01

INTRODUCTION

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I see it all the time: an obviously fit cyclist using a good bike, but riding in a position so bad that it cancels out most of the advantages of the expensive machine and the hours of training.

Finding your optimum position on the bike is fundamental for performance, for comfort and to avoid injuries. But here's the tricky thing: there isn't a magic formula. There isn't even necessarily a 'correct' position. A lot of the time it's about finding the right balance. Complicating things further, is the fact that position matters more for some riders than for others.

If ever proof were needed that bike fitting is not an exact science it comes thanks to two of the British riders on Team Sky. Take Geraint Thomas, a double Olympic gold medallist. A couple of years ago, Geraint rode half a stage of the Tour de France on a spare bike that wasn't his. It was the wrong size. And he didn't even notice! Geraint is what I call a 'macro-absorber'.

On the other hand, Ben Swift, who has picked up several big wins since turning professional in 2010, is highly sensitive to any changes in his position. Put Ben on four different bikes all set up exactly the same to within a millimetre, and, without even riding them he will tell you which one has a new saddle. Ben is what I call a 'micro-adjuster'.

Geraint and Ben are at two ends of the spectrum, and most people – as you would probably expect – are somewhere in between. But for everybody (even Geraint), finding the optimum position on a bike is important if you want to perform to the very best of your abilities. To macro-absorbers like Geraint, the window is wider – but he is not going to win the Tour of Flanders, or contend at the Tour de France, if he is on a bike that isn't set up properly for him.

This is why, at Team Sky and British Cycling, we have put so much thought and effort into helping our riders find out the best position for them. Having riders using the best positions definitely means better performances and reduced chance of injury.
It isn't easy. When Team Sky was set up in 2010 we had to fit 30 new riders, who had been riding 14 different brands of bike the previous year, to bikes made by our supplier, Pinarello. The problem is that a 56cm Pinarello frame is not the same as a 56cm Specialized, Trek or Giant frame – no two manufacturers are exactly alike. The differences may be small (Geraint might not notice; Ben would), but – even for macro-absorbers – they matter.

It therefore became a priority to develop a process for transferring a new rider to a team bike. At the same time, I have worked on a system to find riders' optimum positions. It has taken four years, but I think we've got there.

More people ride a bike now than at any time since its invention around 150 years ago. Riders range in age from the very young to the very old. The popularity of sportive rides (participation events rather than races) is increasing exponentially. The range and type of bikes available has never been so exotic or wide. Our choices when it comes to why, what and how we cycle have never been so varied.

But one thing that hasn't changed is the way we sit on the bike. We still sit on a saddle, pedal with our feet and hold the handlebars with our hands. Sounds simple. And yet the potential variety stemming from these five contact points – two feet, two hands, one bottom – is enormous. How then do we arrive at a healthy and productive compromise of these coordinates in order to cycle?

Some of us just jump on a bike for transport over short distances. It might not even be our own bike – and a simple saddle height adjustment sees everything alright.

At the other extreme, some riders spend hours and hours pushing themselves to the very limits of human

performance. For these people, how those coordinates are arranged makes a very big difference in terms of safety, injury avoidance, comfort and performance.

It is this balancing act – between performance, aerodynamics, comfort and sustainability – that is the crux of good bike fit. But each of these 'pillars' of bike fit is specific to the individual. There's no point being the most aerodynamic rider in a time trial if you can't hold the position for longer than 30 seconds before shifting around, thus creating turbulence, losing the aero advantage and losing rhythm and power.

When someone wants to ride a bike they form a relationship between their body (varyingly adaptable) and the bike (finitely adjustable). This interface between rider and machine is a delicate balancing act, more delicate for some than others – as my example of Geraint Thomas and Ben Swift demonstrates.

Injury is as, if not more, important a consideration as performance. In training and competition some riders seem to get more injured more often than others. The holy grail of sports medicine is to be able to predict who and why and make changes accordingly. In spite of hugely involved assessments of ourselves from multiple angles, we are still not very close to this goal.

