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FM Slalom Tech Series

Article #04_02

Do you need to make setup adjustments?

The short answer is yes. The underlying reasons behind making adjustments are varied. Extracting top performance, countering the effects of changes in water viscosity on different sites, temperature changes, technique morphing with progression up the line, symptom tuning and experimentation are some of them.

All skis will respond to fin adjustments in relatively the same way, but some are much more sensitive to fin movements. Skis that are sensitive, such as the Goodes require more precision and care in setting the fin. Fin measurements are determined to the 1000th's of an inch, and a 2 to 4/1000th adjustment is noticeable on sensitive skis. Skiers like to share data across the world but how you take measurements and the properties of the water you ski on are significant factors.

When and Why

Ideally instruments to monitor a number of variables such as position in the course, speed, ski direction, ski/tip attitude, handle position and load on the rope would greatly assist in setup tuning. However, the effort to do this is high, so for now it's up to the skier to develop awareness in the course to provide essentially the same data.

There are the "symptoms" like slack, being pulled out of position, breaking forward at the turn, wheelies, ski stopping, pulled forward through the wakes. Also there are judgments: early, late, wide, narrow, fast, slow, downwind & upwind performance. And there are "feelings"such as turns hard/easy, squirrelly or loose feel, too much or lack of aggressiveness, too hot/slow for the gate, too much load/pull, not enough load/pull.

Symptom Tuning

Historically symptom tuning has been the popular approach. The problem with chasing symptoms is that you are looking at a single instance or event, when slalom is a sum of many. Also, the fin parameters are coupled to each other, meaning that changing one dimension will affect the performance tied to all fin measurements in some way. Therefore symptoms should be treated as clues or data that can take us back to the square wave tuning principles outlined in tech article #04_01. There is no doubt that symptoms are a valuable piece of the puzzle just as a video, or a coach's analysis can be.

Discussion of Common Issues (Symptoms) and Corrective Measures

One of the most satisfying parts with slalom is executing great turns. So it is understandable a ski is often judged on how it performs in the turns. The turn is the end of a sequence involving the pull, edge change and pre-turn. The turn itself has may be broken into the entry, follow-through and finish.

An important factor for execution of a solid turn is the speed going into it. If you are on an early line and slower with a wider entry, the turn is almost automatic. High speed and straight-lining to the ball causes a number of problems: a hard grabbing effect resulting in break at the waist, an increase in tip pressure leading to tail blowouts, wheelies and slack at the finish. So the first advice to solving turn issues is to rewind the process.

Fin Depth, Length and Area.
The effects of depth and length adjustment are noticed at various phases in the course. It is commonly known that increasing length and keeping depth constant provides tip engagement, or the fin front drives ski into the water when the ski is on edge. The fin torques the ski when on edge, and if more fin area **ahead** of the mounting center of the fin is increased, it will drive the ski tip down.

Conversely if fin area **behind** the mounting center of the fin is increased the tip will raise up higher.

This effect takes place on both sides of the course but is more noticeable into the offside turn, since we have more weight up front on the ski. During offside turn the front foot is the supporting foot and if the tip starts too low and drops lower, the skier may “run out of ski” and break forward at the turn.

The effect of fin length and surface area is felt coming out of the offside turn. With properly optimized fin area, the initial take-off at hook-up and acceleration is good as is holding power through the wakes in an offside cut. With too much fin area, the ski will track narrow and straight into the offside turn making it difficult to get the width required to execute a smooth turn.

If the fin is set too deep for a given surface area, or has too much area altogether, the ski will be prevented from swinging out under the skier and rolling on to edge going into the on-side turn. The result is a narrow and fast entry into the onside turn and slack at the finish.

Having said all that, a ski is designed and tested to work within a certain range of Fin Area. The total fin area, roughly equal to ½ the FL (length) * Fd (depth) provides grip much like the rear tires do on a car.

The fin area controls the ability for the skis tail to slide or over-steer, and the resistance the ski has with side-to-side movements or rolling onto edge. If the fin area is too small the ski feels loose, squirrelly, unpredictable, may lack stability and feel more out of control. With insufficient fin area, you may also get bouncing at the wakes, or too much wing jump (discussed later). With too little fin area the ski will be more difficult in negotiating through the offside turn, and possibly feel loose in the wakes.

