DIY Dynamic Bike Fitting

Using Simple Tools and Observations.

1) Road Bikes

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Introduction

The title of this guide may be a little misleading as although possible to do your own solitary bike fitting, a helper / observer will make the whole process much easier. The 'DIY' in this context relates to being able to do the fitting in your own home using a turbo trainer and simple tools. Elaborate motion capture equipment can make the bike fitting process much easier, I use them all the time, but for most people, a combination of direct observation, subjective impression and simple measurements will get you very close. The intention of this guide is to inform you of what to look for, what to feel and how to use relatively simple measurements to find that elusive 'sweet spot' of comfort, efficiency and performance. What this document can't do is give you the experience and fine observation skills of a quality Bike Fitter, so if struggling with chronic cycling related pains and niggles, you need to find a reputable Fitter and / or seek appropriate medical help.

This guide assumes that your road bike is of a suitable size and can be made to fit you. Although primarily written for road bikes, the principles are applicable to all bikes. The frame is the 'heart' of the bike and the most important thing to ensure is the correct size during the buying process. Crank length and handlebar width are also important and can be both expensive and time consuming to change. If in any doubts that your bike is a suitable size, please refer to Appendix 1 - Bike Sizing before commencing the fitting process.

This publication is not intended to replace Medical care. Cycling injuries should be referred to qualified Medical professionals.

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Chapter 1

Tools Required

Essential

Turbo Trainer

The most important tool to enable a bike fitting is a turbo trainer. Ideally this will have variable resistance and be reasonably representative of rolling along a flat road. Being able to monitor your performance is extremely useful. Some turbo trainers give a direct reading of speed, power or cadence which is ideal. Your bike may have on board cadence or power measurement, which is also good, as is speed, provided the sensor is on the rear wheel. If your speed sensor is taken from the front wheel , see if you can temporarily move it to the rear for the fitting exercise. As you will see later in the guide, my process looks for small performance changes to quick positional alterations, so being able to measure and read increments of 1 watt, 0.1 mph, 0.1 kph or 1rpm will be very useful, though not essential.

Tape measure

Spirit Level

Plumb Line (or small weight on the end of a piece of string).

Small (6") ruler.

Allen Keys / Spanners.

Non Essential but Useful

Vernier Callipers

Will tend to be easier to read than a small ruler.

Goniometer.

A device for measuring anatomical angles.

Ipad / Android Apps.

You may like to replace the spirit level with an 'Inclinometer' App and the Goniometer with video analysis Apps or software such as Kinovea.org, Dartfish or Ubersense.

Torque Wrench (up to 15Nm).

Chapter 2

Process Overview and Measurement Techniques

Process Overview

In overall terms, the Dynamic Bike fitting process is relatively simple. The objective is to find an ideal riding position, optimised for performance, comfort and efficiency whilst minimising the chance of injury. The technique is to take a series of measurements and observations of the current riding position, coupled with subjective impressions of the rider. These parameters are correlated against the expected norms and in a series of iterations, the ideal position established. The penultimate step is to accurately record the position to enable replication across other bikes. The final stage is to ride the bike out on the road, hopefully with improved comfort and performance, but at the very least the rider will have learned something about themselves and how they interact with their bike.

So far so simple, but just to let you know what you are in for, you will be looking for 12 different pieces of information to support establishing the saddle height. A further 4 to ensure a suitable saddle fore-aft location and 7 more to get your handlebars in the correct location. Note, this is all done on the assumption that you are relatively happy with your shoe /cleat set up. The next chapter of this document will cover the basics of cleat set up as this needs to be done first, but if in any doubt about your shoes & cleats, again you need to see a reputable Bike Fitter.

Fundamentally, the cleats need to be set first, the crank lengths checked for suitability, the saddle height and fore-aft position established, then the handlebar and shifter positions located. But if things were not complicated enough already, cleat, saddle, handlebar position and crank length all interact with each other. Changing one will have knock on implications to the rest, so the fitting process is a series of iterations, hopefully honing in on your perfect cycling posture.

