Worlds Apart: the Wind Tunnel and the Real World

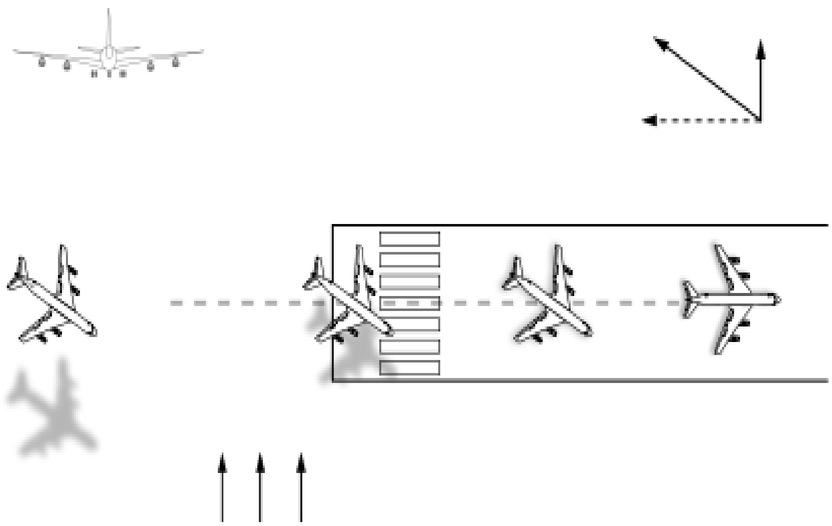
You're a triathlete or time trialist in the market for new wheels, and you've done your research, looking at wind tunnel charts to choose the fastest wheel, or, in other words, the one that has the lowest drag. Do you understand how that "lowest drag" wheel might fit with your personal performance goals? It can be difficult to translate wind tunnel data into real-world conditions. In this article, I'll explain how you can become an expert in de-coding wind tunnel data and relating it to your personal performance goals.

The drag data gathered in the wind tunnel is stated in grams (force) or watts (power). For cyclists, watts are preferred. Watts, or the phrase "aerodynamic watts", refers to the power required to maintain a velocity equal to the air velocity in the wind tunnel. For example, if the air velocity in the wind tunnel is moving at 30 MPH, then the value for aerodynamic watts is equal to the power required to move the wheel or wheel, bicycle, and athlete forward at a velocity of 30 MPH.

When air velocity flows along a path parallel to the test object's course (the "test object" can be a wheel or the combination of wheel, bicycle and athlete), the test object is positioned at zero degrees yaw. Changing the position off of zero degrees yaw is where everything gets confusing.

Yaw is the angle between the heading of the vehicle (the direction the nose of the vehicle is pointing) and the bearing (course direction). The angle of the wind is greater than the heading of the vehicle for all cases where yaw is greater than zero.

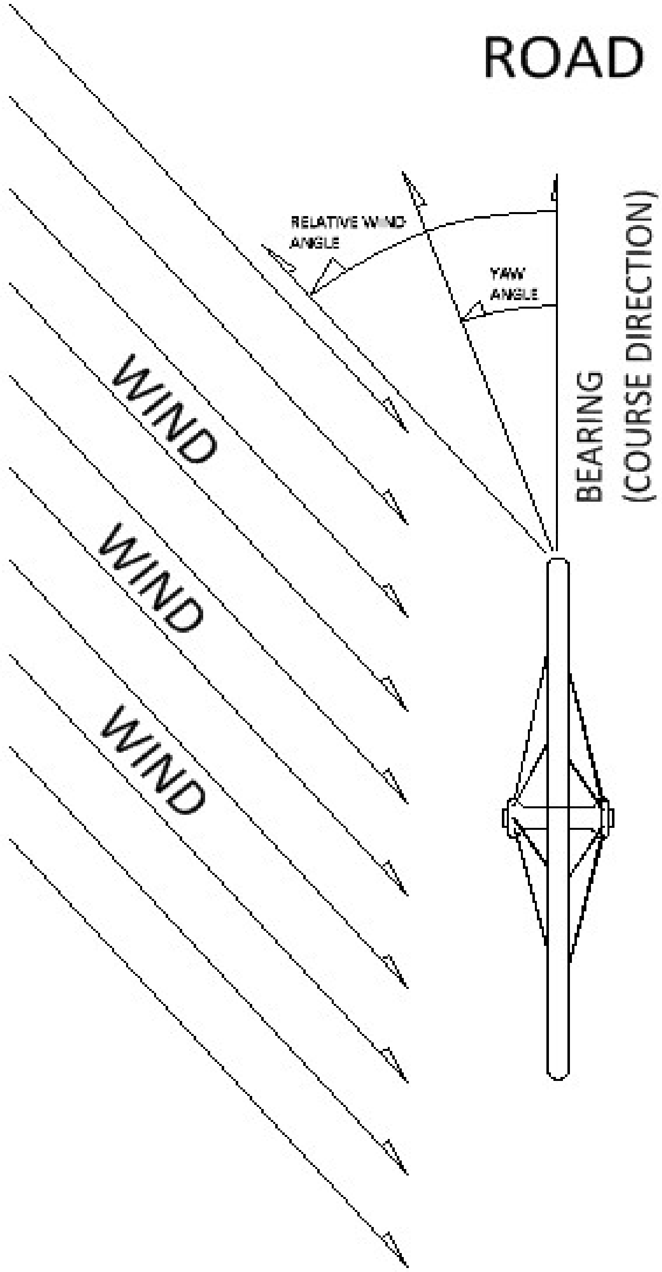
The illustration below offers an illustration of yaw. The wind (shown as three parallel arrows) is coming from 90 degrees in the clock-wise direction off the bearing of the aircraft. The aircraft is flying a bearing (course direction) along the runway; the aircraft heading is pointing approximately thirty degrees in the clock-wise direction off of the bearing. Thirty degrees represents the yaw angle.