Examining the interaction between rider and bike set-up is another form of assessment. I have now completed a great many – and it's fascinating. To my mind it correlates well with how the same riders fare on and off the bike in training: for example when doing hard blocks of riding or gym work. The same people who fail to adapt to training or get injured are invariably those who are very sensitive to changes in their bike position – they are the micro-adjusters. They constantly fiddle with their position to get the right feel. I think they have to, because their ability to adapt to change is so limited they struggle to accept the same position day in, day out.

As you might guess, the people who seem to adapt well to training are the same ones who are not as sensitive to their bike position and can adapt to it no matter what – the macro-absorbers.

BIKE POSITION: A BRIEF HISTORY

Look at old pictures of racing cyclists and you can see how bike positions have changed and evolved.

FAUSTO **COPPI**

Fausto Coppi, the great Italian star of the 1940s and 50s, sat low with high handlebars – as did all his contemporaries. Jacques Anquetil, who came along in the late 1950s and dominated the Tour de France in the early 60s, still sat relatively low on the saddle (his legs weren't as extended as those of today's riders) but he looked to elongate his position; he was stretched across the bike, and looked quite aerodynamic. Others were naturally inspired to copy him. Change was often instigated by the best of any era.

Eddy Merckx, the greatest cyclist of all, followed Anquetil, and he was the catalyst for another change. He sat higher in the saddle – almost resembling a modern rider. Merckx was a micro-adjuster, always tweaking his saddle height and handlebars.

The first ever bike-fitting manual or book was published by CONI (the Italian Olympic Committee) in 1972. The Italians looked at a group of 20-year-old professional male cyclists who appeared to be successful and then set about describing the commonalities of their position on a bike. It was assumed that, because these riders were fast, their positions should be adopted by everyone. The resulting publication is often referred to as the Italian Cycling Bible, and it was treated as such for a long time. This meant that a lot of people were forced to adopt certain ways of sitting on their bikes; for example, it advocated a pigeon-toed pedalling style, with knees nearly touching the top tube. These days, we know that a large number of people simply cannot adapt to these styles of riding.

The Belgians were next on the scene. Like Italy, the country is a hotbed for cycling. But they kept position firmly in the x/y plane – viewing a rider's position from the side-on view only – and simply added a segmental approach to sizing. These were the first attempts to extrapolate someone's ideal bike size and position from a measure of leg inseam.

It was Cyrille Guimard, the legendary French directeur sportif behind Bernard Hinault and the Renault-Gitane team, who endorsed a formula that found popular appeal in the 1980s, not least because it was adopted by the American Tour de France winner, Greg LeMond. This formula takes the rider's inseam length in centimetres and multiplies it by 0.883 to give the recommended saddle height

JACQUES **ANQUETIL**

EDDY **MERCKX**

(measured from the centre of the bottom bracket to the top of the saddle). The Guimard/LeMond formula makes some big assumptions – the main one being that all human beings grow in the same proportions. For example, it assumes that everyone's legs are in a specific ratio to the length of their backs and arms. Unfortunately this just doesn't hold true in all cases. We all come in different shapes and sizes – and in different ratios of those shapes and sizes.

If you plotted the human race in terms of shape and size, for instance the relation of leg length to back length, you'd probably see a graph like the one below.

