boats on the second rank who will be hovering like vultures waiting to grab that space.
- If there is a mass of boats coming down the line then quickly decide how you are going to deal with them - either letting them go past you - luffing to bluff them into going behind you - or deciding to move down the line yourself.

You should also be aware of the rules, particularly the luffing rules, as they can be effectively employed to gain a tactical advantage. BEFORE the start the luffing rules apply, and a leeward boat has right of way and can luff to force an opponent to change his heading, but the luff can only be made slowly giving the windward boat adequate time to keep clear. Also the windward boat does not have to begin to keep clear until the overlap is established. Make use of these rules.

When sitting on the line, keep your boom out as wide as possible to stop other boats tucking under you. The space you create when you pull in the mainsheet is adequate to prevent the lee-bow situation. Also make the luffing boat aware that you are reacting, if ever so slowly. Use bluff as much as possible to keep the advantageous position.

In the last 10 seconds the situation changes very quickly and you can still lose the start badly if you do not respond in the right way. Ideally, in the last 10 seconds the fleet will be sailing down the line to gain speed for the start. Accelerate quickly and use the space to leeward to gain an extra surge of speed. Often, of course, things are far from ideal. In large fleets you simply cannot afford NOT to go with the bunch. If your neighbours, especially the windward ones, start to get edgy and move forward a little early, then go with them. 99% of the time there will be a major surge and there will be a general recall anyway. It is vital, if you are threatened with being swamped, to keep you bow 60-90 cm ahead of the boat to windward, and at least aligned with those to leeward. In large fleets you will not be able to see either end in those last 10 seconds, so keep slightly ahead and convince yourself that you are not over the line!

5.4 Light Air Starts

Under light wind conditions, a pocket of stagnant air forms in front of the massed boats on the starting line. It will be very difficult to get through this area of wind. Consequently, only the areas at the edge of the fleet will have any wind, and starts at either end of the line are generally favoured. Another point is that it takes longer to accelerate from rest in light winds, so the manoeuvres you make to accelerate just before the gun will take longer, and should also be made more gradually.

5.5 Starting in Strong Winds

In strong winds, wind shadow effects are less critical and so there is less concern about obtaining clear wind. The boat can be accelerated quickly, and so you can remain luffing just behind the line right up until the last few seconds before the start. The approach to the line can be made from slightly above the starboard tack lay line. More conservative starts are called for in stronger winds and you will need to avoid boats which capsize or go into 'irons' in front of you.

5.6 The First Five Minutes

The first few minutes are critical for the first windward leg. If you have made a good start you will be ahead of the pack, sailing fast in clear wind. A more conservative attitude is required in large fleets as you can not afford to make mistakes. For example, you should try to be on the correct side of the fleet rather than on the correct side of the course. For example, if the right side of the course is favoured, play the right periphery of the fleet, but do not go right out to the lay line if the fleet goes left.

After you have moved away from the starting line you can begin to implement your plan for the first leg. Stick to your pre-race plan but always be ready to adapt to unexpected developments. The main considerations for success in implementing this plan are: clean air; maintaining the correct tack in phase with the shifts, and retaining the ability to tack. Freedom to tack is vital in large fleets when large gains can be made by tacking to the shifts. This will require observation and anticipation to avoid situations which will deny you this freedom. It may even be necessary to pass behind a few starboard tack boats if you are sure there are advantages on the right side of the course, or there is clear wind beyond. Similarly, call port tack boats through in front of you when you are slightly ahead and have right of way on starboard tack. This will prevent the port tack boats tacking onto your lee bow.

5.7 Coming Back from a Disaster

If you have a disastrous start, you will need a firm and positive approach if you are to recover. <u>Clear wind</u> becomes number one priority. Make sure that you make no more mistakes! Concentrate on making optimum use of the shifts. Remember that many of those ahead are going to make mistakes and this will provide you with an opportunity to catch up provided you sail well and make no more mistakes.

CHAPTER 6

REACHING

The reaches are the fastest and most exciting part of any race, and they are important to the outcome providing a separation between the sailors within each group of boats that round the windward mark. The leaders at the end of the first windward leg can break away from the fleet on the first reach of the course because they have clear air and the first use of it. If you can develop a good reaching technique you will make significant gains because the speed differential between good and poor techniques is greater on the reaches than for any other leg. It is therefore important that you practice your technique and develop strategies and tactics for or the reaching legs. The elements of a good reaching technique can be broken down into three main areas: sail trim and boat handling; strategy and tactics. I will deal with each of these in turn.

6.1 Sail Trim and Boat Handling

The essence of a good reaching ability is the maintenance of speed. Minor variations in sail trim, the heeling angle of the boat, or the body position can be extremely important to achieving and sustaining maximum speed. The heeling force component of the total aerodynamic force generated by the sail is small, especially on a broad reach. Therefore, full and powerful sail shapes can be used. The vang, cunningham and outhaul should all be eased. The centreboard can also be raised to an extent dependent on the sailing angle. Normally the board can be lifted to the point where the boat is just not slipping to leeward; about 20cm for a tight reach and 80-90cm for a broad reach.

6.1.1 Rudder

When sailing close-hauled an exaggerated tiller action is usually fast when sailing through waves. However, this definitely not true offwind. Any excess rudder movement is equivalent to applying a brake. So keep the rudder dead-centre, except under extreme circumstances when you can not steer the boat sufficiently by heeling the boat to windward or leeward.

When an adjustment is needed to maintain an ideal sail orientation and heading - always take the sail trim option before using the rudder. Use the 'feel' of the rudder for sensing that the sail trim or boat heading is incorrect. If you are over-sheeted and pointing too low, you will feel an increase in the weather helm. Ease sheet and watch your wool tufts closely to keep the sail working at optimum efficiency. Both the windward and leeward tufts should be streaming back horizontally. A decrease in weather helm will generally signal that the mainsheet needs to be pulled in a little.

Leech ribbons may help to teach you the correct sail shape required for different conditions. The wind flow should remain attached to both surfaces and exit with equal strength from either side of the leech, and so keep the leech ribbons streaming horizontally.

6.1.2 Heeling

It is absolutely essential that the boat be kept very flat if you are to achieve maximum speed on the reaches, especially when planing. There is a large difference in speed between a boat that is reaching with a slight heel to leeward and one that is flat. Once again, the need to keep the boat flat has priority over the need to keep the boat from luffing occasionally in the stronger gusts. Also, the final sail trim and adjustments for the extra speed when accelerating, should only be made when the boat is flat and moving fast.

Anticipate the arrival of the gusts and prepare for them by heeling the boat slightly to weather. When the gust hits go for full power, pump the mainsheet, torque your body forward to bear away slightly and hike hard to quickly get the boat planing. Head off as the speed increases, not before! Keep the Laser flat!

