Rudderless

by

Bob Szczepanski

Rudder Facts

What a drag! Sail a boat, any boat, full sized or RC sized, and you will soon realize that in addition to making the boat go where you want, the rudder is an effective brake. The bigger it is and the more it is moved increases its braking ability. There is sort of a double whammy going on. Larger shapes have higher inherent drag than smaller shapes and create more turbulence, (which is also drag), when moved. Using the rudder less and retaining boat speed becomes a very significant performance factor, especially on RC boats. Why would that be? It is very obvious, with even a very casual comparison of rudder sizes, that RC boats have much larger rudders than the scale factor would dictate relative to full sized boats. Most classes have rudder sizes that are at least double scale size and many are about four times scale size. (See Photos 1 & 2)

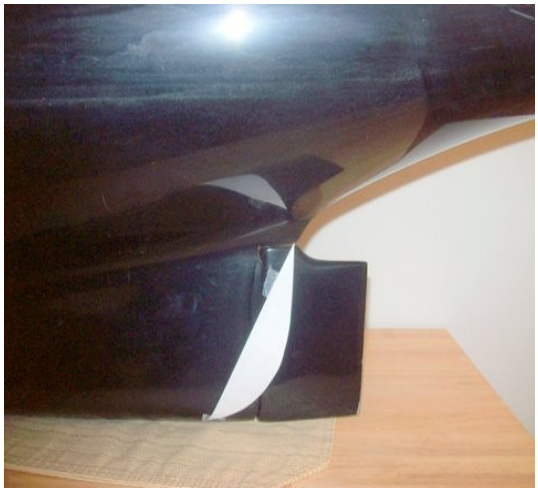


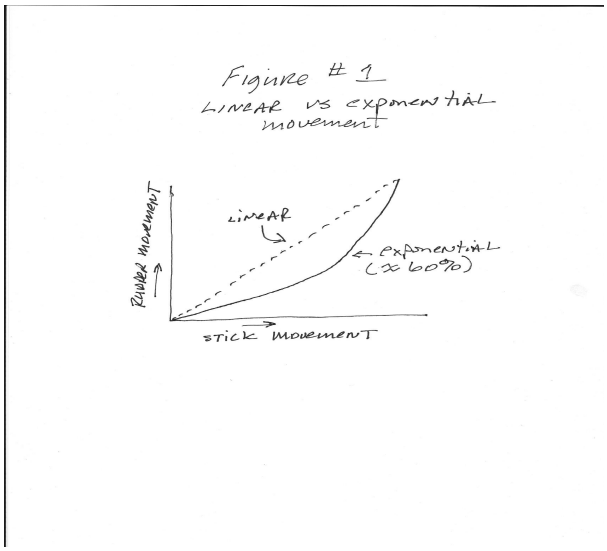
Photo 1 & 2 – Approximation of scale rudder size super-imposed on a Victoria and an EC12 rudder.

Why is this so? Without invoking math, it is all about speed through the water and to a lesser degree the center of effort and the center of resistance of the boat. Basically, the slower a boat moves, the larger the rudder must be to be effective. All know that a boat which is not moving cannot be controlled by the rudder. Even the fastest RC boats sail at very low speeds, so comparatively large rudders are needed for control. The sail area of most of our models is also more than the scale factor would dictate, which further requires more rudder area to balance and control the boat.

Rudder Do's

OK, we all know that a rudder is needed to steer the boat and it is also clear that RC boat rudders work particularly well as brakes. So, from a performance standpoint, it would obviously be better to minimize braking and limit rudder movements as much as possible. The first step to take to minimize rudder movement is to focus on helm balance. If the boat requires no rudder offset to sail to windward (basically sails itself) it will go faster than a boat that requires 2 or 3 or more degrees of rudder offset to sail in a straight line. Hang on, I have always heard, and even read, that some rudder offset is needed for maximum pointing – Not So! Rudder offset, or "feel" is a hold over condition from full sized boat racing when it is important for the human, on the tiller or wheel, to get feedback on rudder position. Without the "feel", the human hunts around the steering groove (moves the tiller and swings the boat.) Each time the tiller moves, the rudder puts on a bit of braking, plus the course change, even if small, negatively effects sail trim. All of this is slow and burns boat speed. So, on full sized boats, slight weather helm and the attendant fewer rudder movements /less drag "feel" it provides is good. On RC boats, the servos on board our boats don't know or care anything about "feel" and are happy to go where the radio signal tells them. If the boat is well balanced and only requires few and small rudder corrections, drag will be minimized, so it will be faster and achieve the best VMG. If your boat won't sail at least 10 boat lengths (more is better), without needing corrections, you have too much helm.

