

C&C 99 Tuning Guide

1.0 Forward

The design of the C&C99 delivers spirited performance while affording the owner superior cruising amenities. Looking at other similarly PHRF-rated designs such as the Evelyn 32, Olson 30, Sovereign 33, one constant remains - none of the aforementioned yacht designs are able offer the interior, comfort, speed, and balance of the C&C99.

This tuning guide was developed in an attempt to fill a void. Most established one-design classes have various guides developed by the original designer, sailmakers, and the owners themselves. Currently, the C&C99 is without a guide and owners are left to guess how to set-up the boat. This guide was developed specifically for the Great Lakes Owner Group – most boats sailing in the area are currently equipped with the standard keel and aluminum rig. The guide serves to assist owners in establishing an initial set-up of the boat. The document is a work in progress and owners may find that refinement will be necessary over time.

The rig itself, with its swept-back spreaders and lack of runners, presents certain challenges when shifting gears to match conditions. On the other hand, the C&C99 rig does offer significant advantages by simplifying boat handling. Two similar boats come to mind when looking at the C&C99 rig - the Mumm30 and the J35. Both of these boats rely heavily on forestay length as the primary countermeasure for light and heavy air conditions. The C&C99 One-Design Rules prohibit the adjustment of forestay length outside of the tolerances of the furler. Considering the boat is equipped with the Harken Unit 0 furler, the procedure for adjusting forestay length is onerous and best done before stepping the mast. With the forestay length set, the boat must be tuned via mast-step location, position at the partners, and a balance of cap shroud tension against D1 tension to control prebend.

The goal of rig tuning is to shape the mast to fit the sails – after all, the mast is only there to hold up the sails. Balancing mast-bend against forestay sag are the resultant attributes of our tuning efforts. The guide also contains set-up tips specific to the C&C99 as well as general suggestions that could be applied to any boat planning to race.

Contributors to the C&C99 Tuning Guide include Ed Botterell of Doyle-Botts Sails Toronto, Simon Kidd of Doyle Sails New Zealand, and Tim Jackett of C&C Yachts. The guide was originally written in November 2003 and was revised based on our experiences racing one-design at Terra Nova Key West Race Week and locally in Toronto. Several guides were benchmarked when authoring this document – namely J35 and Mumm 30 tuning guides.



Michael Kern
“Transmission” Hull #40

C&C 99 Tuning Guide

2.0 Rig Set-Up

Forestay length:

Ensure the forestay is no longer than the maximum length under the OD Rules – 47' 8 3/4" (pin-to-pin). Should the forestay require adjustment, refer to the installation guide for the Harken Unit 0 furler. The procedure is best done prior to stepping the rig; the harken system will allow for $\pm 1''$ of adjustment.

Mast-Step Location:

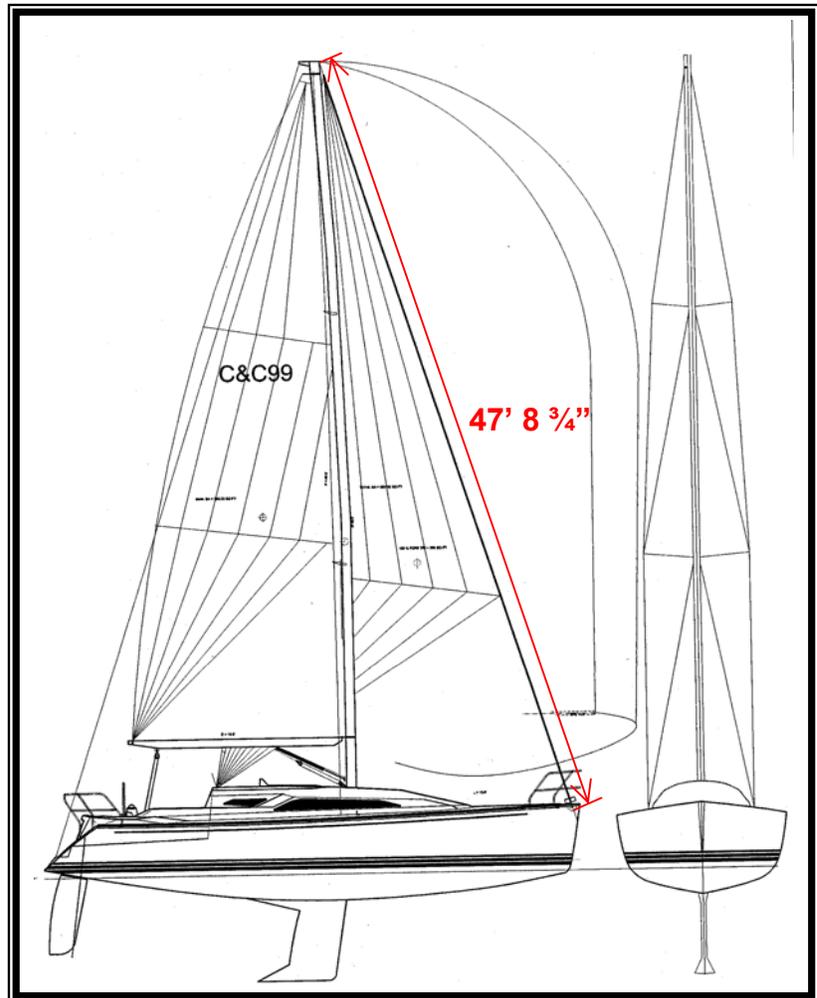
The mast-step should be moved to the most aft position using the factory-supplied holes in the aluminum base. Block the mast 1/2" aft in the partners by placing wedges on the forward and aft faces of the mast to induce a pre-bend to creating a stiffer spar and an open slot.