Heavy weather capsizes when reaching are almost always due to heeling. Either the boom dips into the water or the heeling boat produces an excessive weather helm, the rudder stalls, and the boat suddenly rounds up and capsizes. The trick is to keep the boat flat and 'tracking' by using rapid small movements of the rudder. Keep weather helm to a minimum. If the winds are really strong, heel the boat slightly, very slightly, to weather.

6.1.3 Maintaining a Plane

A major difference in speed on the reaches can often be attributed to a difference in skill, firstly in initiating the plane, and then sustaining the plane for longer as the wind lulls. The more skilled and lighter weight skippers can make large gains in marginal planing conditions. All heading changes should be made with minimal use of the rudder. Heel the boat slightly to windward and the boat will head away in a smooth arc. Strictly speaking pumping the mainsheet is only allowed to initiate a plane (see Section 2.1.1), but less rapid mainsheet trimming is continuously required keep the boat on the plane. To assist with these rapid trimming movements grab the mainsheet directly (i.e. bypassing the mainsheet block) to allow more sensitive control. Keep the body action and trim adjustments smooth; jerking does not seem to be effective except in waves and turbulent wind. Rapid fore, aft and sideways movements of the body will be required to keep the boat planing at maximum speed.

6.1.4 Body Position

In light winds, sit in the middle of the cockpit or slightly further forward. Move further aft as the wind speed increases or the boat begins to plane. As a general rule, during the transition from non-planing to planing and back again, you should move further back after the boat begins to plane, and come forward again just before the boat comes off the plane. On a 'screaming', planing reach, in winds above 20 knots, you will need to be fully hiked, angled backwards at about 45 degrees to the centre line of the boat, with the upper body extended over the stern.

Good techniques are required to gain maximum advantage of the planing and surfing possible in waves. To catch a ride on a wave requires a sudden backward and outward movement of the body to 'throw' the boat forward and to leeward as the wave begins the lift the stern. Once on the wave, steer in a direction which will allow you to stay on the front face for as long as possible. Depending on the direction the waves are travelling in relation to the rhumb line, this may require heading away, or steering 'along the troughs', but avoid running into the back of the wave in front.

Look behind and to windward when sailing in waves, especially in marginal planing conditions, and steer towards the bigger sets of waves that form periodically. Significant gains can be made by riding these waves.

Speed on the reaches depends on experience and time spent on the water and will only come with practice.

6.1.5 Pumping and Ooching

Read the latest changes to Rule 42 and their interpretation (see Section 2.1.1), to ensure that your kinetic techniques are not illegal. Pumping the mainsheet is generally limited to three (?) rapidly repeated trims and releases of the mainsheet in each wave set. Therefore in simple terms you are allowed three (?) pumps to initiate or promote a plane in response to a wind gust, or to catch a wave, but not to artificially propel the boat. Pumping and ooching are allowed to a limited extent when surfing or planning conditions exist, or in waves. Develop smooth ooching, rocking and pumping techniques that are allowed under the rules for the prevailing conditions. These kinetics are very important in winds of 10- 15 knots.

6.2 Reaching Strategy

The elements of a good reaching strategy are:

- choosing the right side of the course
- making the best responses to varying wind patterns
- making best use of waves
- dealing with your opponents to keep in clear wind.

In oscillating winds most people use the simple strategy of heading up in the lulls and away in the gusts. This means making heading changes away from the simple rhumb line course on the reach. While this may be a good principle, it is useful to examine why this strategy works, and under what conditions it provides an advantage or not.

This discussion is technical and some readers may want to skip the details.

To introduce this discussion let us first examine the way in which the performance of a sailing dinghy varies as the heading changes –even when the boat is sailed optimally at all times (See the performance chart in Fig. 11).

The estimated performance chart is typical of sailing performance of boats without a spinnaker. The details may not be exactly correct for a Laser, but they illustrate the concepts. I am unaware of any performance chart specifically for a Laser.

Figure 11 shows the maximum boat speed attainable by a dinghy sailed at various headings to the true wind direction, in true winds with speeds from 5 to 25 knots. Each of the curves shows the performance at one particular wind speed. The boat headings are shown as angles to the true wind, which if you like, is blowing down the page. The boat speed is indicated as the distance from the origin (point '0', at the centre of the figure).