So what are these numerous measurements / observations and how easy are they to do. You may be pleased / surprised to know that at no point will I be asking you to put your heel on the pedal with a straight leg, measure standover height or if you can see the front hub past the stem. You will be hanging a plumbline off the bony bit below your knee cap though, which is my only concession to 'old school' bike fitting. You may also note there are no flexibility or core strength checks, not that they are irrelevant, but because doing them yourself or with an untrained observer would not really add to the process.

More detail on each later, but to summarise, the key dimensions and most relevant parameters are as shown below. Don't worry if this intimidating, or your observer is worried that they have more responsibility for the outcome than they initially thought when agreeing to help. None of these parameters is definitive, some will be ambiguous or even contradictory. Taking so many observations helps to build a picture, which nudges the bike set up in the right direction. After a while both the rider and observer will be 'tuned in' and feel / see the effect of very small changes as the iterations get closer to optimum. Although many of the photos shown are of men, the process is equally applicable to women.

Assessment Parameters		
Saddle Height	**Saddle Fore-aft**	**Handlebar Height and Reach.**
Knee maximum angle. Knee minimum angle. Ankle posture at top of stroke. Ankle posture at bottom of stroke. Deceleration of knee marker at bottom of stroke. Symmetry of knees either side of the bike. Difference between power output on hood and drops. Stability of the hips. Upper body movement. Orientation of pelvis. Inseam to ground. Greater Trochanter to ground.	Knee Over Pedal Spindle. (KOPS) Hip marker alignment to seat tube axis. Balance Weight on your hands.	Default hand position Torso to upper arm Angle Straight or soft elbows when on the hoods. On the Road - How much time do you spend on the drops. Difference between power output on hood and drops. Minimum hip angle Wrist posture on hoods and drops.
Other Relevant Factors		
Hamstring, back, hip, quad, calf flexibility. Hip, knee, neck, shoulder, arm, hand, foot or back pain. Core strength. Foot anatomy.		

Measurement Techniques.

This guide was sold on the basis of 'using simple tools' and in most cases the parameters are subjective or require just a tape measure, ruler or plumbline. Some will benefit from more objective measurements, usually the angle between various body reference points. There are a number of options to do this, from very high, to very low tech.

The high tech options are to use video cameras and free analysis software such as Kinovea.org, or Apps such as Ubersense or Dartfish on a phone or tablet. Ideally the camera would be at least 2.5m from the bike, approx 0.7m off the ground and in line with the crank centreline. There is plenty of opportunity for errors and fast spinning legs can often make the images a little blurry, so these measurements should not be regarded as definitive, like everything else, merely contributing to the overall picture.

A lower tech option is to use a Goniometer, a simple protractor, large enough to be able to measure between body reference positions. These can be found cheaply on Amazon, Ebay etc. and ideally need to be at least 30cm long. Alternatively, you could print off a photograph of the bike and rider, then use a protractor to measure the angles.

The very low tech option is the judgement of the observer, hopefully made easier by the examples I shall be providing.

My recommendation would be to trust the observer, especially as none of the parameters is definitive. As I said before, this is a case of building up a picture and does not need to be precise. I can appreciate this does put some responsibility onto the observer to be good at their job. I'd hate to think the process could cause arguments and strain relationships, but I could imagine comments such as

'What do you mean my torso angle is over 50^{o}, I'm far more aggressive than that.'

I'll leave you to decide if you need some objective data!

Body Reference Points.

To help with the measurements and observations, it is helpful to place markers at key anatomical reference points. It is best to find these points whilst sitting on the bike. Where to place the markers and some to cut out and use are contained in Appendix 2. Whilst doing your Bike Fitting, I suggest you attach the markers after you have warmed up, so giving them less opportunity to fall, move, or be knocked off before you need them.

Bike Dimension Definitions.