Shroud Position:

After stepping the mast, install the cap shrouds on the most forward hole on the chainplates followed by the D2 on the center hole and finally the D1 shroud. Placing the D1's in the aft hole allows better control over shape in the lower sections of the mast while carrying less tension.

Centering the Spar:

Without installing the boom, first center the spar in the partners with wedges. Do not simply eyeball the position – determine the position by measuring from the beam. Hand-tension the shrouds and check the position of the spar over the boat. Hoist a steel tape measure up the main halyard and measure to the base of the chainplates. Attempt to limit the difference between each side of the boat to within 1/8".



C&C 99 Tuning Guide

Tensioning the Shrouds:

Start with all shrouds hand-tight. First tension the cap shrouds, progressing evenly on each side of the boat. As the caps come under strain, the mast will begin the bend and the D1 shrouds will resist, becoming tighter. Continue to tension to cap shrouds until you reach the desired value on the Loos Gauge (see table below). Fully tighten the D1's to the corresponding tension. Finally, check that the D2 shrouds are still hand tight – you will probably get another ½ turn by hand.

Using a wrench, tension the D2 shrouds a couple turns less than the reference tension in the table below. The D2 shrouds do not require much tension to keep the mast straight under load and could pull the mast to weather while sailing upwind if too tight. After the boat is rigged, go sailing in enough wind the heel the boat 15°-20° with full crew hiking and the backstay tensioned nearly 100%. Begin to fine-tune the rig – likely only the D2 shrouds will require adjustment. Note that the leeward cap shrouds should not be loose going upwind – loose cap shrouds result in poor lateral stability.

Rig Tension Measured by Loos Tension Gauge, Model PT-2					
Light Air		Moderate Wind		Heavy Air	
Cap Shrouds	-1 turn	Cap Shrouds	#40	Cap Shrouds	+2 turn
D1 Shrouds	-2 turns	D1 Shrouds	#35	D1 Shrouds	+1 turn
D2 Shrouds	-2 turns	D2 Shrouds	#27	D2 Shrouds	0 turns

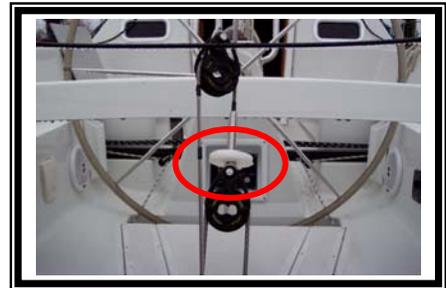
Pre-Bend:

Thus far, it would appear that mainsails being built for the C&C99 require pre-bend to set properly with an open slot between the main and the genoa. To address the situation, relocate the mast-step from the position set by the factory (middle) by pushing the mast-step aft to its maximum position and block the mast ½" aft in the partners. Some fine-tuning will be required as the mainsail tends to be extremely flat in the lower sections and somewhat full at the top batten when sailing in heavy air with the backstay at maximum tension.