If the fin area is too large, the ski tends to get locked in a straight line at the buoy, be difficult to roll on edge, carve wider unbalanced turns, be less responsive or aggressive and generally be harder to handle and ski smoothly. A ski with too much fin will take more effort to manhandle through the course.

Therefore you have to be careful to keep the fin area within a certain range when adjusting the ski for handling in the turns. A parameter called the Fin Constant = Fc helps in determining settings. Use of Fc is best shown by example.

The Goode 9500 (2003/2004) has a standard or stock fin setting of FL=6.872 FD=2.449. Due to water conditions, and where I’ve located my $\mathbf{F_{DT}}$, I might find the ski lacks bite on my offside and the tip is not aggressive enough. Therefore I want to increase by length and I decide to start with a sizeable jump of 0.010 to 6.882. In order to keep the fin area constant I back-calculate the corresponding depth as follows:

Fin Constant, Fc=0.275 (For a standard round fin)

Depth Adjustment = (Previous FL- New FL)* Fc = (6.872-6.882)*Fc = - 0.003.

Therefore in order to maintain the same fin area and keep the handling of the ski as close to the previous settings as possible, but with a lower tip attitude and more aggressive turns, my new settings are FL= 6.882 and FD=2.446.

It is important to know that changing only one dimension in length, depth or $\mathbf{F_{DT}}$ will affect almost all aspects of how the ski handles. Since all fin measurements are “coupled” to each other in some way, the ideal situation is to be changing all three at once. In the example above, I moved the center (hydrodynamic center) of the fin forward by increasing the length and reducing the depth. Therefore I will have to move the fin back by about the Fc*(Previous FL- New FL) or about 0.003“. If I increased the depth and reduced the length, I’d do the opposite and move the fin slightly forward.

Another number that is useful is the overall fin area. The fin is roughly a triangle so the area can be estimated at 1/2FL*FD. For comparing

one fin setting to another FL*FD will suffice. Using the total fin area measurement is useful in transposing another skier's settings to your ski. For example the Goode stock setting yields a number of 16.830. "Rossi" settings give a higher fin area number that equals 2.470*6.860=16.944. As a check of my settings say at 2.446 and 6.910 my number is 16.901, a little more than stock and less than the Rossi. If I wanted to return to stock fin area but keep my fin depth, I could use a length of 6.880.

In summary when tuning the FL and FD for the turns, changing all three dimensions at once keeps the basic characteristics of the ski the same, while adjusting for the desired handling characteristics.

Distance From Tail

We suggest the distance to tail measurement $\mathbf{F_{DT}}$ not be adjusted specifically for the turns, although the effects are noticeable there, but rather to tune for the ski's symmetry in the course. The effects of $\mathbf{F_{DT}}$ changes are most profound at the finish of the turn, although $\mathbf{F_{DT}}$ plays an important role into the turn as well.

A reduction in $\mathbf{F_{DT}}$ (moving the fin back) brings the tip of the ski lower at the finish of the offside turn allowing the ski to build load on the rope. If the fin balance (Length/Depth) is correctly set the ski will maintain an aggressive and level tip profile throughout the turn and finish with a progressive load on a tight line.

When the fin is too far back, the ski finishes the turn with the tip lower than where it started the turn, causing a more abrupt increase in load that peaks into the wakes. The force pulling the skier forward is sometimes quite subtle, causing just an unwanted weight shift onto a flat ski. In any case there should be a margin for error, so if the skier is a bit out of position a catastrophic OTF won't be the result.

If the fin is too far back, a prominent but a similar effect happens on the onside, with the ski tending to load up heavily and unexpectedly at the start of the pull and into the wakes. Fun, if you can hold this sometimes body crushing load, acceleration and speed into the offside. Most often than not the load is more than one can handle.

If the fin is too far forward, the opposite in generally true. The offside turn will tend to finish with the tip higher than the tip at entry, possibly aggressively overturning away from the boat, and finishing with a delay before the line goes tight. This is also why a "wheelie" is often corrected by moving the fin back (or boots forward which is the same thing when considering $\mathbf{F_{DT}}$.