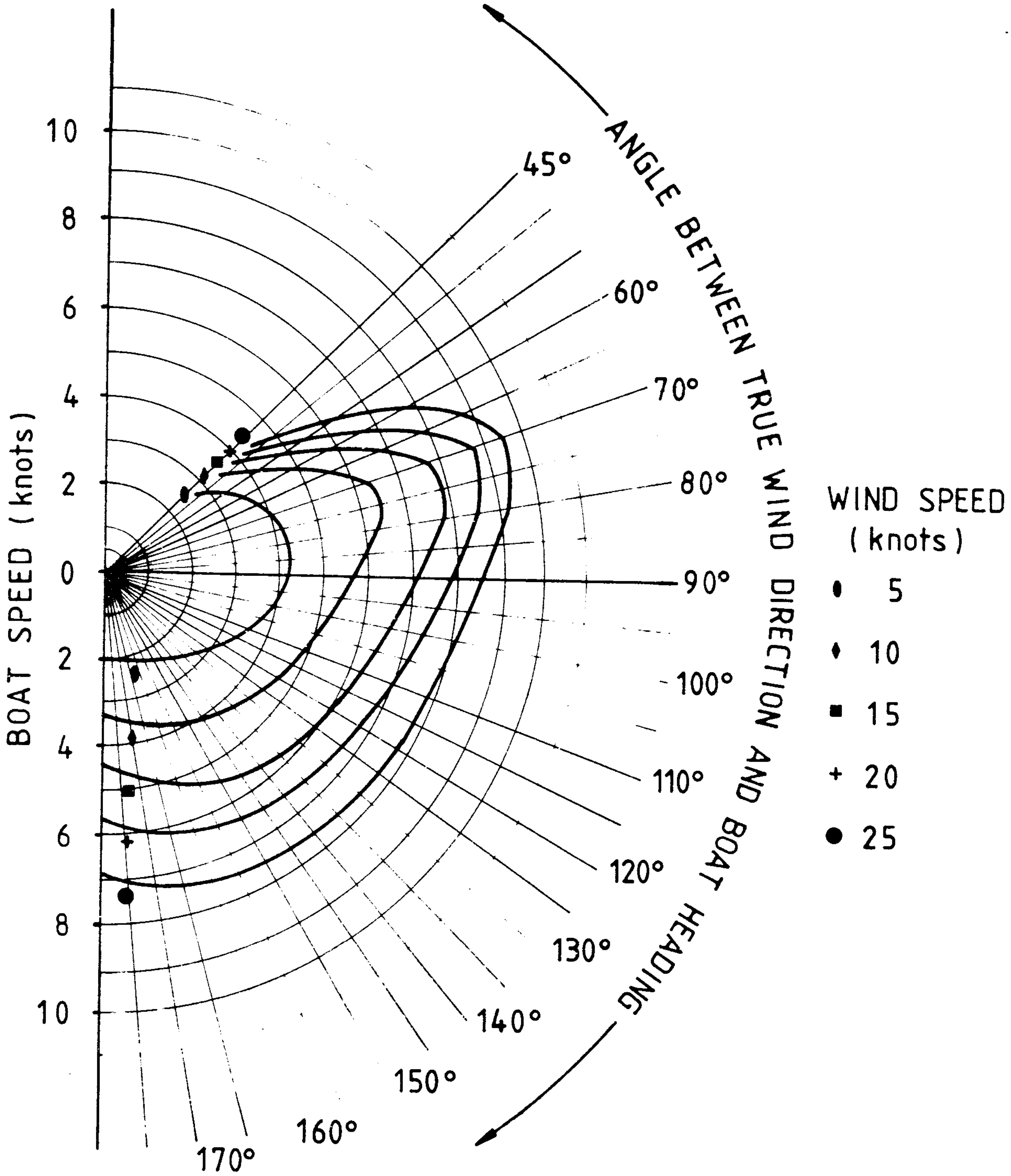


Fig. 11 A polar diagram showing the performance of a typical small planing dinghy at different angles to the true wind direction. The figure shows the boat speed of the dinghy when optimally sailed in winds of different strength. The five curves relate the boat speed to the angle between the true wind velocity and the heading of the boat. Maximum speeds are obtained in the 'reaching sector' with heading of 60-90 degrees to the true wind direction.

For example, the maximum attainable boat speed for a boat sailing in:

- 25 knots is 5 knots at 50 degrees to the true wind,
- 8 knots at 60 degrees,
- 9.5 knots at 70 degrees,
- 9.25 knots at 80 degrees,
- 8.5 knots at 90 degrees,
- 8 knots at 100 degrees, etc.

Notice that the highest boat speeds are always found with the wind at 60-90 degrees to the true wind direction. This is the reaching sector. Also notice the subtle changes in the shape of the curves for different wind speeds.

- In winds of 5 knots, the curve in the reaching sector is fairly flat, i.e. there is not much difference between the boat speed at 60 degrees (3.5 knots) and 80 degrees (4.25 knots). The highest boat speed actually occurs at around 85 degrees.
- At winds above 10 knots there is a bulging of the curves at around 70 degrees, which then becomes the angle for the highest speed. This change is due to the extra speed obtained when a boat planes. Another result of this change due to planing is the narrowing of area in which the higher speeds are attained.
- At 25 knots of wind, a boat angled at 60 degrees has a maximum speed of about 8 knots, whereas at 70 degrees the maximum speed is 9.5 knots. This is a very significant speed difference when sailing.

It should be clear from this discussion that there is a narrow optimum reaching sector, and the key to maintaining speed on the reaches is remaining within this sector for as long as possible.

Now, in order to examine the principle of heading up in the gusts and away in the lulls at little further we have to consider the effects of wind shifts. It should be obvious that this principle is designed to optimize the speed in the gusts. Bearing away will often bring angle and so produce close to back to the rhumb line in lulls, but this will be compensated by the extra speed in the gusts. However, the situation is complicated by the fact that the wind direction almost always changes when the wind speed changes.

When the wind speed increases there will always be a shift in the apparent wind direction, by virtue of the change in the size of the two components contributing to the apparent wind, that is the true wind velocity, and the boat speed and direction. Usually a gust will result in a shift in the apparent wind forward, that is to head the boat. This shift arises because the change in the true wind speed will always be greater than the increase in boat speed it generates. The reasons for this will be clear by examining the vector diagrams in Fig. 12.

In addition, the direction of the true wind itself will change as the wind speed changes. In the Southern Hemisphere the wind tends to back as it gusts (i.e. the wind direction will shift in an anticlockwise direction when the gust hits). The opposite is true in the Northern Hemisphere. The reasons for this are given in "Principles for Sailing on Inland Lakes ", by Dr. John R. Anderson (1982). Gusts usually arise when winds at higher altitudes are brought down from above. These winds have a slightly different direction from the surface winds because of the effects of friction, and so the passage of gusts is associated with a consistent backing of the wind.

Figure 12 demonstrates how the direction changes associated with gusts affects the performance of boats when reaching. It should be clear that the direction change associated with a gust, has a much greater affect on the maximum speed for boats on a port reach, than on a starboard reach. This is because the shift with the gust brings the wind closer to the optimum angle of 70 – 74 degrees, for the port reach, compared with 46 degrees for the starboard reach.