C&C 99 Tuning Guide

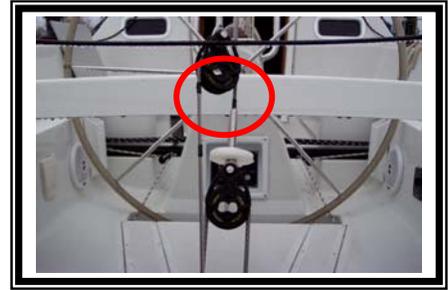
3.0 Basic Racing Set-up

- Mount a clutch for the spinnaker halyard on the starboard side of the mast. This helps get the crew out of the cockpit and on the windward side of the boat when launching the chute on a port rounding.
- Double the purchase of the vang by adding a 57mm Harken Black Magic Air Block to the primary control line. This will also reduce stress on the Harken Carbo Fiddle Block which has been known to explode under strain.
- Inspect the turning blocks for the backstay and traveler. Ensure the lines are correctly lead through the blocks. Some boats were delivered with the lines lead under the blocks (ie. under the cage of the block), creating unnecessary friction.
- If the boat isn't already equipped, install a "wheel" on the backstay as a stop should the rope backstay fail.
- Reposition the stripper of the self-tailor on all winches to be on the right side of the winch (as viewed when facing the winch to trim the sheets). For right-handed trimmers, the position of the stripper follows the rotation of the genoa sheet around the winch and naturally lends itself to locking off the sheet.



C&C 99 Tuning Guide

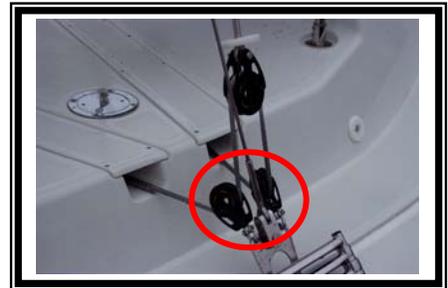
- Mark the wire backstay with tape at 25%, 50%, 75%, 100% intervals to allow for consistent backstay adjustment at various tensions.



- The factory equips the C&C99 with Harken Black Magic Air Blocks. C&C provides a mix of both high-load and low-load blocks. To identify low-load blocks, Harken used red isolators on the setscrews. Low load blocks should be used for halyards, outhaul, reef, vang.



- It is imperative that the Harken Black Magic high-load blocks be used for the backstay turning blocks.



- The hull was designed to sail on her lines with the tanks half full and the ground tackle located in the bow anchor locker. Should the boat be raced in a different configuration, ensure you compensate for variations in fore and aft trim using crew weight.
- Remove the factory-supplied topping lift. The vang from Forespar will hold the boom near horizontal. At dock, steady the boom using the main halyard by attaching the halyard to the tang on the aft-end of the boom.
- Remove unnecessary weight from the boat. Cutlery, dock lines, spare anchor, bedding, and the power cord are not required for racing. These items simply slow the boat down.
- Resist the temptation to store sails and gear in the bow and aft cabin. Crew have a tendency to squirrel-away gear in the corners of the boat and as a result, the stern of the boat will drag. Store sails and gear over the keel on the cabin sole.

