WHAT'S STOPPING YOU

Want to go faster? Course you do. But your legs will only get you so far. Use your brain to unravel the forces holding you back and you'll go a lot further

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Know your enemy, advised Sun Tzu in *The Art Of War*. When it comes to the ongoing battle between cyclist and nature this ancient bit of wisdom is a great shout. So who – or what – is your enemy when it comes to going faster?

Step forward the big three – air resistance, rolling resistance and friction. Well over half of all the energy you expend in the saddle is wasted overpowering these beasts. But, with a little learning and a degree of cunning, you can overcome them to weaken their impact and accelerate your ride.

Before we begin, here's a quick bit of science to help you understand exactly what it is you're up against. Above 16kmh (10mph), your biggest opponent by far is air resistance. When you're cruising at 30kmh (18mph) it's responsible for more than 85% of what's holding you back. Go faster and it rises past 90%. Rolling resistance at 30kmh can account for another 13% of the forces that conspire against you, while friction in the chain and bearings make up the remaining fraction. Got it? Good. Now let's cut to the chase.

AN ILL WIND

Air resistance is a drag, literally. Every cubic metre of air weighs about 1.2kg (at sea level) and you're constantly pushing it away. The faster you ride, the more you have to shove aside, and it never parts with good grace – it grabs at your body, limbs, clothing, helmet, shoes and every little bit of your bike. If we could ride in a perfect vacuum, we'd be able to move at least twice as fast. Unfortunately, we need air to breathe so, you know, the pesky stuff has its uses.

The biggest problem is you. Your entire body is to blame for at least three-quarters of the air resistance, with your bike responsible for the remainder. 'The single most effective thing you can do combat this is change your position,' says Dr Len Brownlie, an independent aerodynamicist who has worked for Nike with the godfather of cycling aerodynamics, Chester Kyle. He has also advised the US and Canadian Olympic squads, Easton and HED wheels and Giro helmets, so as experts go, he's pretty expert.

GO FASTER WITHOUT WORKING HARDER

Tips in descending order of effectiveness

Change your position so you slice through the air – flatten your back, tuck your head, bring your arms and elbows closer together.

Wear skintight clothing with few, flat seams and no pockets. Long socks can help.

Get ahead with an aero helmet to slash scores of seconds from your time – maybe even a 2% improvement in speed.

Shed a few kilos – you'll cut both air resistance and rolling resistance

Invest in a 12-spoke front wheel and a three-spoke rear.

Try a slightly higher tyre pressure or switch to 25mm tyres.

Lube the chain before every ride and clean it before every race.

Change the pulleys on an entry-level derailleur for new ones with bearings.

'Get a flat back, elbows closer together, maybe raise the saddle to unlock the hips. Triple Olympic gold medallist Viatcheslav Ekimov was a master of the aero position. He could make his neck like a stork, fold his head into his shoulders and get a nice low profile,' explains the Doc. 'It won't cost you a dollar to reduce your drag, if you're flexible and can get into that shape.'

If you did want to throw a bit of cash at it, you could invest some time in a wind tunnel to perfect your tuck. Otherwise, dedicated outfits such as Drag2Zero (drag2zero.co.uk) will help to smooth you out, and some shops that offer bike fitting can help, too. Brighton's Prestige Cycles (prestige-cycles.co.uk), for example, hires the same tunnel used by Team GB at Southampton University.

Your body is to blame for 75% of air resistance when cycling

The Doc calculates that, for a good time-triallist aiming to cover 25 miles (40km) in 48 minutes, averaging 31mph (50kmh), a finely held aero tuck can do wonders. In fact, it'll improve their time by a whopping 56 seconds compared to a tuck that's not been perfected in a wind-tunnel session.