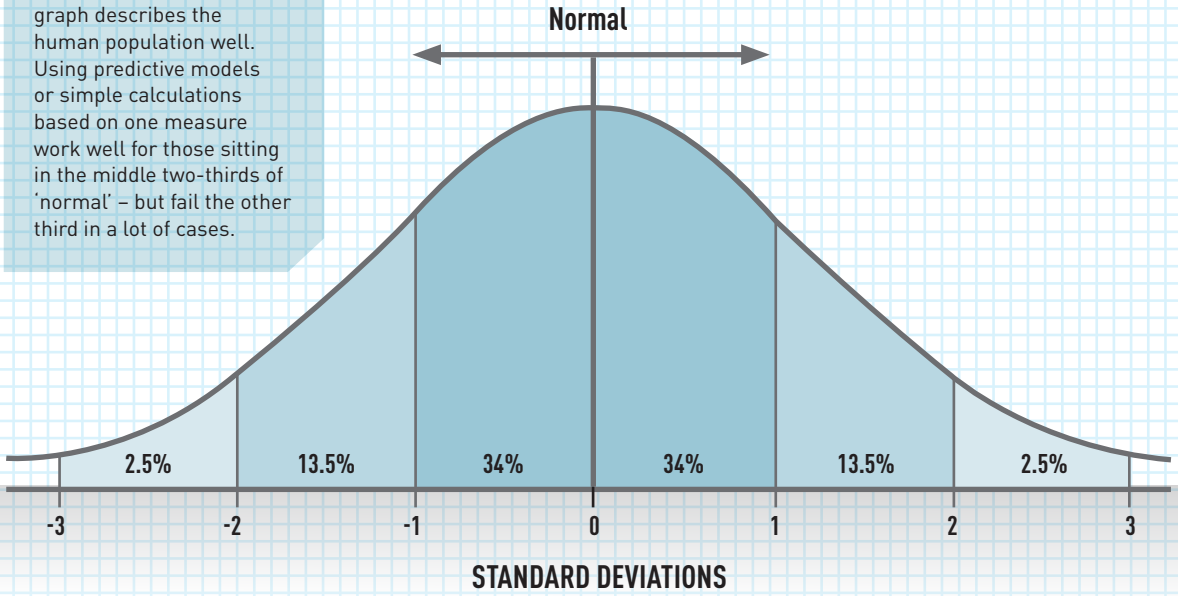
Working out your bike size from an inseam measurement should work for those people in the middle third of the graph – the 'normal' ones. But for everybody else it will be out to varying degrees. For example, a long-legged person with a short back would be fine on the saddle but be unable to comfortably reach the handlebars. Or someone with short legs and a long back (such as Chris Boardman) would be fine with the reach but end up sitting too high.

