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FM Slalom Tech Series

Article #04_01

An Organized Approach to Fin Tuning

Square Wave Theory

Most skiers would say the ideal path through a slalom course is a smooth sine wave-like line.

However if a skier could accomplish infinite acceleration, infinite braking and right angle turns, then 41 off would be standard fare. This is the slalom square wave, which represents the greatest distance a skier can take through the course. The square wave is also the most work. The square wave is of course unachievable but makes for a good background as an approach to analyzing ski tuning.

Key Points on the Square Wave

A skier needs to maximize certain variables in the course and at the same time seek to closely match certain criteria as defined by the rope/boat. The closer a skier is able to do these functions, and match up with the square wave in an overall sense, the shorter the rope can be.

Two key points that are optimized are X1, X2. X1 and X2 are inside the course and an experienced skier can make judgments at these points. A novice skier will find them difficult to judge

Another critical tuning and observation point is the turns inside the course and X0. X0 represents the first turn-in. The turn is where the skier can vividly see the results of the execution through the pullout X1, X2 and so on.

Tuning Goals

Our goals are quite simple. The first goal is to maximize time or distance we have before the buoy. That is move the point X1 and X2 back toward the gates along the line of the square wave grid. The more we can move X1 and X2 back, the shorter line we can ski.

The second goal is to match–up with the boat at the turn. We are specifically attempting to meet the RR variable, or rate of rope removal. The required tolerance for matching the RR variable reduces, the shorter the rope.

The X factor - Making Time and Space

Many skiers will report that good slalom requires time before the ball and excellent acceleration. How please?

Acceleration is governed by the amount of ski edge “in the water” or the length of the ski and the total amount of fin area. Ride a larger ski with appropriate depth and length of fin = acceleration. The constraints are if the skier can handle the load, will the fin area exceed the amount necessary through the turn and is the ski too big to handle comfortably. A bigger ski will ride pretty high in the water and have a different feel to it.

Another key factor is symmetry. The position of X1 and X2 must be about the same, but with a slight backward bias to the entry of the offside turn. That is the offside X may be back toward the gate say 12” more than the entry to the onside. The reason is the offside turn will take more space or radius to complete, and a skier is able to “make-up” for it on the on side. Many skiers like Mapple for example, will have a slight bit of slack and a wildly aggressive turn onside, when compared to the offside.

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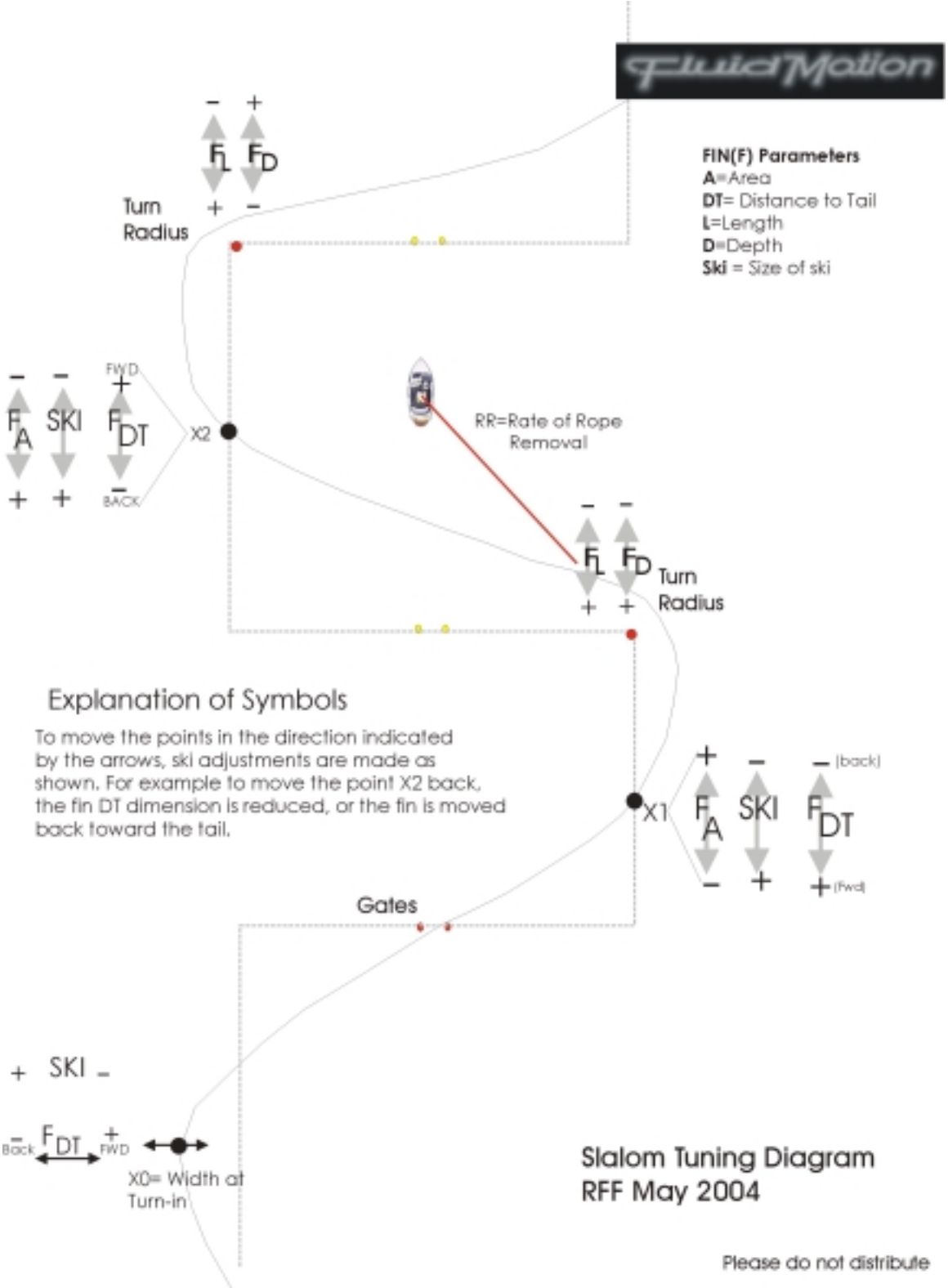