Yaw for a cyclist is the same yaw as for an aircraft, with the exception that the bicycle's bearing and heading must be identical, or the bicycle will skid out of control. As a result, on a bicycle, relative wind can be experienced, but yaw cannot.

"Relative wind" is the wind direction relative to the bearing of the cyclist. If the cyclist is riding a straight road and experiences a head wind coming from 10 degrees in the counter-clockwise direction, then the relative wind is -10 degrees.

So, an explanation of how the wind tunnel and real world differ is experiential. In both conditions, yaw and relative wind exist, but only one component (relative wind) can be experienced. The problem with this is that cyclists experience relative wind, yet wind tunnel data is yaw-based. How then can we relate wind tunnel data to our real-world experience as triathletes and time trialists?



From the illustration and explanation above we can see that the yaw vector exists in the real world, but we have no reference for it. We can only experience it in the wind tunnel. Translating *yaw* from the wind tunnel into real world *relative wind* can help cyclists visualize the practical value of wind tunnel testing, and how it translates to real world performance. After reviewing the two charts below you can become an expert, understating how to translate wind tunnel data into personal performance goals.

The tables below show how yaw in the wind tunnel translates into real world relative wind. The first table is for a pro-level athlete (50 KPH), and the second table is for an age-group athlete (30 KPH). The values 50 KPH and 30 KPH refer (in kilometers / hour) to the total sum of the cyclists' forward speed (computer speed) plus the wind velocity—the "total speed".

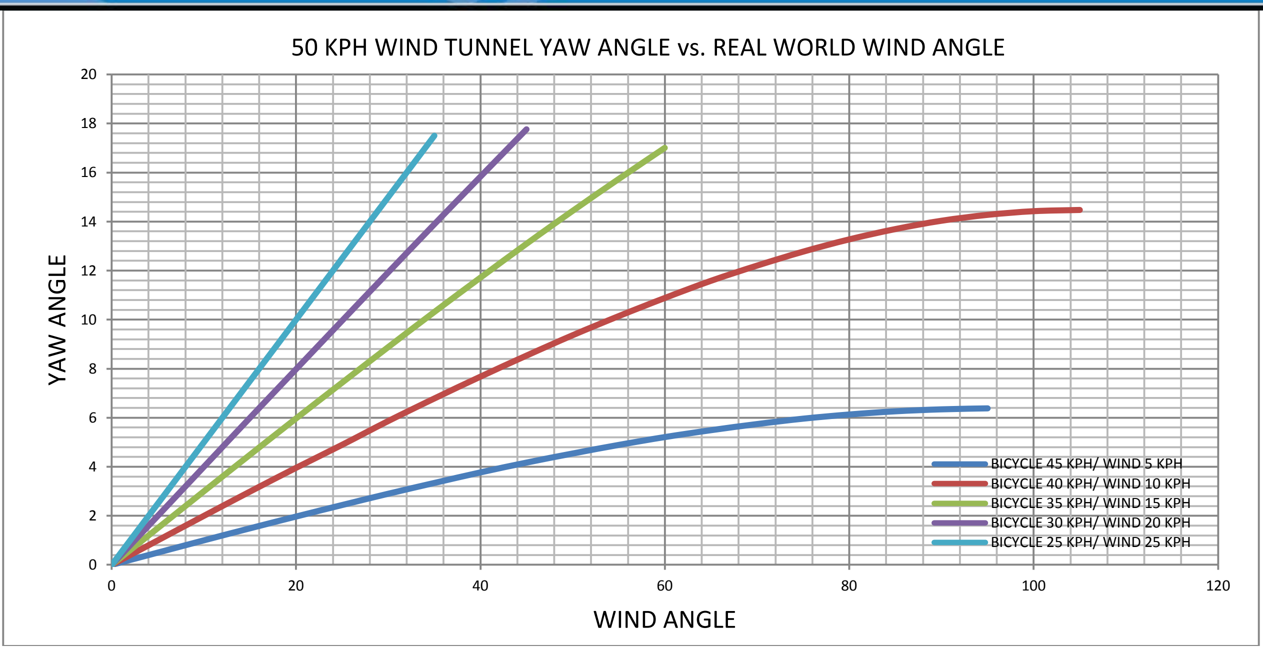
For example: If you ride at 45 KPH (computer speed) and the wind speed is 5 KPH, then you reference the 50 KPH table. If you ride at 25 KPH (computer speed) and the wind speed is 5 KPH, then you reference the 30 KPH table. Tables can be created for any “total speed” value, but for simplicity, I’ve created two for this explanation.