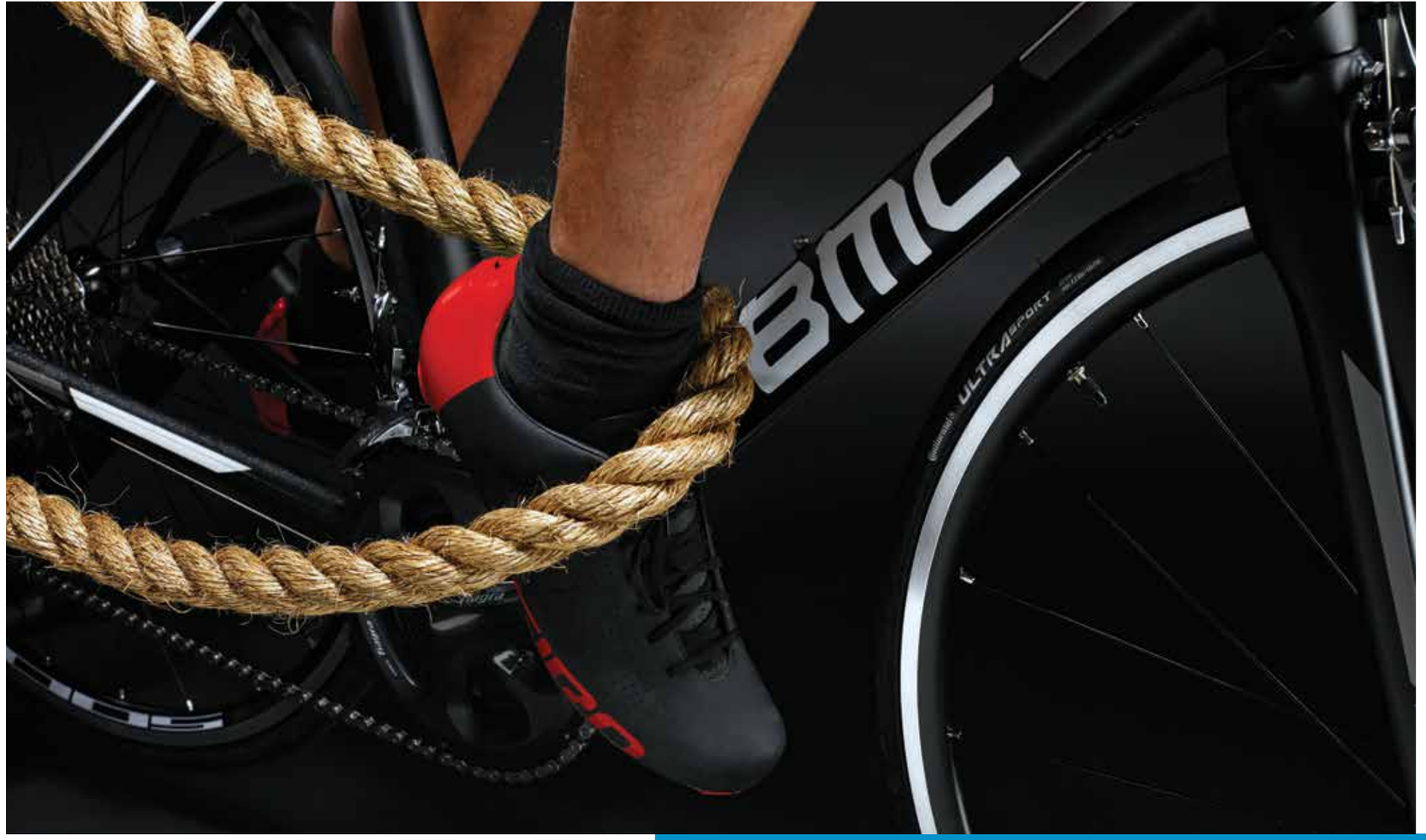
For a free, rough and ready way to find a more aero position there's a DIY trick you can try on a flat road with no wind. Freewheel from 20mph (32kmh) down to 5mph (8kmh), back-pedalling to replicate normal leg movements. Note the distance you travel. Then do it several more times, changing your shape with each. The most aero tuck will take you the furthest. Easy, huh?

If you want any more than that, though, you're going to have to open your wallet. 'The next best improvement you can make is with your clothing. It's an anomaly of evolution that human skin is slow, aerodynamically, and covering it with the right clothing can speed it up,' says Dr Brownlie.

Everything that flaps has to go. The smallest projections, such as the edges of pockets on a jersey, get rid. Seams – put them out of sight of the wind. We're talking skinsuits with textured panels to minimise pressure drag on all parts of the body by helping the air flow around you as smoothly as marbles on a glass table. 'Instead of a conventional bibshort and jersey, a time-trial skinsuit like Nike's Swift can save a rider more than two minutes over 25 miles,' says the Doc.

It's also worth becoming a fashion victim of Team GB circa London 2012. Long socks may look nerdy but with the right roughened surface they cut drag. Shoe covers alone will hide any bumps and save another 30 seconds over a fast 25 miles.

That leaves just one vital body part to consider – your head. By all means smooth



it with a good aero helmet but choose carefully because the best, again according to the Doc, will save you another minute compared to a non-aero road helmet.