Just as the $\mathbf{F_{DT}}$ controls the finish of the turn, this dimension is largely responsible for the distance available inside of the course for pre-turn. Judging distance at speed is very hard for all but seasoned skiers, especially during the toughest passes. When the $\mathbf{F_{DT}}$ is set correctly there is the appropriate amount of distance available on both sides of the course for pre-turn execution. Also when $\mathbf{F_{DT}}$ is set correctly, the width is centered without bias to one side or another

Symptoms of symmetrical imbalance are: being noticeably narrow on one side of the course as if the driver is hugging one side of the gates; persistent slack on one side of the course; pulling directly to the onside buoy from the offside turn; narrow and fast into the offside turn. There is a general feeling of not being able to hook-up and get cross-course properly one way or the other, when the $\mathbf{F_{DT}}$ has not been optimized. Adjusting this dimension requires analysis of three turns, along with clues as to what is happening on both sides of the course.

When the fin is too far forward, it becomes difficult or impossible hook-up properly on the offside at the finish of the turn. The ski has a tendency to straight-line in the pull to the onside buoy. Conversely the onside turn is very quick and possibly overly aggressive, and will be down course with some slack due to being off-line.

Another measure of the correctness of $\mathbf{F_{DT}}$ is how much effort it takes to simply ride behind the boat. If the pull on the rope is very heavy and feeling like the wing is pulling far too much, the fin might be too far back. If the ski glides very easily with too little pull on the line as if the wing

doesn't exist, the fin may be too far forward. One trip through the course will answer these questions.

RFF skiers will often have slack at two ball the make or break point for a pass. I've often corrected slack by moving the fin back 0.004 at a time. By moving the fin back or increasing $\mathbf{F_{DT}}$, I'll build some space before two ball, enter the turn on a wider arc, with more ski tip and wing activated.

Since lakes can widely vary in temperature and composition, adjusting $\mathbf{F_{DT}}$ is a great way to counter the effects of temperature or waterborne contaminants affecting viscosity. As water gets colder, more clear and pure, the viscosity increases. An increase in viscosity acts like moving the fin back. The decrease in viscosity is the opposite, acting like a fin move forward. A rule of thumb is about 2/1000's per DegF. We move 20/1000ths back from the start of the season to the finish, following the temperature increase.

Along with $\mathbf{F_{DT}}$ moves, there will likely be small adjustments in length and depth. Look to reduce depth and add length for high viscosity situations. For low viscosity, move the opposite by adding depth and removing length. The theory is that if the ski is in a firmer or more viscous substance, you'll need less depth to execute the required turn radius. Also the ski will ride higher in more viscous water, therefore more length is required to compensate. The length increase also helps to offset the need for reduced depth.

The Wing

I like to view the wing as a miniature version of the foil on an air chair. The wing is also much like a trim tab/stabilizer on a boat. It's also important to understand what the wing does for you in the course so you can use your technique to take advantage.

If the skier can assume a "sitting chair" position coming off the 2nd wake, the wing is activated to lift or jet the ski out of the water and reduce the wetted surface. The ski can hop ahead having established speed and direction to gain a significant amount of space in the course. This hop is starts to be most effective at 32 off or better, amplified by compressing into the ski and an aggressive pull.

Another benefit of the wing is tip "dump" into the ball. The wing seems to create a rapid tip engagement or dump just at the ball, which is the ideal position for it.

Overall the wing induces drag, which is a penalty in creation of speed. For shorter lines 32 off or better, the acceleration phase is short and intense. At the longer lines, the amount of time spent pulling is longer and the speed builds less abruptly. Therefore the wing is spending more time working against the ski by scrubbing speed of acceleration, than assisting the skier by dumping speed before the ball. Coaches will often recommend removal of the wing for long line skiers.

A wing set at a greater "trim" angle sets the tail of the ski lower while riding straight, adds tip pressure into the turn and finishes the turn with the tail lower and tip higher.

With respect to symmetry, a greater wing angle acts much like moving the fin forward or increasing $\mathbf{F_{DT}}$ and will reduce width going into the on-side turn.

