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Lastly we have acceleration ; every time you speed up you use power to do that, unless you're rolling downhill. It can range from 0.5 (square meters) when sat up on the hoods, 0.3 when low on the drops and all the way down to 0.2 with aerobars, helmet and a TT bike. You can’t perform that action at this time. The wind conditions were not quite calm (though the wind was neither strong nor blustery) so this example shows that small differences in aerodynamics can be spotted even under non-ideal conditions. Because wind can change direction or bluster it is still a good idea to perform these tests in a sheltered environment on as windless a day as possible. And even then velodromes have problems because (believe it or not) riding around the track you (and others there at the same time) will create your own tailwind ! How Virtual Elevation works The single most important thing we do is to run multiple loops on the same course with a power meter; every run will have the same overall elevation change (none), same distance and experience the same environmental conditions whilst the power output and speed will vary. When cycling without a draft, typically during an individual time-trial or bike leg of a triathlon, roughly two-thirds (or more) of effort is spent pushing air out of the way. Hence the name 'Virtual Elevation'. And of course, wind is the most obvious problem. Virtual Elevation - aka The Chung Method Ultimately we all want to get faster on the bike. When the estimate for CdA and Crr are correct the VE plot for a lap will show the start and finish point at the same elevation (i.e. they will be level). Air gets thinner as you go to altitude, its why hour records might be attempted there (lets ignore the fact there is also less air to breath). Assuming you have done all you can to shed unwanted pounds there really isn't much you can do to change the wind, air density the course profile or gravity. You signed out in another tab or window. You do the work. But we need to make sure we don't brake, lose air from our tires or change position, because none of these things are going to be taken into account. Its only in the bottom two plots that we can see a level start and end for any given lap; those are the laps that were performed with the associated CdA and Crr. We can see that the top left plot is clearly wrong as each lap finishes higher than it started; the CdA estimate is too low. The effects of slopes, gravity, air density will be the same for each run; we have not eliminated their effect by riding a loop but we have made them identical for each run. Reload to refresh your session. The more streamlined and slippery we can become in the wind the faster we go for the same watts. Estimating using Virtual Elevation The example shown to the right (courtesy of Dr Chung) shows a field test of 7 laps where the rider had his hands in one position for the first several laps then changed hand position part way through the test. That leaves our tyres (Crr), bike and posture (CdA) to work on. Similarly for 17km/h on 5% and 10km/h on 10% every kilo will take 2-3w of power to lift to the top. Remaining factors include; weight if you're riding on the flat or downhill then extra weight can be advantageous as momentum and gravity help you go faster; but as the road tilts upwards its gonna need more power to overcome. To avoid spending lots of money on time in a wind-tunnel there is a practical approach called 'Virtual Elevation' (VE) devised by Dr Robert Chung that can be done outside using a power meter and speed sensor. Pushing air out of the way isn't the only thing you pedal against, the tyres on the road have a coefficient of rolling resistance or Crr ; even skinny road tyres might have a range from 0.0025 up to 0.005. We can then make some educated guesses about what Crr and CdA were and plot the associated virtual profile. or its affiliates Instantly share code, notes, and snippets. Riding with a 20 km/h headwind or sidewind is no fun; but riding with a 20km/h tailwind is great ! So windspeed and just as importantly wind direction (yaw) can have the biggest impact on how fast we can go for any given power. © 1996-2014, Amazon.com, Inc. The top right shows the CdA has gone up but still each lap finishes slightly higher than it started. Amazingly, Graeme Obree reduced his CdA to 0.17 for his hour record but his posture was pretty extreme ! Aside from CdA there are a number of other factors that will affect how fast you go for any given power output. Of course, the better the conditions, the fewer the laps and the more precisely and reliably you can pin down the differences. Typically, on a 2% slope an 80kg bike and rider will need 233w to maintain 25 km/h, every 1kg of weight extra costs another 2w to go the same speed. The drag coefficient for a cyclist is called their Cd; if A is the rider's frontal area then the drag coefficient times their frontal area is their CdA sometimes called their "drag area". In the past, in order to test position and equipment and calculate our CdA we needed to know accurate values for; weight, speed, windspeed and yaw, power Crr, Rho, incline, gravity and acceleration. Supersets, Custom Exercises, CSV Export, Apple Health, Warm-up Calculator, Siri Shortcuts, 3rd Party Integrations, Dark Mode, RPE, Advanced Charts, Body Part Measurements, Workout Sharing, Custom Timers and more. Given we spend so much effort pushing air out of the way it should come as no surprise that the density of the air (Rho) can make a massive difference to how fast we go for any given power output. So a field test would typically be performed on a still day on a flat road; removing the need for the windspeed, yaw, incline and gravity terms. Luckily there are lots of folks testing them so you don't have to. The change in hand position was actually quite small: the first 4 laps were with the hands on the bar tops, the last two-and-a-half laps were with the hands on the brake hoods. You signed in with another tab or window. If you have sufficient laps and variations in positions you will be able to determine which lap yielded the best results – and thus identified a good position and its associated CdA. Strong has all the features. Then looking at speed for each run it would be possible to check if a position was faster or slower. Aside from altitude, air density is also affected by humidity, temperature and air pressure; we can calculate the air density if we have all three of these. But riding without wind and hills was almost impossible to do outside of a velodrome. Now since each lap is performed in a single position and the physical elevation change at the start and end of a loop is zero we need to adjust Crr and CdA until the start and end of a lap in the VE plot are the same. The clever bit is what Dr Chung does with this formula; it is solved for slope instead of watts. This is what Aerolab in GoldenCheetah does; it plots this virtual elevation from a ride as you adjust estimates for Crr and CdA until you can see a good fit for the elevation profile. In fact, the exact point at which the rider switched his hands from one position to the other is easily spotted – two-and-a-half laps from the end. The lower the CdA the more slippery they are. So we end up with a formula that combines all of those opposing forces into a virtual slope we had to ride up and down to get around our loop. If we do this then the power we used for each lap was used to overcome; rolling resistance in the tyre (Crr) elevation changes (slope changes) accelerations (speed changes) air resistance (CdA) This can then be converted to a relatively simple formula to calculate power used based upon Crr, Cda, speed and accelerations, gravity and slope, acceleration, weight etc. We need to eliminate it from our calculations. But changing tyres really can make you faster (or slower). We can also assume that as a rider we weigh the same in each run. The aerodynamics of a cyclist and their bike has a huge bearing on the maximum speed they can get at any given wattage.

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