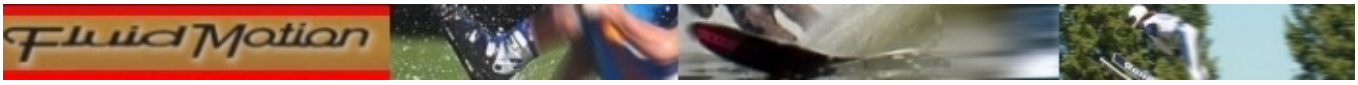


FM Slalom Tech Series

Article #05_05

The Six Senses of Slalom

Balance, Tip, Grip, Slip, Twist & Tilt

Slalom is an extreme sensory experience, relying on "feel" to guide the skier. It's all up to the skier's senses, experience and observation through coaching or video to make decisions about what to try next.

The focus of this article is to put some words to the characteristics of ski behavior that you might feel when skiing or watching videos. Because things happen so fast you may have just snippets of memory across several passes to piece together. So it is helpful to have a bit of a game plan to sense one or two aspects before hitting the water.

Also keep in mind that to get a feel for a new ski setup, free skiing can take your mind off the buoys and on how the ski is working – with one "rule". *What feels good free skiing may not necessarily be good for the course, but what is good for the course always feels good free skiing.*

Definition of Characteristics

Balance

A ski must ride with the appropriate wetted surface on plane in order to provide stability, power and handling dynamics for the skier. We define the balance of the ski as the adjustment of force or weight applied to the front or back of the ski while riding flat or on edge.

In the auto racing example engineers use a car's suspension adjustments for weight balance and the front/rear wings for aerodynamic balance.

For a slalom ski, we have the binding position to trim the front and wing to trim the rear. When on edge the fin is used to alter a ski's tip to tail balance.

Bevel adjustments, and skier weight and ski size are something to consider here as well.

Tip Profile

The behavior of a ski's tip through the turn is a vital component to running shorter lines. Progressively building tip pressure at the turn is accomplished by increasing wetted surface of the ski into the turn envelope. The tip pressure peaks at the apex of the turn and then reduces quickly to a smooth release by transitioning to the pull without delay, slack or other events.

The goal is to have a smooth and authoritative turn process on both sides of the course. In the turn the tip is a skier's combination of brakes and steering.

Tip profile also plays a role in the pull. With more ski in the water there is a greater platform to accelerate from.

Grip

Both a car and ski need to provide grip during cornering.

A ski's fin area (Fa) acts like tires on a car and together with how the ski is balanced give the skier what is necessary for quick but controlled turn.

Slip

In the pull the ski is constantly side-slipping or drifting down course.

While it may seem like slip is undesirable, if there is insufficient slip on the ski the skier will get pitched forward into the wakes or be unable to hold position and get pulled onto a flat ski.

If the ski has too much slip, the skier is left with a less than ideal platform to accelerate the ski and heads straight for the next ball.

Slip is affected by the binding center to fin center dimension on the ski coupled with the balance of the ski.

Twist & Tilt (Roll)

Directional stability or the ski's resistance to twisting is another characteristic we feel is important to be aware of. At the completion of the pull, the rope naturally pulls the skier toward the boat.

The ski's ability to stay on track and allow a skier to hold direction off the second wake postpones the inevitable. Being able to hold direction determines how wide an outbound arc and how aggressive the inside edge is set before the turn.

The "tilt" or roll of a ski is how much effort or lean is necessary to put the ski on edge.

Theory of Operation

What makes slalom tuning so complex is that all of a ski's parameters that define its characteristics are inter-twined or coupled with each other. Each singular adjustment that we make plays a role in every sensation or performance characteristic that we feel on the ski.

Therefore to change just one sensation or performance outcome, several if not all adjustments on the ski have to be changed in one go.

A high degree of expertise is required to make multiple changes at once including an understanding of a particular ski.

Developing models of ski behavior for use in making adjustments are time-saving tools. That is the principle behind the FM Sports Fin chart program. The Fin chart program uses skier and environmental inputs to calculate fin settings and binding positions for ski setup. The chart extrapolates the stock settings to settings based on our experience and conditions. The calculations of the program make it possible to adjust all four dimensions – binding position, fin length, depth and distance from tail and deliver very ski-able setups if the user inputs are accurate.

Adjusting a Ski Balance

Most coaches or pros would say start with the boot positions and that is perfectly good advice. The boot position provides the basic trim for the ski and the default level for the amount of tip consumed.

The ratio between obtaining the power to generate cross course speed plus the ability to scrub off speed versus the amount of the release outbound from the pull is fundamentally controlled by the boot position.