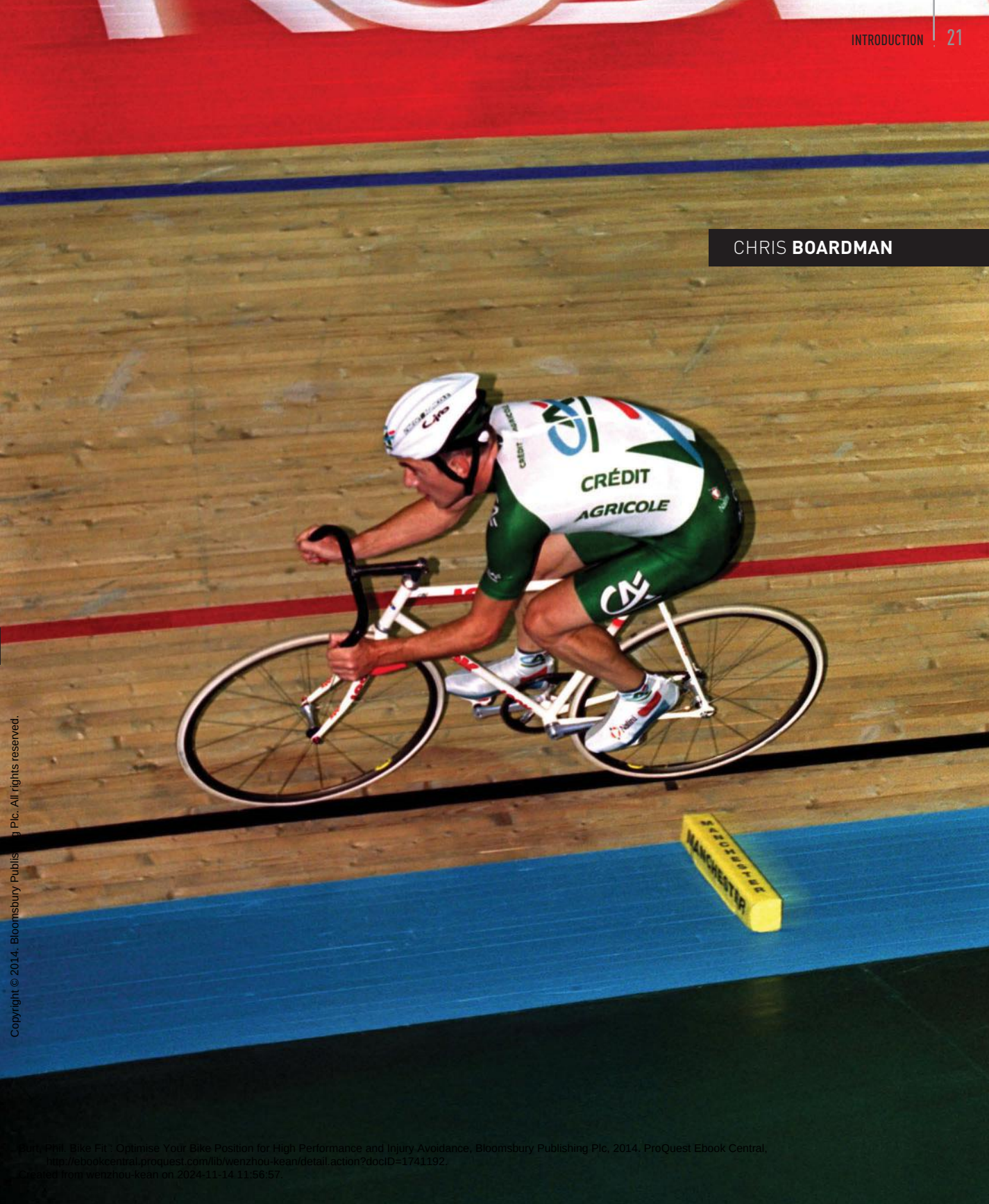
A great example of a well-known cyclist the Guimard/LeMond won't work for is Chris Boardman. The next time you see the great man on TV, take a few seconds to examine his overall composition. He has a very long back compared to his relatively short legs. This anomaly is probably what enabled him to adopt the incredibly low, flat back aerodynamic position that helped to win Olympic Pursuit Gold and Tour de France Prologues. Chris would never have been able to work out his optimal position from inseam x formulae.

The situation becomes even more complicated when you consider the differences in people's degree of flexibility and control over their bodies. Simple extrapolations from chosen limb measurements can't account for this. I once rode Bradley Wiggins's bike back from a time trial at the Tour de Suisse. I am 6'4", and slightly taller than Brad. I could not believe how high he had his saddle. I could barely ride it and found it painful. I realised how much Bradley had adapted over the years of pursuiting to achieving a hamstring

GRAPH OF **NORMAL** DISTRIBUTION

A normal distribution graph describes the human population well. Using predictive models or simple calculations based on one measure work well for those sitting in the middle two-thirds of 'normal' – but fail the other third in a lot of cases.





flexibility that allowed him to pedal in this super efficient and powerful position.

Meanwhile, another innovator, Andy Pruitt, has been working away at the Boulder Center for Sports Medicine in Colorado, USA. For the last 30 years he has been working in the field of cycling medicine and he was the first (and to date only) person to write a truly helpful medical guide for the cyclist. It remains one of the few books in print that takes the time to explore the concept of bike fit from a dynamic point of view, of the rider in motion as opposed to statically in position on the bike. And it brought bike fitting into 3-D with consideration to the frontal plane, that is, the rider's position as viewed from the front.

Dynamic bike fit gradually superseded the static fit, though it has taken a long time for the data-capture to be perfected, and for the service to be accessible to non-professional cyclists. People can now turn up to clinics and laboratories to get their bike position assessed and modified to help them with performance, comfort or avoiding injury.

It was one of Andy Pruitt's co-workers who helped changed the way we do bike fitting in 2007. Todd Carver helped develop and deliver one of the first 3-D motion analysis systems that was easy to use (i.e. not research or laboratory based) specifically for cycling – the Retül system. This package of hardware and software could record not only biometric data but bike data as well, and do so within seconds. It changed the game for dynamic fit – today a cyclist can drop in to a good clinic, studio or shop and receive fitting advice using state of the art technology within hours rather than days.