Another way to help keep rudder movements small, without sacrificing maximum rudder travel, is to utilize the exponential programming capability available on most computer radios. Normally, the stick and rudder movements are linear and proportional. To change this, the exponential function can be programmed so that servo movement around the center stick position is less and increases, in an exponential fashion, as the stick is moved away from the center line. To be effective, the exponential curve has to be significant. I recommend about a 60% curve. (See Figure 1) Since the exponential function can be turned on or off with the dual rate switch, it is also a good idea to program both positions identically. Doing this avoids accidentally turning the exponential off. Realize, however, adding exponential rudder response is no magic bullet. Since maximum rudder throw is not reduced, banging the stick over for tacking or mark rounding is still bad from a drag/boat speed standpoint. Care must be taken to carve tacks or mark turns and utilize the sails as much as possible to control the boat.



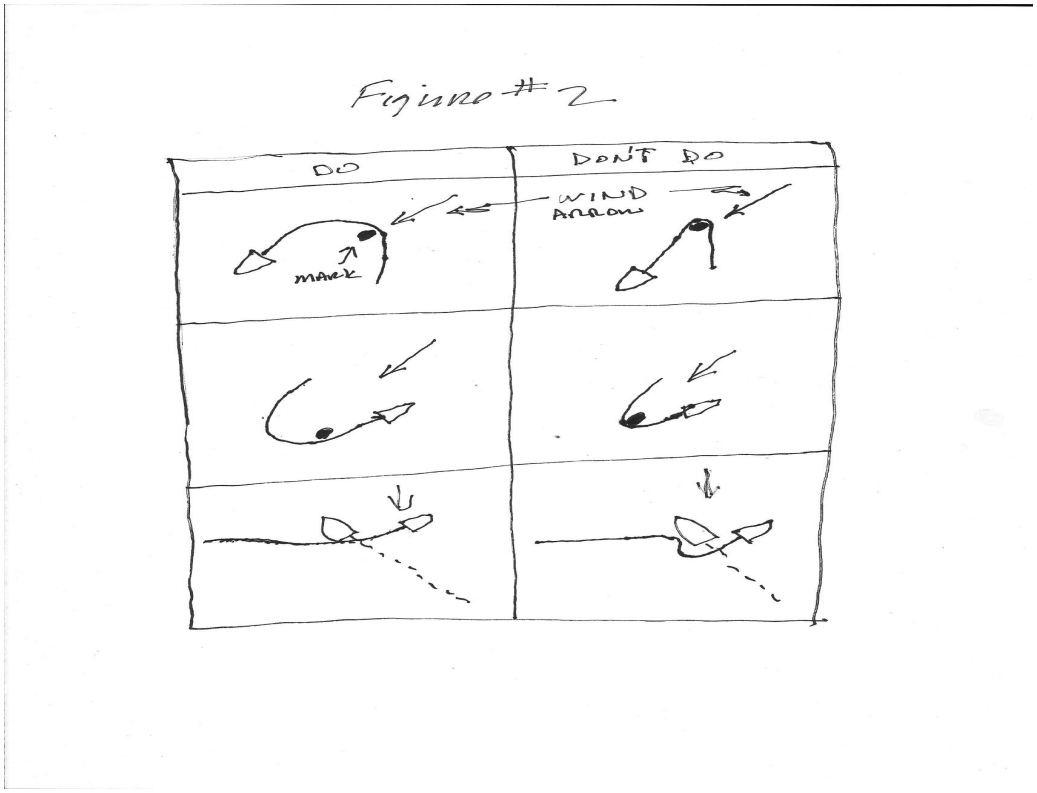
More Do's

On classes that allow a separate jib trim servo, the boat can be steered upwind or helped to make an efficient tack by use of this capability. On a beat, a well balanced boat can be steered without any rudder movements. For example, if the boat gets low in the steering groove, the jib can be eased out, the balance will change, and the boat will head back up. If the boat gets a bit high in the steering groove, moving the jib in a small amount will move the bow down. While some rudder movement is necessary to tack, it can be drastically reduced by using the same technique. Just prior to initiating the tack, jib trim can be fully eased, causing the boat to head up. As it does, some rudder is needed to move the bow through the eye of the wind. Once just past head to wind, jib trim can be used to tighten the jib sheet as much as possible, to start backwinding the jib, which will help push the bow down to the new tack. Again, some rudder movement is still needed to control the heading, but effective use of this technique has a significant effect reducing rudder movement. Comparative testing has shown that a boat length loss or more, per tack, can be avoided by using jib trim to aid tacking.

On boats with no jib trim, using a “P” switch (see Issue #166 “Dynamic Twist Control”) programmed to sheet in a small amount, can be used in much the same way, when tacking, to help reduce rudder movement. For those not familiar with programmable mixes, a six channel (minimum) computer radio is required. The “P” switch, which is short for “point”, is the “AUX” channel switch usually located on the top upper right of the transmitter. See Photo 3.