Moving boots forward of "stock" equates to more work and acceleration achieved in less time and less distance. Ahead positions also deliver increased braking ability by using more wetted surface. A backward move equates to more outbound release off the pull, offset by more distance consumed to achieve acceleration and decreased braking.

If your weight and water composition are a close match for the stock setup conditions, there is no need to move the boots. The goal in positioning the boots is to achieve that perfect balance between wetted surface and outbound release. In cold or clean water, or skiers that are on the lighter side of the ski sizing chart will have the ski will riding higher and have reduced wetted surface. Therefore it follows that moving forward in these conditions restores the balance.

On the contrary very hot and soft water conditions, or heavier skiers may require the boots be moved back from stock settings.

When moving the boots, the fin should follow in the same direction by a ratio of distance that belongs to that particular ski brand. See the discussion on slip below.

Using the Wing as a Trim Device

In addition to the boots, the wing is used to trim the ski by providing down-force on the tail. In fact the wing is an excellent indication of how the ski's overall trim is set. If you find yourself having to run a wing angle that is outside the normal range for the ski then it is probable that your binding location needs to be re-examined.

For example if you are riding a ski and can hardly feel the effect of the wing at more than 8 to 9 degrees, your boots need to move forward to trim the nose down. The opposite applies when riding too forward and too flat, although other operative issues would likely alarm you in this condition.

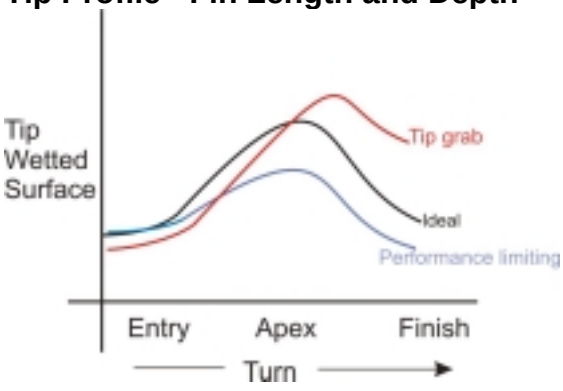
When asked about the wing, Mapple stated "A ski should work for you to a point, with a wing set at a lower angle (3 to 5 degrees). If you have to crank it down (greater than 9 Degrees) then you should be on a smaller ski"- Waterski October 2001.

True enough, however we'd add you could try moving the boots and fin forward as far as you feel is necessary to get the balance right and the wing angle back in check.

"Fast" skis such as the Goode, Monza and Sixam have caused some skiers to drop a size down because the ski rides higher. In more viscous lakes (up North) there is not enough ski in the water to put the brakes on with stock settings. I ended up with what could be described as the tip of a 66" and the tail of a 69" ski. The setup delivers balanced acceleration, sufficient release and braking while the wing can be felt at a comfortable 8 degrees.

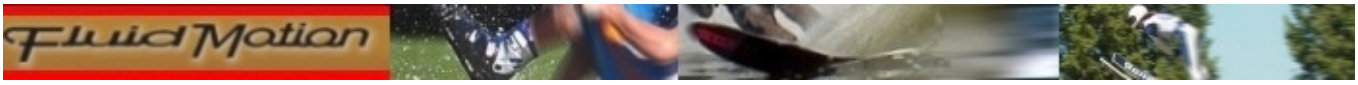
Since wetted surface is critical for performance, perhaps we should be thinking in terms of referencing all dimensions from the tip of the ski rather than the tail!

Tip Profile - Fin Length and Depth



The last part of the balance equation is how the ski performs when on edge and through the turn.

It is well known that increasing the length of the fin and reducing the depth will increase the wetted surface of the ski (tip bite) in the off-side pre-turn. The same fin effect plays a role in the pull and in the onside turn, although not as obvious. Binding position and fin settings sum with each other in this respect. If you have your boots forward, expect that you'll have to be adding



fin length/reducing depth. The opposite is true if boots are back.

Top skiers are able to wet the ski tip with the slimmest of margins at the shortest ropes (e.g. 39-41 off). Tip load into the turn is a product of the acceleration phase. If everything is working together in harmony, the ski should theoretically be fully involved at the apex of the turn at these extreme line lengths.

If the peak tip pressure is not timed with the apex of the turn, this will be a problem for the skier to manage. If the tip pressure fails to fully release the ski will not complete turn. If the tip pressure fails to reach the theoretical maximum level, the skier may hit a roadblock in progressing to a shorter rope.