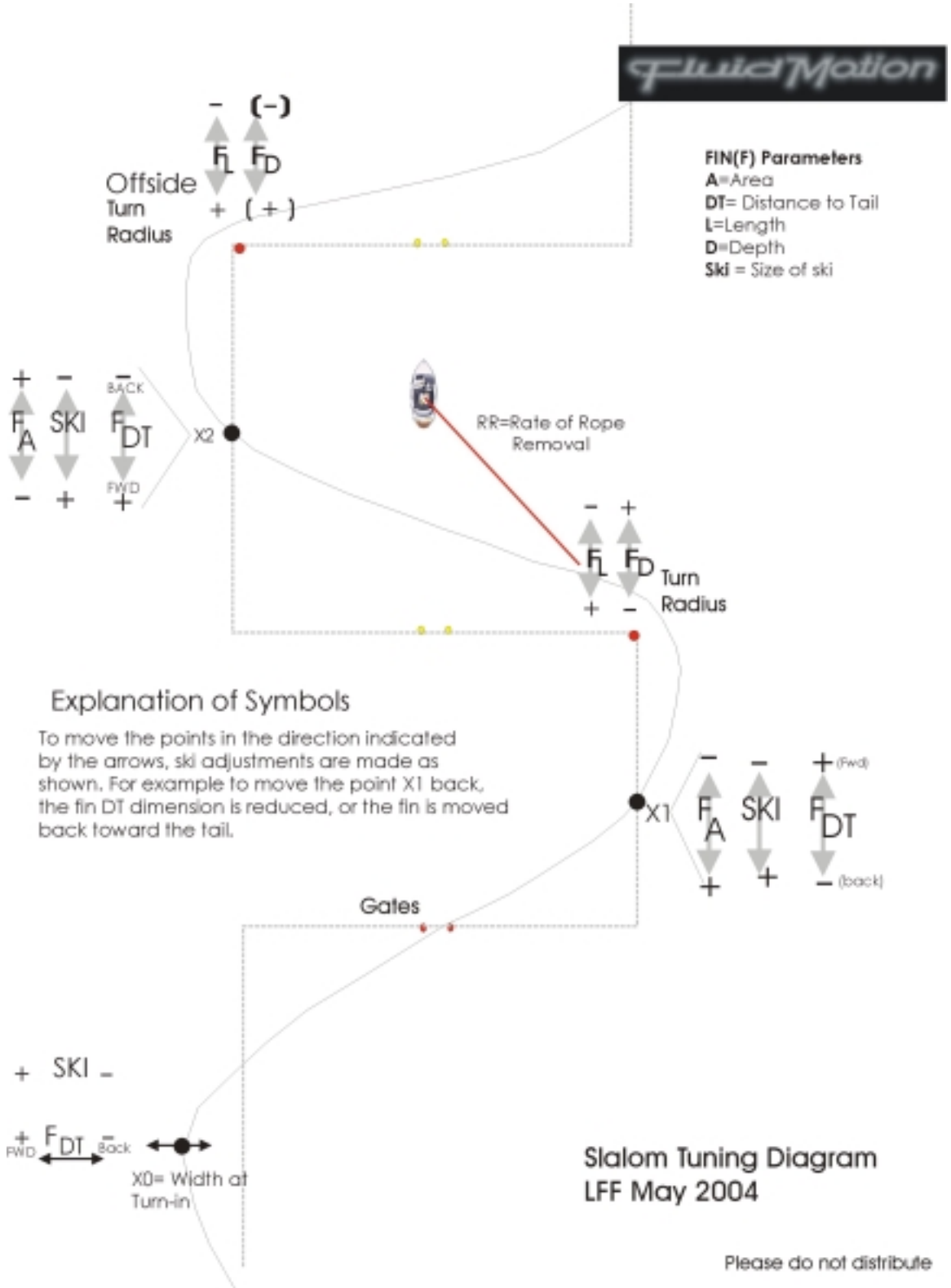
Fluid Motion
– (–)
F_L F_D
Offside
Turn
Radius
+ (+)
FIN(F) Parameters
A=Area
DT= Distance to Tail
L=Length
D=Depth
Ski = Size of ski
+ – –
BACK
F_A SKI F_{DT}
– + +
FWD
X2
RR=Rate of Rope
Removal
– +
F_L F_D Turn
+ – Radius
Explanation of Symbols
To move the points in the direction indicated by the arrows, ski adjustments are made as shown. For example to move the point X1 back, the fin DT dimension is reduced, or the fin is moved back toward the tail.
– – + (Fwd)
X1 F_A SKI F_{DT}
+ + – (back)
Gates
+ SKI –
+ FWD F_{DT} – Back
X0= Width at
Turn-in
Slalom Tuning Diagram
LFF May 2004
Please do not distribute