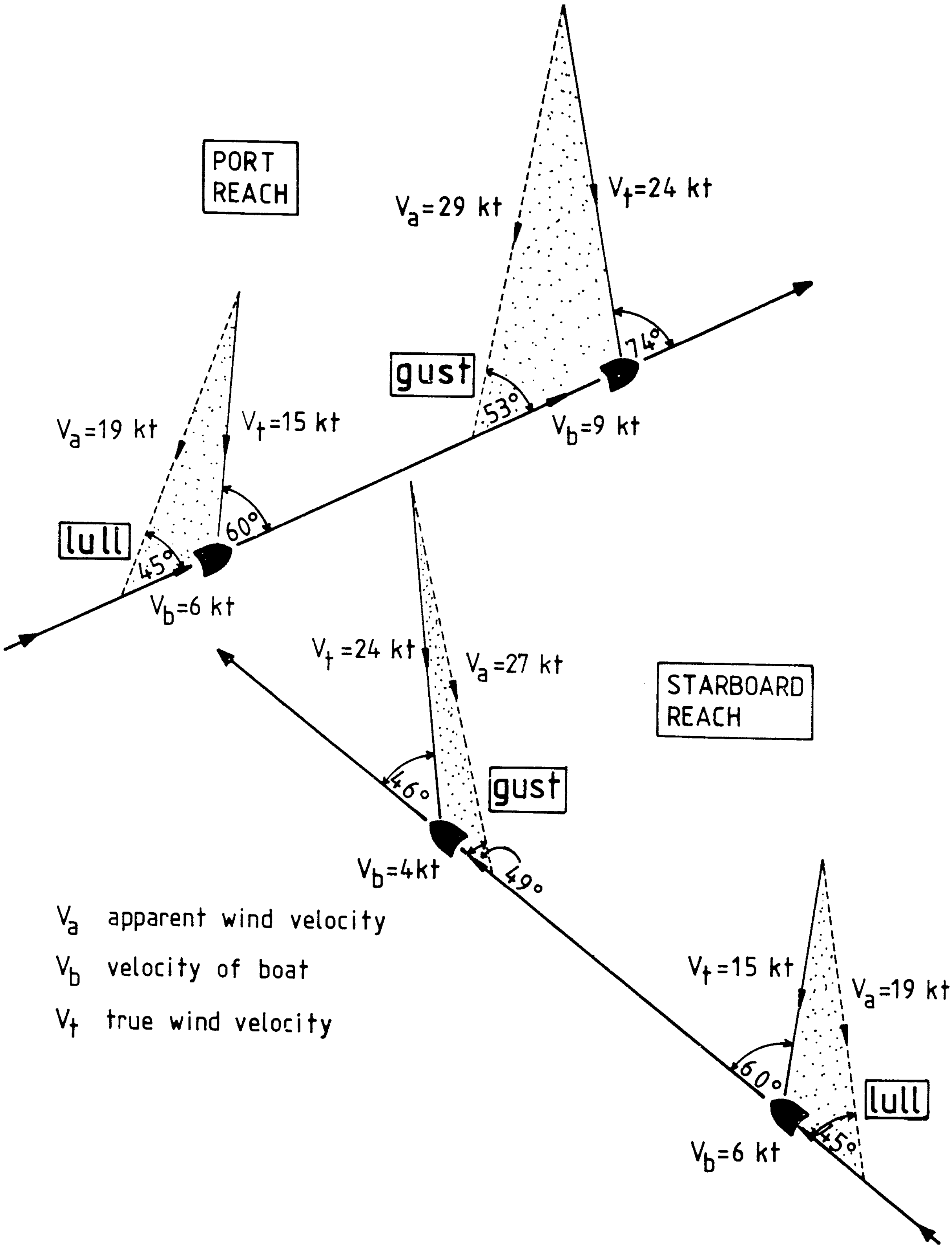


Fig. 12 Strategy for port and starboard reaches in oscillating winds. The changes in apparent wind produced by a wind which backs 14 degrees as the speed increase from 15 to 24 knots. The boat speeds for each of the different sailing angles are derived from the performance characteristics as shown in Fig. 11.

Let us now consider the effect of different strategic responses to gust/lull sequences on the performance of boats on the reaches. Consider two skippers who adopt different approaches. The first, referred to as '**RL**' always sticks the rhumb line and responds to the wind changes in the gusts and lulls by adjusting the sail trim. The second referred to as ' **HL**' follows the strategy of heading high in the lulls and low in the gusts. I will now discuss the theoretical effects of these different strategies on the starboard and port reaches.

Starboard Reach

On the starboard reach **RL** is faced with a true wind speed in the lulls of about 15 knots, and a true wind direction 60 degrees to the rhumb line (Fig. 12). Looking at the performance chart in Fig. 11, we can see that sailing along the rhumb line he is just about in the reaching sector and doing about 6 knots. So he is not doing too badly; his speed is just below the highest achievable speed of 8 knots, at an angle of 70 degrees.

When hit with at a gust, the wind increases to 24 knots and backs 14 degrees. Therefore, to remain sailing on the rhumb line he has to pull in the mainsheet to accommodate the new wind blowing at 46 degrees to the rhumb line. His heading has now fallen out of the reaching sector and his boat speed has consequently fallen to 3.6 knots. This strategy has therefore produced a considerable loss of speed in the gusts.

Now let us consider the outcome of the other strategy. **HL** is attempting to maximize his net speed over the entire leg by heading off in the gusts by a maximum of about 20 degrees below the lay line. In order to do this, he sacrifices some speed in the lulls to bring him back to the rhumb line. For example, he may head 10 degrees above the rhumb line. We can see the effects of these headings by looking at Fig. 11 and 12. When the gust hits **HL** will bear away from the rhumb line and plane at a heading of about 70 degrees. His speed in the gusts will be around 8 knots, which is about double that of **RL**. This gain in speed in the gusts more than compensates for the slower speed in the lulls (about 4 knots at a heading of 50 degrees). Therefore **HL's** strategy provides an advantage on the starboard reach.

Port Reach

On the Port Reach (remember that there is always a port and starboard reach on a triangular course) **RL** still maintains the rhumb line. The situation in the lulls is much the same as for the starboard reach. When the gust hits there is a shift in the true wind direction to 74 degrees, so on the rhumb line heading **RL** has an optimum speed of about 9 knots. Now let us see what happens to **HL.** He religiously sticks to his strategy and so he heads up in the lulls and loses a little speed compared to **RL**. When the gust hits he heads below the rhumb line, taking him to an angle of about 90 degrees to the true wind. This is outside the reaching sector and so his speed will again be lower than **RL** (8.5 knots compared with 9.25 knots)

This example provides a case when the basic strategy of heading up in the lull and down in the gusts does not work. It shows that you must be prepared to adapt your strategy to the conditions.

The more fundamental principle is to remain in the reaching sector for the longest time possible on each reaching leg. If the gust provides a shift that optimizes the sailing angle, then there is no need to bear off away from the rhumb line.

On a very broad starboard reach it may even be better to head up in the gusts and away in the lulls! Only by doing this will you be heading at 70 degrees to the true wind direction in the gusts.

The concept of a reaching sector is just as important as knowing the right balance between pointing and boat speed when close-hauled. Only experience and past performances will allow you to be sure that the extra speed gained by bearing away from rhumb line in a gust will more than compensate for the extra distance and poor sailing angle required to return to the rhumb line.

Up to this point the concept of a reaching sector is not very practical as it relates to the heading of the boat in relation to the true wind direction. There is no room on a Laser for the computer required to make the calculations! However, we can read and use the apparent wind direction for determining when we are in the reaching sector for the apparent wind. In general terms the apparent wind direction for a small dinghy is about 15 degrees less than the true wind angle when close reaching in moderate to strong winds, and about 30 degrees less when broad reaching. The fastest point of sailing for a Laser in moderate winds appears to be about 60 degrees to the true wind, increasing to around 90 degrees in strong winds. So the reaching sector for a Laser, in apparent wind terms is 45-60 degrees, with considerable variation according to the wind strength. You can keep within this sector when sailing on the reaches by using a wind indicator, especially if it is fitted with some device to directly indicate these angles.