A key part of this process is correlating predicted saddle height dimensions based on leg lengths against actual measurements. Once complete, you also need to be able to record your position and be able to transfer it onto other bikes. Appendix 3 gives a description on how each dimension is defined and measured. Please refer to your Bike Owner's Manual for instructions on how to make the adjustments.

Chapter 3

Cleat Set Up

Contrary to some opinions, setting up your cleats is a relatively simple affair. This is not to say that the foot / shoe / pedal interface is simple, because it is not, but the cleats themselves can be set with three simple rules. The subject of foot anatomy, insole choice, wedges and shims is worthy of another document similar to, if not bigger than this one and as such is not the remit of this guide.

In simple terms, cleats can usually be placed onto shoes with adjustment in three directions, Longitudinally, Laterally and Rotationally.

Longitudinally.

This is the fore-aft placement of the cleat and controls which part of the foot sits on top of the pedal spindle. Most road cleats such as Shimano SPD-R or Look Keo allow a range of adjustment of approx 10mm in this plane. The intention is that the 'ball' of the foot sits over the pedal spindle, but the ball can be defined as quite a large area. My preference is to prod the feet to find the end of the metatarsal heads and use this as a indicator of the 'ball'. An alternative and generally 'safe' approach is to move the cleats as far back as possible. Cleats that are too far forwards tend to encourage toe numbness or 'hot foot', can give very 'toe down' ankle postures, expose foot instability problems due to weak calf muscles or insteps and over-compress minimum knee and hip joint angles. By comparison, there is little downside to the cleats being back and doing so can help to mitigate the effect of cranks being too long for you. I would expect that at least 30% of the people reading this document have cranks that are too long for them!

The reason that the cleats have to be done first is the same reason that some people believe that moving their cleats back and forth has given a noticeable power benefit or loss. This is because the cleat fore-aft location is inextricably linked with the saddle height. For most people, moving the cleats back 10mm has the same effect as raising the saddle 5-6mm. I would hope that by the end of this process, you will know that even 2-3mm saddle height modification can feel like a big change, so of course moving your cleats around can feel significant.

So where to place your cleats longitudinally.
As a start point, prod your feet to find the ends of the metatarsal bones and align the best average with the cleat centre line. If in doubt, just move them back as far as possible.

Laterally.

If you thought that the 10mm longitudinal adjustment was meagre, then the typical 3-4mm of lateral adjustment might appear almost worthless. There are two considerations here on where you place your cleats laterally, the width of your hips and whether your feet tend to be toed in or out. Starting with hip width, if you are quite slender, you will find that the pedal spacing may be wider than you hips, which can encourage the knees to lean in towards the frame. Alternatively, your hips may be wider than the pedals, which is one of a number of factors that push the knees into more outboard trajectories. As a general rule, skinny hipped people should push their cleats out, which brings their feet inboard and so closer to being under their hips and knees. People with wider hips

should move their cleats inwards, towards the bike, which places their feet further apart. If you are noticeably duck toed i.e. your feet point out like Charlie Chaplin's, there is every chance you heels will rub against the cranks or chainstays, so you will have to move the cleats inboard / feet outboard anyway.

Rotationally.

We have just touched on foot posture in terms of being toed in or out. A good way to assess this is to sit on a table and let your legs dangle off the edge, looking down to see if your feet turn in or out. Another approach is to note the angle of the feet whilst walking, with the foot position between heel strike and toe off a good representation of the cycling posture. Don't be alarmed if you are asymmetrical, this is quite common. Whatever the posture the feet wish to adopt, whether toed in or out, the cleats should be set to permit this with minimal constraint. This is achieved by either having cleats that permit enough rotational movement (float) to accommodate this position, or being quite precise in the angle at which the cleats are attached to the shoes. In practice, it tends to be a combination of both that dictates the cleat position. Look and Shimano both offer cleats with three levels of float, high, medium and low. Some people like the locked in, solid feel of cleats with no float, but this does require some precision in setting up. Lots of float gives a much wider tolerance of set up, but can give a loose feel.
To check your cleat position, ride normally on either the road or turbo and let the feet adopt their natural posture. Whilst pedalling (assuming they have at least some float), you should be able to move your heels both towards and away from the bike without starting to unclip. If this test is unclear, bring the feet to rest with the cranks vertical and again try rattling your heels both in and out. If you find yourself already against an 'end stop' in either direction, you need to twist the cleat on the shoe to allow the heel to move either in or out and let the foot find its natural posture. This will change where the cleat now actually releases, so practice unclipping a few times in a safe environment.