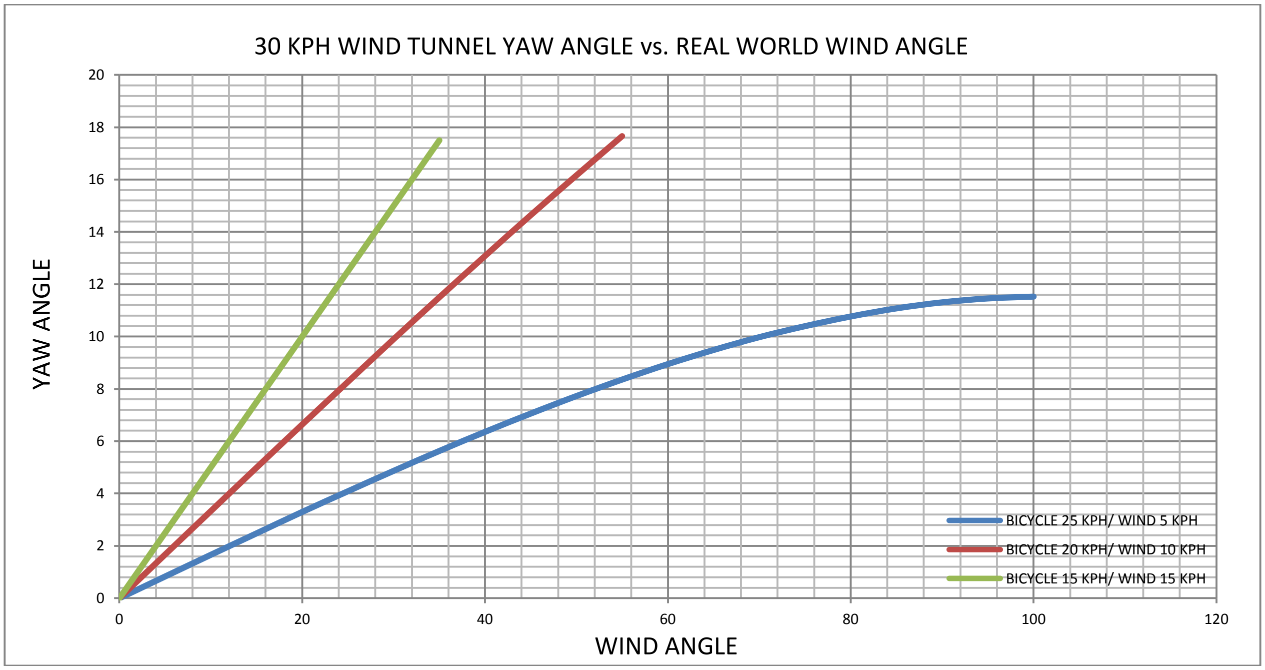
Let’s get started…

1. Identify the table that is appropriate for you: the pro-level or age-group level
2. Identify the colored line that corresponds to your computer speed and the wind velocity
3. Estimate the direction the wind is coming from, with straight ahead equal to zero, and directly from the side equal to 90. This is the horizontal axis (x-axis), the WIND ANGLE
4. Follow a vertical line from the wind angle to the intersection of the line that corresponds to the colored total speed line. At the point of intersection, move directly to the left and read the corresponding YAW ANGLE the vertical axis (y-axis).

Here’s an example of estimating the wind tunnel yaw angle using the 50 KPH table:

- Find the dark blue bicycle velocity = 45 KPH and a wind velocity = 5 KPH line.
- Assume 60 degrees relative wind (the wind is coming more from the side than from the front)
- Result: the yaw angle in the wind tunnel is equal to 5.2 degrees.





As illustrated, the difference between the wind tunnel and the real-world yaw angle vs. wind angle is significant. Wind tunnel tests can be misleading without an understanding of how the two angles are related. Most people are surprised to discover that it's nearly impossible for a pro-triathlete or TT specialist to experience yaw angles greater than 15 degrees, and age-group athletes rarely experience yaw angles greater than 20 degrees. Now you can be an expert the next time you read an article with wind tunnel data, and you can determine how the data relates to your personal performance goals.