Dynamic fit can be expensive – you could spend limitless amounts of money on these services. It is a great tool, but not necessarily the panacea. What the evolution of dynamic fit has created is a spectrum along which bike fit services can be plotted. The first methods of using static measurements of the rider and bike can maybe now be considered 'sizing' for a bike. The later dynamic methods, depending on their level of application, are more in line with this statement from the Medicine in Cycling group 'A bike fit is the detailed process of evaluating the cyclist's physical and performance requirements and abilities and systematically adjusting the bike to meet the cyclist's goals and needs'.

With the advent of online shopping the role of the humble bike shop is changing. Specialized was the first big brand to recognise this and has a well-established fit process and fit product list, including shoes, insoles and clothing, adding value to the shop and the brand. All major big-brand bike manufacturers at the time of writing have or plan to have their own bike-fit kit and processes in order to capitalise on this new area of bike sales.

What does the recreational cyclist or the keen new sportive rider do when they can't find the solution to their positional issue, be it pain, injury, discomfort or underperformance?

You're unlikely to spend £300 on a bike fit if your bike only cost between £500 and £1,000. I'd like to think this book will bridge the gap between occasional cyclists and wealthier, top-end riders, and will provide the majority of today's cyclists with a handy guide to help you help yourselves. I aim to arm the you with the information to make sound decisions about bike positioning, help you solve issues around performance, injury, pain and discomfort, and help you get more out of cycling, without emptying your wallet at the same time.

SUMMARY OF METHODS OF FIT

- Traditional
- Observational
- Generic
- Individualised
  - o Static
  - o Dynamic

TRADITIONAL

Following 'CONI' the Italian cycling bible named after its publisher, and concentrating on riding position and foot placement, that is, with the ball of the foot on the spindle.

Advantages: quick and easy.

Disadvantages: does not take individual body type into account, forces the body to adapt to the bike.

OBSERVATIONAL
Based on beliefs of individual about what a rider should look like.

Advantages: improves upon traditional by actually looking at the individual.

Disadvantages: no objective data, most riders end up looking the same.

GENERIC
Equation-based fit, using measurements of body segment lengths (CONI, Bioracer).

Advantages: improves on observational method by measuring the body and recognising that proportions are important to bike fitting.

Disadvantages: static measurements; doesn't take into account the interaction between bike and rider.

INDIVIDUALISED FIT
Static
Uses plumb bob and goniometry. (A plumb bob is basically a piece of string with a weight at the end used to find vertical positions, and a goniometer is a large protractor used to measure angles.)

Advantages: uses joint angles to optimise fit.

Disadvantages: static nature can use only a theoretical riding position, not the true position(s) of the rider in motion.

Dynamic
Using either video or motion analysis data to adjust the bike to the rider while they are riding (in other words, while they are dynamic).

Advantages: uses objective data and the dynamic element provides a true reflection of someone riding.

Disadvantages: costly.

NEUTRAL VERSUS ACCOMMODATIVE FITTING
All of the above are tools to help you to bike fit. Of course, as with any tool they can only be as good as the person using them. Just because someone has a £12,000 3-D motion-capture system doesn't mean they will automatically do an optimal and appropriate bike fit for you. In fact, many in the know now consider the industry to be diverging into two categories: those who bike fit to a neutral set of ranges versus those who possess the skills and experience to complete an accommodative fit. Accommodative fitting is where one limitation of an individual is accommodated within the overall fit perhaps at the slight expense of another parameter, nevertheless giving a better overall fit, which remains safe.

I will use the term fit window to mean the range of bike adjustments within which a rider will find suitable levels of comfort and performance. For the purposes of this book I describe the fit windows referenced to a neutral position for each of the different types of riding. I have alluded to lots of the common cases and reasons for fitting outside of this window, but ultimately it may be beyond the scope of this book to help you complete a difficult fit accommodation. If you need an especially complicated fit, I recommend consulting an appropriately qualified practitioner.