Grip Adjustment

The shape of the turn can be controlled by the ratio of depth to length or fin tilt. As discussed in previous technical articles, it is important that the fin area Fa be kept close to stock setting when changing the fin length and depth.

Fin area provides the mechanical grip similar to the back tires on our race car. If a car rides with tires that are too wide, it will understeer.

I have noticed that a higher riding ski with a shallower & longer fin requires slightly more fin area to feel stable (1-2%). The fin constants that are used in the Fluid Motion Fin chart program are pre-adjusted for this observation.

Slip Adjustment

A ski can be pointed cross course and be slipping under full line load at the same time. This is a good thing because without this slip, the skier would lose the edge, be buckled or worse, tossed out the front with no mercy.

A ski has to slip in a constant and linear way so that the skier can maintain a strong body position, keep on edge and stay on the maximum an outbound path. With the appropriate ski balance and ski slip working together, the skier can go to full bore right out of the turn and through the wakes for maximum velocity.

When the load of the rope is released off the second wake the ski immediately begins to track without slipping down course. But since skier has been able to stay on edge and keep the tip pointed away from the boat, the skier is jettisoned on the widest arc possible.

Just so long the body position is reasonable, slip protects the skier from the dreaded out-the-front. With well adjusted the balance, the skier has no fear of excess speed because there will be plenty of ski in the water when the skier arrives wide and early to just kill the backside of the ball.

The primary adjustment for slip is the distance from tail. It makes sense that in more viscous water, the distance from tail (DFT) is increased by moving the fin toward the bindings. In softer water, the distance from tail is reduced (fin back).

Keep in mind that when moving bindings the distance from tail should also be moved, dividing the adjustment amount by a factor of 2.5 to 10.

The DFT also affects the trailing portion of the tip profile curve. How deep the tail drops in and consequently how high the tip rises at the completion of the turn is mostly due to the DFT setting.

Lastly, the wing comes into play for slip. An increase in wing angle mimics moving the fin toward the boots, because it will bring the tail down, raise the tip and accomplish the same effect as increasing DFT. This is the reason why some, including pros will use the wing exclusively for changes in water conditions from site to site.

Twist and Tilt

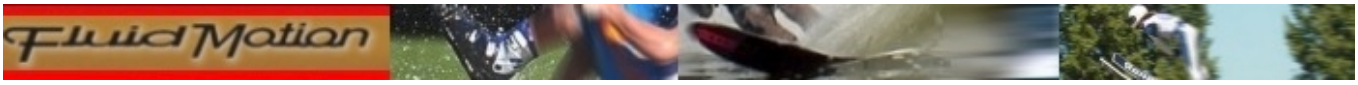
A ski has to be able to resist twisting in the water to enough to provide a platform for the skier to maintain direction off the second wake. Resistance to twist is best judged at the completion of the off-side pull exiting the second wake. Being pulled narrow and riding a more direct route to the ball eventually leads to slack of some sort.

Technique & binding setup plays a role here too. Skiers that can hold load and protect the ski's position will find the geometry of shorter lines easier.

Basically the more rudder or tracking ability the ski has, the more it can hold direction even though the skier on top of it is being rotated toward the boat. A deeper riding ski or a ski with a larger fin center to binding center dimension is more resistant to twist. As a ski rides higher to the surface it becomes more trick-ski like and will have reduced resistance to twist. Therefore skis that are riding higher need to compensate. It is understandable that more fin length (with a reduction in depth) restores the resistance to twisting capabilities of the ski.

The opposite is true as well. Skis riding deeper might feel a bit too much on the rails, and a shorter but deeper fin blade is necessary. I theorize that this is one of the reasons why the "AMF" blade was developed. With its cut off back end and set with more depth, the AMF blade shape was used by Goode skiers such as Rossi and Favret in the deeper riding waters of central Florida.

Lastly how a ski rolls up on edge determines how aggressive a skier can get. A fin that is set deeper will



prevent the ski from rolling as much and provide support for the ski. A fin set shallower will react to a skier's input more readily. Again, in softer water of Florida you'd expect to be running more depth as the water is less supportive, and on firmer substance of the North less depth to make the lean more aggressive.

It's convenient how these adjustments seem to work with each other for different water conditions.

Conclusion

If you are lucky enough to be of the same weight and ski in similar water and as the skiers who determined the "stock" settings for a ski, that's great – it will save you a lot of work & time.

However, if you are skier who does battle in big deep lakes, across four seasons or other extreme conditions and want to ride a decent handling ski, then clearly something has to be done.

The new generation of more sensitive skis do perform better overall but they are making setup more challenging. So it is important that our understanding of ski behavior and the tools necessary to establish setups evolves with them.