An alternative method of keeping within the reaching sector is to maintain an optimum boom angle. The boom is generally carried at an angle of about 10-15 degrees to the apparent wind, so that the equivalent sector angles for the boom are between 35 degrees and 45 degrees to the centreline of the boat, the angle varying with the wind strength.

6.3 Reaching Tactics

So far, what we have discussed relates only to a single competitor selecting an optimum way of sailing the reach leg. We have not yet considered those annoying beings – other competitors! When sailing in large fleets, having a set of tactics is often very important, especially when you are sailing in a bunch with a group of competitors. Sailing in lee shadows, and the lack of freedom to apply your strategies can be very detrimental to speed on the reaches. A major decision has to be made whether to go high or low on the reach.

In general a rhumb line course is only appropriate when:

- The sailing angle is broad

- the wind is moderate and steady
- there are few boats close behind you
- there is no significant advantage to one side of the course

Another consideration is the need to be in the favoured position at the end of the leg.

- Going low initially will allow a higher and faster approach at the end of the leg, compared with those that go high initially and come down to the mark on a very broad reach.
- Going high has the added disadvantage that you often get caught in luffing matches. If you have a little extra speed, the boats ahead will often luff and make you go very high to overtake them.

Going low avoids these problems and is the preferred option in large fleets when most people seem to go high, leading to a procession of slow moving boats travelling in an arc well above the rhumb line.

As you approach the mark, the advantage lies with those who are on the inside of the fleet and so can gain buoy room. This can also dictate the tactics for the second half of the reach. To gain the inside position will mean that you will want to head low for the first reach around the course (starboard reach) but high for the second (port) reach.

Incidentally, this fits in with the earlier points regarding the correct responses to the wind direction changes on port and starboard reaches. Heading away in the gusts and travelling below the rhumb line on the starboard reach will mean a low approach to the mark at the end of the leg. On the other hand, staying on the rhumb line, or just above it, on the port reach will be the correct response to the gusts and will mean that you will be above the fleet, and on the inside, at the leeward mark.

6.4 Rules for Reaching

The following list of rules provides a summary of the principles involved in selecting the right course for the reaches.

1. Always head for the favoured side of the course. One side may be favoured due to current, tide, or the differential distribution of wind or waves.
2. Sail the rhumb line when the wind is steady, there are few other boats nearby, and planing is possible almost all the time (i.e. in winds above 15 knots).
3. In oscillating winds deviate to windward initially, and then sail up in the lulls and down in the gusts to optimize the sailing angle for the gusts. However, steer to remain in the reaching sector and do not head away in a gust that provides no advantage. If you are already planing stick to the rhumb line.
4. In marginal planing conditions - ride down the gusts - almost irrespective of the heading so as to remain on the plane for as long as possible.
5. If the wind is light, but likely to increase later in the leg, deviate to windward

initially so as to save the disadvantageous heading late in the leg, to the time when the new wind will give you extra speed.

6. When the wind is light and dying, sail to leeward initially so that you will be on a more advantageous sailing angle when the wind speed decreases.
7. In consistently strong winds, assume the sailing angle which will allow planing at the start of the leg. Change your course to maintain the planing with each gust, but keep as low as possible to allow the fastest possible approach to the mark at the end of the leg.
8. When you are followed by a large group of boats, avoid going low initially, as you will fall into their combined shadow. Sail on the rhumb line initially, and if you can break clear you can then head low.
9. Avoid luffing matches at all times. Luffing a single opponent is silly if you lose 5 or 6 other boats in the meantime. Avoid all such situations by going well to windward of another boat before attempting to overtake it. Alternatively, go well to leeward of boats you are attempting to overtake to leeward. The lee shadows of boats to windward may extend 5 to 10 boat lengths to leeward.

CHAPTER 7

RUNNING

7.1 Sail Trim and Boat Handling

Sail trim adjustments are not as important when running as they are for the other points of sailing. In general, it is not necessary to ease the outhaul or vang, though the cunningham should be eased. An extra long mainsheet is needed to let the boom go 'over-square' allowing the boat to be heeled to windward in light winds.

7.1.1 Rudder

As when reaching, it is essential that the rudder movements be minimized. Steer by heeling the boat to either side. If the course will allow it, heel the boat well to windward most of the time. This is generally fast as it reduces the wetted surface of the boat, it lifts the sail higher into the wind, and it moves the centre of effort of the sail directly over the centreline of the boat (aligning it with the centre of lateral resistance) and so reduces weather helm.

7.1.2 Centreboard

The centreboard should be fully up when running. The only exception is in choppy conditions, when having the board partially down helps to keep the boat moving with greater stability and stops the boat rocking from side to side venting wind.

The board can be lowered occasionally in stronger winds when the boat wants to start a 'death-roll'. In very strong winds it may be best to keep the board half-way down, or even fully down, if you have trouble keeping the boat stable. The speed losses from lowering the board in planing conditions are fairly small.

7.2 The Advantages of Sailing-by-the-Lee

When running before the wind the sail acts as a barrier to the wind flow, rather than as an aerofoil, deflecting the wind flow and drawing power from the differential speed of flow over the two surfaces. Consequently, sail shape is less important.

In most winds it is faster and safer to sail-by-the-lee, that is, to induce the wind to flow from the leech to the luff, rather than in the regular direction that applies for the other points of sailing. This allows a faster wind flow over the sail because it avoids having the wind pass over the mast before reaching the sail. Sailing-by-the-Lee also produces some flow over the leeward surface of the sail and allows you to lift the boom end skywards. The faster induced wind flow means more power.

In light winds sailing-by-the-lee can be achieved by letting the boom out 'over-square ', and assuming the ‘wrong’ tack for the run. That is, you choose the gybe which will bring the boat into a position that the wind comes from the same side of the boat as the boom is set. Adjust the heading of the boat until the wool tufts on the front (and hopefully the back as well) of the sail begin to stream towards the mast. A wind indicator can be very helpful to get the angle right.

The performance chart (Fig. 11) shows that there is a slight speed increase when sailing with a heading above or below 180 degrees to the true wind. However, with Lasers the extra distance required to sail the run by tacking downwind is seldom compensated by the extra speed achieved. Pulling in the mainsheet a little, or choosing an appropriate gybe, to induce a reverse wind flow over the sail has the effect of producing a little extra speed while maintaining the dead-downwind course.

In moderate winds there are still advantages for sailing-by-the-lee, with the vang eased. Less heeling will be required than for lighter winds. Pull the mainsheet in a little to induce the reversed flow with a boom angle of about 70-80 degrees to the heading. Select the appropriate gybe, and as before, use the wool tufts and wind indicator to get the wind flow correct.