C&C 99 Tuning Guide

- Reconfigure the spinnaker pole down-haul system to operate from either side of the boat. By adding a Harken 1584 shackle to a 57mm Carbo Block, the turning block can be attached the pole using a shackle and can be easily removed for storage. Also, following the modifications to halyard/control line location described in this guide will result in a free clutch on port and starboard sides of the boat.
- Remove the covers for the backstay controls. The system should operate smoothly and the backstay tag lines should be no longer than 40” to ensure maximum power can be developed. Fully loaded at dock, the backstay tension should read at least #42 on the Loos gauge.
- Shorten all control lines as required to effectively run the boat. Factory supplied control line lengths are generous and the extra length only creates clutter.
- After the traveler line has been shortened, tie the tails together. With the tails joined, the system operates quite effectively as a windward sheeting system.
- While racing route all control line tails through the cockpit hatches but beware when pulling the lines out of the hatch – the rubber gasket disintegrates and should be protected with electrical tape while racing.
- The Harken Unit 0 furler was specified for use with the C&C99. The design team went to great lengths to accommodate with furling gear without sacrificing performance by placing the furling drum in a shallow “well.” To date, we have not noted any sacrifice in sail shape using the furling and have experienced gains during spinnaker hoists. We highly recommend the use of the furler for short course and windward/leeward racing.
- Relocate the main halyard from the starboard side of the mast (factory position) to port. By moving the halyard to the other side of the mast, you now have separate dedicated cabin-top winches for the genoa and main halyards. We recommend you leave the halyards on the winches for ongoing adjustment whilst sailing upwind.
- Add some nylon webbing similar to a sail-tie to close off the lower gate where the lifelines are interrupted. It is questionable whether the nylon webbing officially constitutes a lifeline but it’s good practice and better than the lower gate being left open.
- Mark the wheel on dead center. Underway, the mark will indicate weather helm, providing feedback to the mainsail trimmer. When the boat is out of the water, carefully center the rudder, lock the helm and mark the wheel.
- Mark the forestay against a reference point on the genoa to gauge luff tension as opposed to marking the halyards or placing reference scales on the deck. This system provides better accuracy and keeps the pit crew’s head looking forward.

C&C 99 Tuning Guide

4.0 Sails

The C&C99 One-Design Rules allow for the following sails to be carried on board. There is no restriction on sail material.

- Mainsail
- Two genoas (LP not to exceed 20.15')
- Jib (LP not to exceed 13.65')
- Two symmetrical spinnakers (maximum girth not to exceed 26.5')

For short course and windward/leeward racing, the following sails can suffice.

- Mainsail
- All-Purpose Genoa
- Jib
- Running Spinnaker

C&C 99 Tuning Guide

5.0 Upwind Sail Trim

True Wind Speed				
<i>MAINSAIL</i>	<i>0-6 kts</i>	<i>7-12 kts</i>	<i>13-19 kts</i>	<i>20+ kts</i>
Halyard	Eased to create 1" wrinkles	Smooth out wrinkles, ensure draft is 50%	Taut. Tension halyard as backstay is added	Taut. Tension halyard as backstay is added
Backstay	10%	25%	75%	100%
Outhaul	Eased 1½" from white band	Eased 1" from white band	Eased ½" from white band	Maximum
Boom Position	Centerline	Centerline to 3" above centerline	Centerline to 4" below centerline. Helm and heel dictate position.	Eased at least 6" off centerline. Helm and heel dictate position.
Cunningham	None	Smooth-out 50% of wrinkles	Remove all wrinkles	Remove all wrinkles plus 1"
Vang	None	None	Slack removed	Tight for vang sheeting
Heel Angle	10°-12°	5°-10°	15°-18°	20°-22°
Crew Position	Below decks to leeward over the keel	One person ahead of shrouds and everyone cheek to cheek	Hiking hard, shift everyone back one position	Hiking even harder, no one ahead of shrouds
<i>HEADSAIL</i>	<i>0-6 kts</i>	<i>7-12 kts</i>	<i>13-19 kts</i>	<i>20+ kts</i>
Halyard	Eased with small wrinkles	Eased with small wrinkles	Firm. Tension halyard as backstay is added	Taut. Tension halyard as backstay is added
Genoa Leads	Top 5" to 8" Base 6" to 8"	Top 3" to 0" Base 4" to 0"	Top 0" to 12" Touching Base	2 nd batten down is parallel to centerline
Headsail Choice	Medium Genoa #1 or AP1 (153%)	Medium Genoa #1 or AP1 (153%)	Heavy Genoa #1 or AP1 (153%)	Jib (105%)

5.1 Genoa Controls

Halyard:

Halyard tension controls draft and draft position dictates the relationship between power and pointing. When the genoa is first hoisted, initially tension the halyard to remove most wrinkles from the luff of the genoa. Light and moderate conditions require less halyard – luff wrinkles should be quite prevalent. Heavier air requires less wrinkles and therefore more halyard. As you begin tuning-up before the start, monitor the wind and constantly adjust the draft in the genoa in preparation for the start. The key is to hold the draft in the most effective location for the conditions (power versus pointing in flat water versus wind/waves).