A greater wing angle also amplifies the hop at the 2nd wake if the skier can work but increases the amount speed scrubbed off the ski increasing line load overall.

A larger wing puts more metal into the water and increases the stabilizing effect. The larger wing boosts drag as well, without going to a steeper angle.

It seems that if you can really compress and are not limited in side-side speed, it is possible to use a steep wing angle (>9 Degrees). Most pro skiers will run 7-9 degrees, and the ski manufacturer will be able to suggest settings. .

The wing does not need to be set with the same accuracy as the fin with +/- 0.5 degrees usually good enough. If the wing is set with too much

angle, acceleration cannot be accomplished within the required time window. The ski tip could finish the turn too high and throw off your symmetry requiring the $\mathbf{F_{DT}}$ to be reduced further increasing drag.

With too much drag overall, you might yourself having to work very hard to obtain width, and keep the ski on-line. If the wing angle is too shallow, there is a feeling of speed into the ball despite being in good position and the generation of slack delays at the shorter line lengths.

I've seen several skiers run without a wing in the North, because the high viscosity water is more difficult to achieve the acceleration and width to even reach the buoy line. Acceleration tends to trump all other characteristics, so it all depends on how quick the ski is side-side in determining whether a wing can be used. Also moving the fin backward or reducing F_{DT}, engages the wing more. In correcting on-side slack, I've moved my fin back to build space, and at the same time engage more wing, without changing the setting from the 9 degrees that I run. The resistance of the ski or load on the rope when riding behind the boat is a good indicator if you can sense it.

Too much wing or fin too far back, and the ski will be tiring to ride. With too little wing and/or the fin forward it will feel like you are on ball bearings. There has to be just the right amount of resistance.

In future articles we'll take a look at environmental and other factors and how they affect ski setup.

The FM Slalom Tech Series is a service provided to users of the Six Slalom system. A season subscription, which includes updates and access to factory R&D information, is available on a yearly basis. Please check our website at www.jagersport.com for details or write pjager@telus.net for more information.

Glossary

FL= Fin length, Fc= Fin Constant, Fd= Fin depth, FDT = Distance from tail, FA= Fin Area

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SUMMARY CHART		
Adjustment	**Effect of Change**	**Notes**
Fin Back	Lowers tip at completion of turns, increases width into on-side turns. Increases effectiveness of wing and overall drag. Increases load in the pull.	Tune for symmetry in the course and as water warms up, look to move the fin back.
Fin Forward	Opposite of above. The ski will lose stability, be very quick, tend to hop up harder at the wake on short lines. A good offside finish with tip bite will be harder to execute. The tip will finish the turn higher. The ski may over-rotate off side.	In conjunction with fin length, use the Fin <-> to keep the tip of the ski as level as possible from entry of the turn through to the finish. Managing the tip attitude will result in a finish on a tight line without lost distance.
Fin Deeper	Reduces tail slide into the turn, and increases the ability of the ski to hold direction through the wakes. A deeper fin provides more upright support and makes the ski harder to roll on edge.	Depth is set in conjunction with fin length to multiply for fin area. Length and depth must be set just right, balancing the handling of the ski on both sides, the radius of the turns and acceleration of the ski. Also the blend of ski and fin must suit the skier. Too small of a ski for the skier with require more fin area, resulting in handling anomalies.
Fin Shallower	The ski will turn with a shorter radius, and have a more pronounced tail slide in the preturn. The ski will roll onto edge and produce a more dramatic edge change.	With insufficient fin area or depth, the offside turn is more difficult to negotiate. There must be sufficient fin area to adequately support the offside turn.
Wing Increase	Increases drag overall. Trims ski tail down, tip up. Engages more tip into the turn, but raises tip at completion of the turn.	Increasing the wing angle will affect the ski's symmetry so look to move the fin back slightly in addition to this adjustment
Wing Decrease	Lowers drag overall. Trims the ski tail higher, tip lower. Tip finishes the turn lower.	A wing mounted upside-down, lower or further back on the fin amplifies the rocking effect of the wing. This jets the ski higher at the second wake and dumps more tip at the bouy.