In stronger winds, if you have the skill, sailing-by-the-lee with the vang eased is fast and definitely safer because the heeling force is easier to balance (Fig. 13)! Sailing-by-the-lee also tends to reduce weather helm and the periodic stalling of the sail when the boat rocks from side to side. However, if you misjudge the angle you may crash into a gybe, especially in an unexpected gust, so care is required. Watch the wind indicator!

7.3 Weight Distribution when Running

Sit well forward in the cockpit in the lighter winds; right next to the centreboard. Moving further forward in front of the centerboard, may slow the boat if the bow is buried.

In moderate winds, sit just aft of the centreboard. Play the mainsheet to obtain maximum speed in the gusts and to initiate a plane.

In strong winds the position of the body is important for maintaining not only speed, but stability. Moving further back will generally help to keep the boat from rocking. While the Laser is planing, keep to the middle or aft of the cockpit. As the boat slows to come off the plane, or to stop surfing, move forward a little to help maintain the speed for longer. Conversely, moving aft lifts the bow and helps to accelerate the boat onto a plane.

Steer to keep the Laser always sailing down the face of waves and not into the back of them. Remember to move laterally, as well as fore and aft, as the boat speed changes and is accompanied by a change in both speed and direction of the apparent wind. The mainsheet will have to be adjusted for the different speeds.

Look behind to see where the next set of waves is forming behind you, steer to intercept the larger waves and head so as to remain riding on each wave for as long as possible. Wave riding provides a major speed differential for the running legs especially in marginal planing conditions.

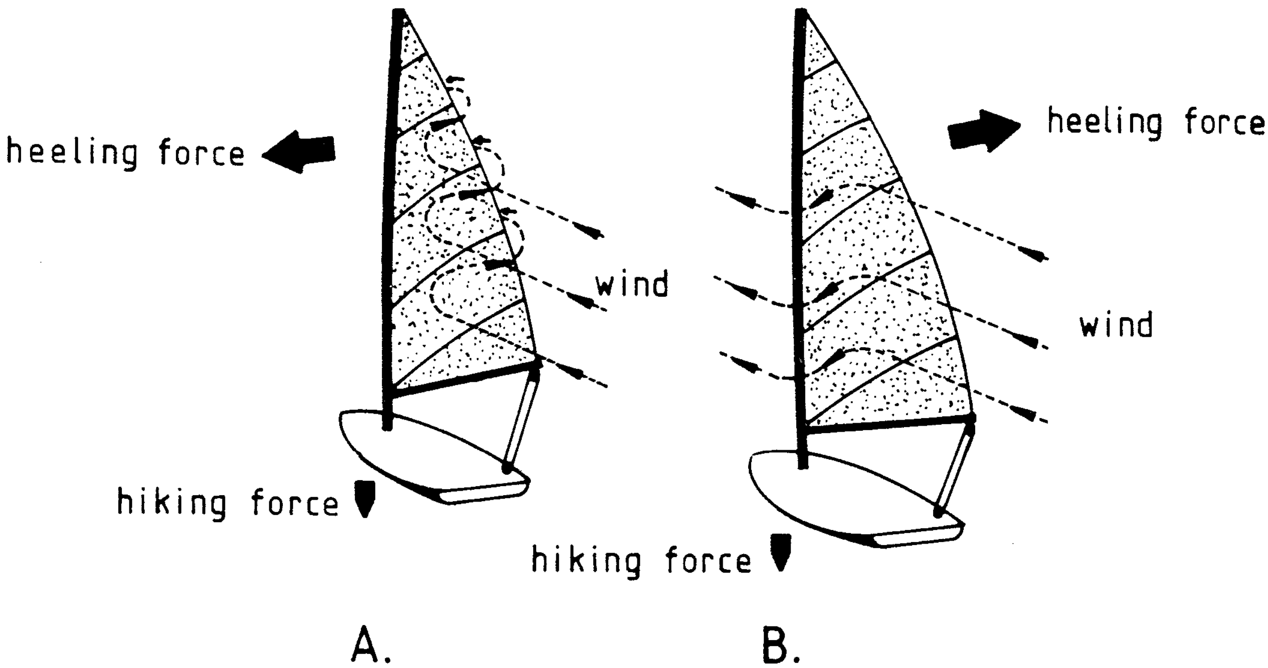


Fig. 13 The changes in the balance of forces when running. When sailing-by-the-lee (**B**) the wind flows from the leech of the sail to the luff. This flow produces a heeling force to starboard which is opposing the hiking force generated by the helmsman sitting on the port side of the boat. When sailing with the air flow from luff to leech (**A**) the heeling force and hiking force act in the same direction, and this often leads to capsizes when running. Therefore, sailing-by-the-lee provides greater stability and slightly greater speed when running. In strong winds the sudden change in the way the wind flow across the sail, and the periodic bending of the mast forwards tends to spill wind from the sail. This leads to changes in the heeling force which alternates from port to starboard and then back to port. If this is allowed to continue it will lead to a 'death-roll', capsizing towards the side the helmsman is sitting on.

7.4 Techniques for Heavy Weather Runs

If you have progressed to the stage where you only capsize your Laser on the runs and gybes, you can regard yourself as a reasonably competent Laser sailor!

In the 1982 N.S.W. Laser Championships every one of the 80 or so competitors capsized at least once on the run. Admittedly, the winds were averaging 30 knots and gusting to 40 or 50 knots, but this still demonstrates that you should not get disheartened if you capsize. Lasers are renowned for being difficult to sail on the runs. Here are a few techniques which may help.

Firstly, in strong winds never allow the boom to go anything like completely square. The best way to prevent this is by tying the knot in the mainsheet progressively further in, shortening its maximum length, as the winds freshen. Do this before you leave the beach, or on the water if there is a sudden increase in the wind strength. When sailing in strong winds reduce the mainsheet length still further by pulling more of it through the mainsheet block to maintain stability in the gusts. The boom angle may only be 60-70 degrees to the centreline of the boat under extreme conditions.

Figure 13 shows the effect of pulling in the sheet on the wind flow and therefore the balance of the boat. When sailing-by-the-lee, with a reversed wind flow, the heeling force shifts to a direction that can be balanced by hiking.