C&C 99 Tuning Guide

Now that the basic draft position has been identified, it's time to fine tune for the conditions. If you need the draft to move aft, ease the halyard. Easing creates a flatter entry and a narrow groove. A flat entry can rob the genoa of power, sacrificing speed, and comprising the hydrodynamic lift generated by the keel. Many sailors believe a flat entry facilitates pointing - a common misconception. A fine entry only works well when sailing full-tilt at higher angles in smooth water for short periods of time. Conversely, if you are sailing in chop/waves/slop, placing more tension on the halyard will move the draft forward creating a round entry with a wider groove. The best method for tensioning halyards involves over-hoisting the sail followed by easing to the desired luff tension thus creating an even tension across the entire luff length.

Headstay Sag:

Headstay sag affects the depth of the sail, especially in the forward sections. Before the start, set the initial backstay tension as a starting point – 25% in light air, increasing progressively with wind speed. Similar to luff tension, as the wind changes, headstay sag requires adjustment to maintain the desired shape. Allowing the headstay to sag results in power and depth and is ideal when power is required to punch through waves or to accelerate quickly. In flat water, tension the backstay to decrease sag creating a flatter genoa suited for pointing. Headstay sag creates a round entry while increased backstay tension results in a fine entry. If the backstay is tensioned to point, be sure to adjust halyard tension – the halyard must be snugged in order to pull some shape into the luff, otherwise the sail may be too flat. Sagging the headstay will create a round entry and the halyard should be eased slightly so that the entry does not become too round and the ability to point is all but lost.

Genoa Lead:

Lead position affects the power and shape of the genoa. Once you have sorted through the variables, halyard tension and headstay sag, it's time to look at lead position. Initially, position the lead such that the genoa has an even shape from top to bottom. For instance, set the lead so the genoa leech is the same distance from the upper spreader as it is from the chainplates when sailing close hauled. Do not attempt to make the top telltales break simultaneously with the middle and lower telltales – the genoa lead will be too far forward. Fine-tune the lead position by looking at the behavior of the telltales. A properly set lead will result in the top telltale breaking first with the remainder of the telltales following smoothly in sequence.

Power is required in waves and chop and moving the lead forward creates power in the genoa – the shape will be round and deep. With the lead in its most forward position, you will see all telltales break simultaneously. This setting is not great for pointing. Sailing in smooth water calls for pointing and the ability to point well comes from moving the lead aft to open the leech, allowing the genoa to be trimmed hard without interfering with the slot. The foot of the genoa will be stretched tight. The genoa #1 on the C&C99 will be tight against the shroud base with the top telltales breaking early to the bottom telltales appearing to be somewhat stalled. The same aft lead setting is useful in heavy air – moving the genoa lead aft will twist open the top of the leech to spill excess power out of the genoa, reducing heel. When sailing in the upper wind

C&C 99 Tuning Guide

range of the Genoa #1, position the lead such that the leech touches the cap shrouds from the chainplate to the bottom spreader.

Think of the genoa sheet one-part outhaul and three parts mainsheet. In conditions where the outhaul on the mainsail would be set to its maximum tension, the genoa lead should be moved aft so that the foot of the genoa will be tight, making the genoa sheet act like an outhaul. The C&C99 is equipped with cars that can be adjusted under load. Theoretically, the cars can be moved not only to set the shape of the genoa but also to deal with short-term speed requirements. Move the lead forward after a tack to hasten acceleration or when approaching a large set of waves where power will be required. If you do move the car forward to accelerate, ease the sheet to avoid trapping the top of the genoa. Be sure to return the lead to the proper position once speed/power you require has come to fruition and trim the sheet. Use the leads to constantly balance between power and pointing in relation to wind and sea state.

5.2 Mainsail Controls

Luff Tension:

Luff tension controls draft position. Draft position is directly related to drag. A draft-forward mainsail shape is low drag and conversely a draft-aft main creates excessive drag. When raising the main, first ensure the sail is at its maximum hoist. Ideally, the draft in the main should be 40-45%. When overpowered, move the draft forward using the cunningham if the sail is already fully hoisted. Allow the draft to move aft in light air and chop to create power. Increasing backstay tension on the C&C99 will bend the mast and move the draft of the mainsail aft – increase halyard and/or cunningham tension to compensate. Ensure that halyard tension is decreased when easing the backstay.