It is used to turn a programmable mix on or off. The programming of the mix is simply master/slaving the sail control channel (throttle) to itself. Somewhere between a 5% to 10% movement setting is needed. Then, when the AUX. Channel switch is turned on the, the sails will be sheeted in slightly beyond their normal full in position. To use this capability to help reduce rudder movement while tacking, the switch is turned to the on position to initiate the tack. As the boat heads up by responding to the tighter sheeting, some rudder is needed to move the bow through the eye of the wind. As it does, the tighter sheeting will help push the bow down to the new heading. Just prior reaching the new heading, the “P” switch is turned off and the rudder is used to complete the tack. While not quite as effective as a jib trim servo, powering up into the tack preserves boat speed and reduces the total rudder movement needed to tack. All good!

Even More Do's Coordinating the sail trim position with rudder movement at a mark rounding is another opportunity to minimize the amount of rudder needed to make the turn. At the weather mark, if the sails are eased to avoid either stalling or luffing them, as the rounding is made, less rudder will be needed to effect the turn and more boat speed will be retained. At the leeward mark, sheeting in as the boat rounds, combined with just enough rudder to get the boat around, is effective to retain boat speed. (See Figure 2) An extension of preserving boat speed by using less rudder movement is anticipation. In addition to rounding marks as described, getting the boat in position for a controlled turn is equally important. A tight spin around a mark is slow. Avoiding panic maneuvers is also a form of anticipation. Deciding early on to duck a starboard tacker, and giving way a bit, retains more boat speed than having to turn hard to avoid a collision and get back on course.



A Maybe

Not to contradict, moving the rudder a lot does equal bad, but some rudder movement is always necessary and can be good. A rudder movement technique, used very effectively on full sized boats sailing close hauled, is doing what is called “taking a bite to weather”. Born from the use of velocity prediction software, when the target boat speed, for the conditions, is stable or exceeded, the boat is purposely turned up for a short distance, then returned to the previous course. Regularly repeating this technique on the weather leg can significantly improve VMG and reduce the distance sailed, which overcomes the increased drag. (See Figure 3) Legend has it, that an America's Cup was successfully defended solely by taking “bites” while the challenger did not. Cool, but the question is, can this be effective on RC boats? The short answer is yes, within certain limits. First, the length of RC race courses are very short compared to full sized course distances. This immediately limits the opportunities and positive results of taking many bites to weather. The second limitation is inertia verses drag. Heavier displacement boats can more easily handle a “bite” while still retaining speed. In flat water and steady wind, lighter boats can benefit from

taking “bites”, if not over done, or by making them too big. Like most techniques, taking “bites” must be practiced to establish the bite size and frequency that your boat will tolerate to overcome the increased drag of the rudder movement. If understood and not overdone, it can be a boat handling trick that can be kept in mind to help win a race or two when the conditions are favorable. Other than then, it is always better to go Rudderless.