Now, even when you have pulled the mainsheet in a little, there is still a tendency for the Laser to ' Death-Roil '. It is worthwhile considering why this instability occurs. It occurs because of the effect of wind flow patterns on the heeling force and sail force directions, and the rapid oscillation with gusts, sail position and boat trim. The bendy, unstayed mast of the Laser also contributes. As the wind gusts the mast tends to bend forwards. At a certain point the bend reaches a critical point where it suddenly allows the sail to spill wind. Wind is also spilled when the leech stretches. When this happens there is a sudden reduction in heeling force produced by the sail. Now before this spill occurs, you will have been hiking hard to compensate for the original heeling force. When this heeling force is suddenly reduced, your weight is sufficient to heel the boat to windward. Soon after these events, the mast will return to its original position This movement of the sail through the wind flow will generate a sudden increase in the heeling force in the opposite direction, tending to roll the boat to leeward. Meanwhile you will have shifted inboard to compensate for the loss of heeling force with the mast bend. If the correct response is not made to this rolling action from side to side, your body weight transfers are just sufficiently out of phase with the movement, to increase, rather than decrease, its frequency. The result is that the oscillations increase in amplitude and frequency and you are headed for another spectacular 'Death-Roll' and capsize!

To overcome this situation you have to break the cycle.

- The first thing to do is to lower the centreboard which will provide a lateral resistance inhibiting the rolling motion. The best way of doing this is with a swift kick. You will only make things worse, under strong wind conditions, if you attempt to move forward in the cockpit and lower the board with your hands. So simply bang on the top of the board with a foot released momentarily from under the toe-strap.

- The next thing to do is to move your weight in opposition to the rocking of the boat, almost in anticipation of the rocking action. As a desperation measure, dropping everything and violently throwing your weight from side to side will often save a capsize one the 'Death-Roll' has started.
- However, the most effective means of stopping the action before it gets out of control is by lowering the board, and pulling in the mainsheet at just the right time. When the boat starts to roll to leeward, hike hard and pull in a metre or so of mainsheet. This will generally break the cycle. When the gust passes and you are once again in control, lift the board a little and ease sheet for extra speed.

Righting the Laser after a Capsize and avoiding Re-capsizing

Other problems arise after you capsize and have to get safely back onto the run, heading downwind. These problems often lead to multiple capsizes and this can be very disheartening if not damaging.

After capsizing you will have to swim the bow around so it heads upwind. Once you have righted the Laser you will have to bear away onto the reach and bring the heading back around 180 degrees to resume the run. Generally there is no problem bearing off to the angle of the broad reach. However it is often hard to get the Laser to turn around the extra 90 degrees! Even with the rudder angled right over to one side the boat will not come around, especially in strong winds! Often the rudder will cavitate, stall and you will lose control and capsize again. The trick to preventing this is to retain a couple of metres of mainsheet when you are on the broad reach. This can be let out as you bear off and come around to the run, momentarily depowering the sail and reducing the weather helm. Heel the Laser to the weather a little (!!) at the same time. Also remember to have the board half way up, or all the way up, when trying to bear away.

In summary you get the Laser going at maximum speed on the broad reach hike hard to keep the Laser flat - better still induce a slight windward heel. Then, when you have the boat steady, pull on the tiller and release a metre of so of mainsheet. A slight heel to windward, induced by letting out the sheet will help to bring you around onto the run. As you come around you will have to quickly move inboard because of the reduced heeling moment on the run compared to a reach. Lower the centerboard a little to keep the Laser steady. You can raise it once the Laser is stable on the run.

7.5 Strategy and Tactics

The key principle for strategy and tactics is to look behind when running! Too many people face forwards all the time when that all the action is behind – the gusts, the waves and the other boats threatening to take your wind. You need to be aware that a gust is about to hit, so that you can anticipate by pulling in the mainsheet a little. Also you need to know where the gusts are coming from and where they are heading. You may want to sail on the other side of the course if the gusts are coming from that side, or you may want to steer into the path of the gust to get the extra speed.

Initiating and sustaining a plane is a key objective on runs like it is on the reaches. Head in a direction that will achieve this and ignore the rhumb line course. Try to predict the direction that the gust is moving so that you can stay in it longer. The wind direction changes associated with gusts are also very important because you may be able to initiate a plane by quickly changing direction. The tactics for the run generally involve trying to stay out of the wind shadows of the boats behind you. Generally it is better to go low initially so that you can approach the mark at the end of the leg on a broad reach.

CHAPTER 8

TACKING, GYBING AND ROUNDING MARKS

Most of your tacks should be roll-tacks. Roll-tacking has several advantages and when done correctly you actually gain speed from a tack rather than losing it. By actively rolling the Laser using your body weight, the sail moves quickly through the air, and it keeps drawing longer than if you simply ease the sheet and push the tiller to leeward. Rolling the boat also imparts a steering force which helps to swing the boat onto the new course without excessive rudder movements. In fact, a Laser tacks best when you virtually let the helm pass across the boat almost of its own accord. At the end of the roll the boat is pointing in the right direction for the new tack, but is heeled over slightly. Hiking to bring the boat upright again produces an extra surge of power. (Note: Check the rules in Section 2.1.1).

The roll-tack is initiated by letting the boat heel slightly to leeward. Hike hard and apply minimum rudder movements to get the tack started. You simply release the weather helm and let the boat begin to round up of its own accord. Let the roll continue until you are almost head to wind, and the windward gunwale is almost in the water. Keep the mainsheet tight for long as possible. Then quickly move to the other side of the boat, hike hard and pull the mainsheet on tight again.

Do not pull mainsheet in completely until you have gained the extra speed imparted by bringing the boat into an upright position again. The fuller sails will give extra acceleration.

Always ensure that you face forward through the tack. Also to try to develop a tacking technique that does not involve dropping the tiller. You can retain hold of both mainsheet and tiller if pass the tiller extension behind your back as you rotate. You will need extra mainsheet length for this, so let it slide through your hands a little as the boat is tacking. As you come to the new position on the other side of the boat, bring the hand holding the mainsheet across the body to grip the tiller extension. The other hand, holding the extension behind your back, is then transferred to gripping the mainsheet and you have then swapped hands ready for the new tack. Develop your own technique that is smooth and fast, but always retains control.

8.2 Gybing

A correct gybing technique requires experience and practice. Your pre-race preparation should always include a few gybes, hopefully to increase your confidence! There are two important elements to successful gybing.

- The first is to ensure that the boat is sailing directly downwind (a good wind indicator is essential) and that the boat is moving at maximum speed before the gybe is attempted.

- The second major principle is the development of confidence and a positive attitude to eliminate any hesitancy which can be disastrous.

The speed is vital. Wait until you are moving fast. In waves this will mean waiting until you are moving down the face of the wave, planing or surfing. Often this need for maximum speed before gybing may mean that you will have to go well past the mark, but capsizing is definitely slower than sailing a few boat length past the mark!

Gybing when the boat is going slowly or is about to be hit with a gust is almost suicidal.

The key to a successful gybe is ensuring that the boom comes across to the other side as gently as possible, and not with the violent action which accompanies a slow speed gybe. If you are moving at maximum speed just before the gybe, then the force on the sail just after it, will be about the same or slightly reduced compared with that before the gybe.