Mast-Bend:

Bend the mast on the C&C99 using the backstay to alter the shape of the main in the upper and middle parts of the sail. Mast-bend flattens the main by allowing the mast to assume a curve similar to that of the luff of the sail thus removing depth. As the breeze builds, we add backstay tension to reduce headstay sag with a concurrent reduction in mainsail power. Similarly, when we are pointing in flat water, mast-bend is added to reduce drag. When we need to power through chop, allow the mast to straighten. When adding backstay, be sure to re-tension the mainsail halyard and trim a little harder on the mainsheet.

Mainsheet:

The mainsheet is the primary control for the mainsail and affects leech tension and twist, controlling power and pointing. Tensioning the main also affects the angle of attack and depth of the sail. As a rule of thumb, the mainsheet should be tensioned such that the top batten is parallel to the boom. Once the general set-up has been achieved, the mainsheet should be fine tuned in order to facilitate flow over the upper leech telltales while occasionally stalling when

C&C 99 Tuning Guide

sailing upwind. Another rule of thumb – if you want to point higher, trim the main a little harder in all conditions except very light air. This guideline assumes that you are already sailing at full-speed (remember: speed first then pointing). Trimming the main harder results in an increase in weather helm forcing the bow up. Additionally, the slot will open allowing the genoa to be sheeted a little further in. Generally, speaking you will begin to lose speed by employing this strategy and it must be used in concert with footing. Another item of interest is backwinding – some believe backwinding is acceptable in certain conditions and others believe it is a contraindication to pointing. The current mainsail design on the C&C99 is quite flat and should not show signs of significant backwinding in moderate winds. If backwinding occurs, trim the mainsheet a little harder and check the outhaul position. Should backwinding persist, check the genoa lead position – is it too far forward? Also, apply backstay tension to flatten the main but be sure to adjust secondary mainsail controls as well genoa halyard and genoa sheet. Backwinding of any significance should not occur until sailing in the maximum wind range of the Genoa #1.

A few simple guidelines. The C&C99 is sensitive to twist – use it to cope with adverse conditions. Increase twist in chop to allow the helmsman to play the waves. In flat water, control the main using the traveler to maintain tension in the upper leech maintaining the ability to point. If you have overstood the windward mark and pointing is no longer of primary concern, add twist to the mainsail to dump air off the upper leech relieving weather helm while decreasing heel angle.

Vang:

The vang is not a primary mainsail control for upwind sailing. However, in heavy air, vang sheeting will do two things. First, when tensioned for heavy air sailing, the vang will attempt to push the boom through the back of the mast thereby bending the lower sections of the mast and flattening the sail. Second, vang-sheeting in heavy air allows the mainsail trimmer to substitute the mainsheet for the traveler. The vang is primarily used for off wind sailing.

Outhaul:

The outhaul controls the depth in the lower portion of the mainsail. When sailing upwind, the outhaul should always be within a couple of inches of the white band on the boom. Place maximum tension on the outhaul when over-powered and ease a couple of inches when power is required to punch through waves.

Traveler:

The traveler controls the angle of attack vis-à-vis the position of the boom. Generally, the boom should always be positioned on centerline when sailing upwind. As the wind builds, the boat will heel, and the crew should be hiking hard. As the upper wind range of the Genoa #1 is reached, the traveler may be lowered up to 12” off center to keep the boat on its feet. The optimum angle of heel is 10-15%. The C&C99 is equipped with a powerful traveller with cleats located conveniently on the cockpit coaming. We have found it is easier to respond to a brief

C&C 99 Tuning Guide

puff using the traveler than the mainsheet. However, if the duration between puffs begins to become shorter and the frequency higher, we recommend adding twist to the main and continuing to use the traveler.

Many people feel that the traveler should be eased in puffs to decrease weather helm and rudder drag. However, a puff is the perfect opportunity to use the extra power to pinch above close hauled and “feather” the boat upwind. To effectively take advantage of a puff, the helmsman must anticipate the arrival of the puff and begin to feather prior to feeling its full force otherwise the traveler will need to be eased to help the helmsman cope with the pressure on the helm. In a prolonged puff, we often sheet the main harder to help keep the bow up and shift gears (backstay, cunningham, outhaul). Pray for feathering conditions when you’re not quite fetching the weather mark.

