

# SWIFT TO WIN!

## WITH OUR MATHEMATICAL OPTIMIZATION MODEL

Dear *Directeur Sportif*,

It's our honor to show you the results of model—a system called **RIDERMAN** to you. **RIDERMAN** is a mathematical optimization system that can give effective strategies in rider's races. "As a mathematician you're used to solving problems on your own, so that's the way I approach cycling," said by Anna van der Breggen, Women's Individual Time Trial champion at the 2021 Tokyo Olympics. Anna holds a PhD in mathematics from Cambridge University and is a mathematician. To some extent, her victory shows the importance of mathematical optimization in sports competitions.

Through the steps of dynamic modeling, subsection analysis, nonlinear programming solution and so on, a system of optimal power output strategy can be solved according to the information of the track and the players. We applied it to the Tokyo Olympic track, the Belgian UCI track, and a home-made track, and showed that even moderately fit athletes could achieve near-world championship times using the power output strategy given by our model.

Next, we will explain RIDERMEN, a system based on track information and player data to a rider, and put forward some suggestions according to our mathematical optimization model.

Dear rider, I am **RIDERMAN**— your little helper on the road. Allow me to ask you one question first.

**Are you a time trial specialist or a sprinter?**

If you are a **time trial specialist or a rouleur**,

**WATCH THIS**

**RIDERMAN** has prepared unique strategies for you to take the crown.

First of all, for a particular track:

Let us **divide the road sections into turns as nodes** and **determine the type of road sections** according to the following criteria. (U for up, D for down)

Straight type comparison table			
Slope	0~2°	2°~4°	4°~6°
Road type	Flat ground	U4/D4	U6/D6

(Tips: Your time trial experience will come in handy for sections beyond the descriptions of the above labels.)

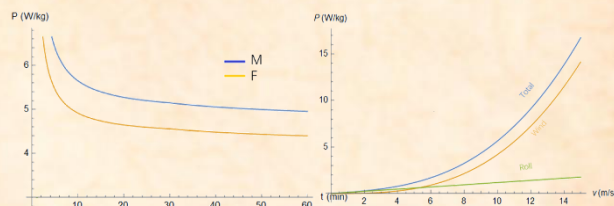


Now, let us take a look at what **Strategies RIDEMAN** have prepared for you to deal with different road types.

① For a track with **more than 90%** of the road sections on **flat ground**:

Trying to **distribute the energy evenly** during the ride is the best solution.

(**RIDEMAN** have drawn **power curve** and **power-speed conversion curve** below for you to determine the actual and appropriate average output power expected to accomplish.)



Power Curve

Power-Speed  
Conversion Curve

RIDERMAN'S GUIDANCE FOR A RIDER





②: For **multi-ramp** tracks:

**RIDERMAN** has prepared a **corresponding** strategy for each type of ramp:

**U4-type Uphill:** **maintain or slightly increase the power** passing of the original flat ground, you can **save physical energy consumption** under the condition of **less speed loss**

**U6-type Uphill:** the **output power** can be temporarily **increased by 8%-10%** of the leveling power, so as to **reduce the acceleration and deceleration time** before and after passing through the curve.

**D4-type Downhill:** the **output power** can be **reduced by about 24%**.

**D6-type Downhill:** the **output power** can be **reduced by about 30%**.

Now it is time for the **sprinter** to show.

If you're a sprinter professional but have a heart for being at the top of the time trial,

### WATCH THIS

**RIDERMAN** has specially prepared a **different strategy package** for you to better adapt to the race and stand out in the time trial.

First of all, for a particular track:

Let us **divide the road sections** like a specialist, but according to **a different criteria**. (U for up, D for down)

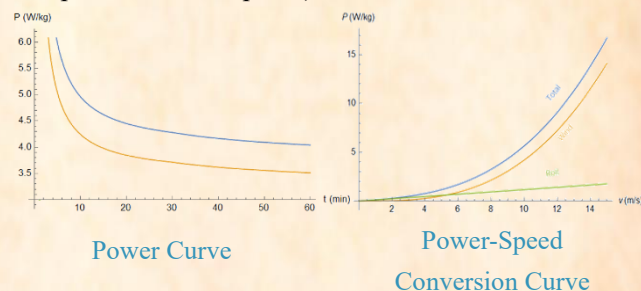
Straight type comparison table		
Slope	0~1°	1°~2°
Road type	Flat ground	U2/D2

Straight type comparison table			
Slope	2°~4°	4°~6°	>6°
Road type	U4/D4	U6/D6	UM/DM

①: For a track with **more than 85%** of the road sections on **flat ground**:

Trying to distribute the energy evenly during the ride is the best solution.

(**RIDERMAN** also draws **power curve** and **power-speed conversion curve** based on **sprinters' average level** for you to determine the actual and appropriate average output power expected to accomplish.)



②: For **multi-ramp** tracks:

**RIDERMAN** also prepares different **corresponding** strategies for each type of ramp (use the characteristics of sprinters to **accelerate/decelerate quickly and easily connect different states** to **reduce the loss of climbing**.):

Ramp	Strategy
U2/U4-type Uphill	<b>increased the output power (about 3%)</b>
U6-type Uphill	<b>increased the output power by 5%-8% of the leveling power</b>
UM-type	<b>reduce the speed to about 60%</b>
D4/D6/DM-type Downhill	<b>decreased the output power by about 24%/30%/50%</b>

Next, considering that the time-trial cornering strategy is quite different from sprinting, **RIDERMAN** prepares an **additional spreadsheet** and **calculation formula** ( $v_{\max}^2 \left(1 - \cos \frac{\theta}{2}\right) = g\mu \cdot \cos \alpha \cdot \left[d + r - r \cos \frac{\theta}{2}\right]$ ) for you. It is recommended that you fill in the curve data and **calculate the maximum cornering speed**.

Turning Statistics			
Number	Inner diameter(m)	Slope(deg)	Turning angle(deg)

**RIDERMAN** wish you good luck in the time trial, don't forget to flexibility according to the actual situation.

**RIDERMAN'S GUIDANCE FOR A RIDER**

*Thank you for reading, you can print it or send it to the team members by email. You can also focus on the guidance during training to improve the efficiency and purpose of training.*

*Best of luck to your team in the upcoming time trial.*

*Yours Sincerely*