You must have a positive attitude to gybing in strong winds. When you decide to gybe, be prepared to go the whole way quickly and smoothly!

- Push the tiller away in one fast, smooth action through about 45 degrees.
- Watch the leech and as soon as it begins to collapse, give the mainsheet a sudden jerk (about 60-90cm) to start the boom on its way and then duck!
- When gybing, kneel in the centre of the cockpit (not necessarily praying!) with your weight in the middle of the boat.

Most people have trouble with the gybe because they are hesitant and attempt to do it too slowly. Give the mainsheet an extra tug as the boat gybes to lift it up and over the transom. Also straighten the rudder, with a sharp pull, as the boom starts to cross the boat. This helps to get the boom moving and also brings the boat around to a correct heading for the run on the opposite tack.

After you get a bit more experience you can try gybing from one reach to the other without first letting the boat run square to the wind, but avoid this when you are learning.

Be a little conservative when gybing to round the marks. If you have to gybe at the leeward mark to prepare for the next windward leg then leave it until you are aligned with the mark or just past it. If you happen to capsize , when you right the boat you will be able to immediately sail upwind for the next leg and not have to head off on a reach, get around to the run, and maybe have to gybe again; all within a few boat lengths of the mark!

Even when you can gybe with confidence it is not a good idea to attempt to round the mark and gybe at the same time. It is far better to go wide when approaching the mark, and then gybe and come up to the mark on a progressively narrowing reach.

8.3 Roll Gybing

Roll Gybing is very similar to roll-tacking except that the movements are in the opposite direction. When you are ready to gybe, heel the boat rapidly to windward as the boat begins to turn and bear away due to the immersion of the lee side of the hull. Just after the sail fills on the new tack, the boat should be flattened abruptly and accelerated onto the new course. The aim, as in roll-tacking, is to move the boat through the water and air, without rudder movements or unnecessary luffing. The aim of this is to complete the gybe without any loss of boat speed. Roll-gybing I relatively easy in light to moderate winds. It is more difficult in heavy winds, but the same principles can be applied with the boat kept a little flatter. Always face forward during the gybe manoeuvre and ease the mainsheet a little before the gybe.

8.4 Rounding Marks

Rounding marks requires adequate preparation and good technique to ensure a smooth course change with minimum loss of speed. You should pass as close as possible to the marks. Ensure that you have a detailed plan in mind before you get to the mark. For example, when approaching the leeward mark and preparing to round for the next windward leg, there are three options. You can choose to go close to the inside face of the mark, to the leeward face, or to the outside face, that is to the face closest to you when you have completed the rounding. The third option is the best.

You should aim to round and leave the mark as close as possible to it, and at optimum sailing angle and speed. This principle also applies to the other marks. To achieve this you actually change course at an imaginary mark, one to two boat lengths on the inside of the real mark. Then, maintaining speed, you come up to the real mark at right angles to the rhumb line for the last leg. As you get close to the mark you quickly trim the mainsheet and pass as close as possible to the outside face. Use a rapid hand-over-hand method for rapidly trimming the mainsheet. With practice and the correct technique this can be an extremely effective manoeuvre. Ideally, you can retain a little of the extra speed of the reaching phase and use it to shoot very high to windward above the lay line for the windward leg. This will enable you to come up inside those ahead who leave the mark away from the buoy. It also means that you will be able to get the ideal position slightly to windward of the other boats rounding the mark.

The complexities of rounding marks can be simplified by establishing priorities. The first priority is to maintain speed right through the manoeuvre. The next aim is to get an advantage over those other competitors rounding the mark at the same time. The third and last priority is sail trim. Remember that many of the previously discussed sail adjustments are made before you reach the mark, this means well before you get involved in the rounding itself. The sail trim adjustments that have to be made after rounding the mark should be delayed until you have dealt with the other boats. Do not let other boats plough over the top of you while you are fiddling with control lines.

The correct time to lift or raise the centreboard between work and reach and vice versa, is just as you round the mark. You can be a little early in lowering the board before reaching the leeward mark, but do not delay lifting the board at the end of the work. Leaving the board down will make it extremely difficult to bear away for the reaching leg, especially in stronger winds. Therefore, raise the board as you round the mark. Raising the board may also be useful when you have to bear away when sailing upwind, for example to duck behind a boat on starboard. Trying to bear away by pulling on the tiller, with the board right down, will often have the opposite effect. The boat will go faster, heel more and so want to round up and eventually the rudder will stall. The end result of this will be an awfully loud bang!

Under very strong wind conditions it may be safer to leave the board down on the runs, and even the reaches. It is often hazardous coming forward in the cockpit to lower the board before reaching the leeward mark, as the boat becomes very unstable. The trick is to bang the board down with a swift kick!

8.4.1 Tactics to be used when approaching and rounding marks

Many books and articles have been written on these subjects, especially in relation to the complicated rules that apply. It is important that you know these rules thoroughly, and that you prepare early, avoid trouble and optimize your position well before the mark. Look around and anticipate where the other boats will be when you will be trying to round the mark. Do the hard work outside the two boat length circle and get clear ahead of boats inside so that everyone knows who has right of way!

When approaching the windward mark do not fall into the trap of tacking on, or below the rhumb line, especially in large fleets, and be forced into pinching in an attempt to clear the mark. Overstand slightly to prevent this loss of speed and allow some chance of manoeuvring close to the mark. It also allows for the unexpected - for example adverse current, a heading breeze, unfavourable chop, or another boat who tacks ahead and to windward. At the same time avoid tacking on the rhumb lines too early, especially is there is already a procession of boats on the starboard lay line. Keep your options open by coming up to the mark on a port tack, or tacking onto starboard well to leeward of the procession.

A port tack approach close to the mark will generally be better, even if you have to lay-off and pass behind one or two boats to grab a late position in the queue. Sailing in the procession is very slow because each boat is sailing in the lee of the boats in front. Delaying your entry into the procession also leaves you free to make use of the wind shifts in the last few minutes at the end of the leg. However, keep out of the area of disturbed wind and water about 5 boats lengths or so to leeward of the mark. Especially avoid tacking in this area, because the losses are large and you may be left floundering as many boats overtake you to windward.

There are two different options for approaching the wing mark, that is, the mark between the two reaching legs. The choice of options must be made very early, in fact at the start of the first reach.

- You can sail high on the reach and make a slow high approach to the mark.
- Alternatively, you can sail low and come up to the mark fast on a tight reach.

In terms of the mark rounding, it is better to make a low approach because you can use the extra speed to advantage. You will often be able to surge into a gap and obtain the favoured inside position ahead of slower moving boats.

THE END

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