5.3 Wind Shear

The previous two sections on genoa and mainsail trim assume the wind is consistent at the water level as well as aloft in both strength and direction. Rarely does Mother Nature provide consistent conditions and we must therefore strive to determine the magnitude of wind shear present in order to set-up our controls.

Before the start, sail into the course area and observe the conditions. While sailing upwind, check the position of your Windex and then tack. Once trimmed and moving at full speed, again look at your Windex. If the Windex indicates you are “reaching” on one tack and in “irons” on the next, the wind aloft significantly differs from the wind at the water – wind shear. You will need to set the genoa cars in different positions on each side of the boat. On the “reaching” tack, the genoa will require significant twist (move the lead aft) and on the other tack, little twist will be necessary.

Trimming the mainsail to cope with wind shear is similar to the genoa. One tack will require more twist than the other. Set twist with the mainsheet while keeping the boom on centerline using the traveler.

Recognizing wind shear also provides us with valuable weather data. Wind shear indicates that a persistent wind shift is nigh. This is especially true in light air. Also, wind shear is directly related to gradient (the delta between the wind speed aloft versus the surface). The wind will fill-in vertically from aloft. The air-to-water interface at the surface causes friction that slows the wind at the surface when the air is light, hence the need to flatten the sails in the lower half with the top half twisted. The wind may differ as much as 30° at the masthead. Again, cope with wind shear by moving the genoa lead aft thereby twisting the top half of the genoa while flattening the bottom half and position the boom on centerline with lots of twist in the mainsail and a tight outhaul.

C&C 99 Tuning Guide

6.0 Downwind Sail Trim

<i>Adjustment</i>	<i>Description</i>
Halyards	Ease main halyard as much as 3". Hoist spinnaker halyard to within 2" of masthead.
Backstay	Slack. Ideally the mast should be set straight as possible.
Outhaul	Eased 6-8" from white band on boom. Open foot shelf on main if equipped.
Cunningham	None. Ease main halyard as required to introduce wrinkles in luff.
Vang	Play the vang to keep the top telltales flying. Do not stall the upper leech. As a rule, the top batten should be parallel to the boom.
Heel	In light air, heel the boat to leeward to help the spinnaker fill. As the wind increases, move weight to heel the boat to weather, maximizing projected sail area.
Crew Position	Minimize crew in cockpit to only those necessary. All others should be positioned to weather at the mast. The foredeck crew can stay in front of the mast. In medium conditions, positioning crew in front of the shrouds can be fast – better to have the bow slice through the waves than drag the stern of the boat. In heavier conditions, move the crew aft to help the stern carve through the water. Under no circumstances should the crew obscure the Helmsman's vision by standing in front of the steering station.
Sheet	Trim the sheet to increase the angle of attack of the spinnaker. Trimming the sheet reduces the depth of the spinnaker. Constantly trim and ease the sheet to generate a 4" curl along the luff of the spinnaker.
Guy	Trimming the guy reduces the angle of attack and increases projected sail area. Set the guy in order to position the pole perpendicular to the apparent wind. The guy should be fine-tuned so that the luff rises vertically from the pole.
Pole Height	Raising the pole reduces depth, reduces twist, and destabilizes the sail. Generally, the pole on the C&C99 is set approximately 18" above the gooseneck on the mast.
Twing	Pulling the twings reduces twist, increases depth, and stabilizes the spinnaker. Trimming the twing on the sheet will make the spinnaker shape symmetric by closing the leech. Watch your competitors' spinnakers for signs that the leeward twing needs trimming – their spinnakers will be asymmetric with the upper leech ballooning up and away from the mast.

A note on fore and aft trim - when sitting at dock, the C&C99 sits slightly aft on her lines. Boats that carry their volume aft have the propensity to sail bow-down when heeled. Tim Jackett addressed the issue by trimming the boat slightly lower in the stern when stationary with tanks half-filled and ground tackle located in the anchor locker. When sailing, the boat will sail on her lines and maintain the proper angle of attack for the keel. One word of caution – the boat needs to be moving to balance on her lines. Sailing off the wind in light air requires all non-essential crew to move forward to lift the stern out of the water and reduce wetted surface area.