Of course, having reduced the rider's drag means the bike itself is to blame for a greater share of the total drag so we're moving into deep wallet territory. Wider tyres can cut drag if paired with deep-section 65mm rims. Going further, a deep-rim, 12-spoke front wheel and a three-spoke rear wheel would together slice 71 seconds off a 25-mile time trial – assuming it's a course with no crosswinds to further complicate the equation.

And what about an aero frame and bars? 'They'll all help to some degree but for a keen amateur road cyclist they're not going to make much of a difference compared to changing body position,' says Dr Brownlie. 'Start with that, then move through your clothing choice. When that's all sorted, it'll be time to look at the bike and components.'

EASY ROLLER

Onto your next nemesis – rolling resistance. Your tyres flex where the rubber comes into contact with the road. They flatten and spread a little. The flexing is continuous while you ride because your wheels are constantly turning, laying new rubber onto the road. They are also deforming with each tiny stone or pothole they bump across. And it's your energy the rubber is using up.

Petri Hankiola runs Wheel Energy, a unique tyre-testing lab in Finland. Petri knows exactly how much energy is gobbled by the tyres of pro teams such as Team Sky and FDJ. Tyre makers Michelin, Vittoria and Hutchinson also buy his expert services, as do Mavic, Trek and Specialized. If anyone would know how to tackle nemesis number two, it would be Petri, so we gave him a call.

'For 23mm wide tyres inflated to 103psi, with a bike and rider weighing 70kg, the best will absorb 17 to 20 watts and the worst up to 40w,' he told us. 'Rolling resistance increases with weight so for a set-up 10kg heavier, the best 23mm tyres will consume just 19-22w and the worst up to 45w.'

Or to put it another way, just switching to faster tyres could add 10% to your speed, which could make a huge difference. And that's only the start of the story. The main function of Petri's lab is to produce useful benchmarks, so the figures above are for a perfectly smooth track. More realistically, out on the road, the roughness of the asphalt can increase rolling resistance by up to 20%. Factor in any kind of puncture protection and your tyres will eat even more of your energy. A heavier bike and rider will make rolling resistance even worse, while reducing pressure with the same tyres does likewise.

What does Petri recommend? 'A normal road tyre is 23mm wide but if you switch to 25mm you can reduce the lost energy by 2w,' he says. So a light 70kg total set-up, fitted with the fastest tyres inflated to 103psi could eat as little as 15w on the track and 18w on the road.'

Cool. So does that mean the more you bump up your tyre pressure the more you drive down the effects of rolling resistance, right? No. Inflate your tyres too much and though they'll barely flex, they're now more vulnerable to nemesis number one – air resistance – because their frontal profile has been changed. Pro squad Phonak learned this lesson the hard way. By swelling their tyres to 180psi, they achieved minimal rolling resistance but the gains were outweighed by the extra drag created, with every bump sent shuddering up through the frame and fork.

THERE'S THE RUB

Right, onto bad guy number three – friction. To help us get our heads around this one we approached literally the best people on the planet – Friction Facts.

Friction Facts is unique. Based in Boulder Colorado, it's the only independent lab in the world that assesses the friction in bicycle parts – the chain, wheel bearings, bottom bracket, pedal bearings and derailleur pulley wheels. Since Jason Smith set it up in 2012, he has tested hundreds of moving bits and their lubricants for component manufacturers, pro teams and his publicly downloadable reports. It is, erm, a smooth operation.

'You'll lose 7-10w of your energy to the friction in your chain,' says Jason. 'Which is fortunate because it's the easiest part of the bike to access and improve. If you do nothing else, make sure you lube before every ride. If the weather's bad and you have to postpone a training ride, spend that time cleaning your chain and lubricating – do that and you can cut the friction losses to 5w.'

But what about the bearings in the wheels and bottom brackets which can cost a further 6-8w of your energy? According to Jason, the simplest and cheapest solution would be to 'swap out the pulleys from an entry-level rear mech, because they rotate in inefficient bushings, and replace them with a set that uses ball bearings.'

Jason's final tip on the subject is possibly his best – and certainly his cheapest. In fact, it's free. Sure, if world records are your goal and marginal gains keep you awake at night you can always splash out on pricy ceramic bearings. But for us mere mortals, with mortgages and kids, absorb this great truth: 'Never cross your chain from the smallest chainring to the smallest sprocket or from the largest chainring to largest sprocket. The friction losses alone will burn your muscles.' Simple when you know how, isn't it? 🚲

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