The positioning of X1 and X2 relative to each other on the square wave grid is primarily controlled and fine tuned by the **distance to tail measurement,** named $\mathbf{F_{DT}}$.

To create more space before in the offside buoy, $\mathbf{F_{DT}}$ is increased or the fin moved forward.

To create more space before in the onside buoy, the opposite is done. $\mathbf{F_{DT}}$ is decreased or the fin moved backward toward the tail.

To maximize the acceleration of the ski the bindings can be placed to use the entire ski available for a given length. Therefore stock position or a mid-position will generate the most acceleration. Note that a bindings back move is about the same as a fin forward, so bindings can be placed forward with the equivalent fin move forward as well, adjusting the fin $\mathbf{F_{DT}}$ with the corresponding Fin ratio for that model of ski.

For example for Goode skis we use a ratio of approximately 15. If the $\mathbf{F_{DT}}$ is set perfectly for a certain binding position and we want to move the boots forward 0.25", then the fin is moved forward 0.25/15=0.016 at the same time, then fine tuned after taking a set or two. By using this factor, the symmetry performance of the ski is retained. Likewise if we move the boots back 0.125" it is the about the same as moving the fin forward or increasing $\mathbf{F_{DT}}$ 0.008".

Bindings are a coarse adjustment, and $\mathbf{F_{DT}}$ is available for fine-tuning. Increased acceleration from larger ski sizes is the reason we have seen the trend to longer skis. Because manufacturers scale molds and dimensions, the single most critical factor in making a longer ski work for individual conditions is the determination of $\mathbf{F_{DT}}$. When making adjustments for skier weight, water temperature and viscosity the parameter $\mathbf{F_{DT}}$ is a dominant variable.

To maximize the acceleration of the ski consideration should be given to fin area as well. However a more important and over-riding factor will likely be the adjustment of fin area to match the turn radius with the rate of rope removal or **RR**.

Tuning for the Turn and RR (Rate of Rope Removal)

Building distance before the ball requires speed. From the point of X1, X2 the skier's speed and direction sets up the turn entry and turn execution that culminates in a finish on a solid, tight line. The equation to meet this requirement is:

(Turn Radius) + (Turn Time) = Rate of Rope Removal (RR).

Basically an inequality in the above equation in either skier radius (skier direction) or the duration of the turn (skier speed) results in either slack line or getting pulled out at the finish.

If the skier's direction is fine, but the speed is too high, the RR is exceeded and slack results. This slack is something we call "friendly" slack because recovery involves a delay then absorption of the slack and continuing on.

If the time before the ball was compromised resulting in the direction being off line with a high speed, serious slack occurs. This is a proverbial "taking the hit", which we do not recommend in any situation.

Another problem that occurs with high speed into the turn is the ski grabs hard and causes an abrupt break at the waist especially if the skier has to move to the front in an instinctive move to slow the ski.

Likewise if the skier's speed coming out of the turn is too slow or the turn is radical there may be a "stopping" effect, a hard hook-up and symptoms like getting "pulled-up" or breaking forward can occur.

Turn Fin Adjustments

We need fin area and depth to negotiate the offside turn. The offside turn we lever out over the ski, and the fin acts much like a "stick in the mud". For example, if there is not much of the stick down in the mud, you can't lean on the stick

very much. Same for the offside. The fin is what we lean against to cause the ski to turn. In reducing fin area, the ski will start to feel very loose and unsatisfying through the offside.

The fin length dimension controls the amount of ski tip driven into the water, which is commonly known. Increasing fin length $\mathbf{F_L}$ increases the amount of ski in the water into and through the turn for both sides of the course.

While an increase in fin depth $\mathbf{F_D}$ helps us to be more aggressive with the offside turn, an increase in fin depth or area increases the radius of the on-side turn.

Therefore the depth of the fin must be carefully balanced between offside and onside performance. Fin depth and area creates speed but overdone there can be too much propping effect and a longer radius turn for the onside. A fin that is set too deep tends to prevent the ski from rolling out on edge properly in the return.

The result is reduced tip engagement, and again slack line at the completion of the on-side turn.

Tech Series #04_02 is a discussion of factors around the complex art of ski tuning, including the use of bevel tuning.

Carbon Double Six Quattro featuring the new VPS Platform

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