Your feet don't actually rotate much whilst pedalling, typically less than 1^{o} either side of the nominal. High levels of ankle articulation in dorsiflexion / plantarflexion couple with rotation, possibly giving a higher range of motion. This is also affected by saddle height, so it is worth rechecking your nominal cleat position if the height changes significantly.

Chapter 4

Initial Assessment and Data Gathering.

Initial Baseline.

On the Road

Before we make any changes to the bike we need to take a baseline of your current position. As discussed, this will involve the assessment of a number of different parameters on the turbo, but the intention is to improve your 'on road' cycling experience, so this needs some form of baseline too. Presumably you have been riding around in a similar position for at least a few rides and will have some feel for your performance and comfort. You may have detailed performance data from races, Strava.com or similar, or just keep an eye on your average speeds. It will also be worth making a note of any aches and pains as these are often the best indicators of incorrect bike fit. We don't need reams of data here, but a feel for how fast you go and in what degree of comfort would be useful. One important aspect to consider is to know where your hands normally reside whilst riding your bike on the road. As a Bike Fitter, a question I ask every customer is 'where do you normally put your hands'? The intention is to find out if they spend most of their time on the hoods, bar bends, bar tops, drops etc, or maybe move around a lot. You may be surprised to know that some people have to think about this and aren't actually sure! Wear or dirt on the bar tape can often give the game away, but is not always conclusive. So whilst out on a ride before you embark on the fitting process, regularly check where you hands reside on the bars. This is not where you think they should be, but where they naturally fall. Also contemplate how much time you spend on the drops i.e. never, 5%, 50% etc and whether you would like this to be any different.

On the Turbo

Respondents who have followed this guide have suggested it can take a good 2-3 hours, so make sure you leave plenty of time. The rider will get quite hot on the turbo, whereas the observer is relatively sedentary. Remember that the observer does not stand to actually gain much out of the process other than the gratitude of the rider, so it might be best to ensure they are warm enough and well stocked up with drinks and snacks.

Set up, Warm up, and Observation

Install the bike onto the turbo ensuring the front hub is at the same height as the rear. Hopefully you will be using some sort of speed, power or cadence measuring equipment, ideally with a high enough resolution to be able to detect small changes in output. The observer should be able to get an unobstructed view of the rider from both sides, front and back. Space can be limited though, so placing the bike alongside a wall may be necessary. It would be better to have one good side view from 2-3m away rather than a tight 1m view from each side. This is certainly the case if you intend to take some video footage as the camera will need to be this far away.

Whilst warming up, the turbo should be on a relatively light load allowing an easy spin of around 13-16mph (24kph). Don't be tempted to push it harder to warm up more quickly, just gently get the legs spinning and blood flowing. For some, this may be your first time on a turbo trainer, so allow yourself time to settle in, play with your gears and any load adjustment on the turbo to see how it works.

It is worth considering where you actually sit on the saddle and introduce the notion of the 'neutral saddle position'. The neutral position is defined by a combination of both the saddle and your shape (particularly sit bone width) and is where you would sit naturally given a suitable saddle height and torso angle on a normal level ground cruise. You may push yourself behind the neutral position whilst climbing, or come forwards whilst working hard on the drops. An excessively high saddle will tend to tip you forwards off the neutral position. If the reach to the hoods is excessively long, you may also be pulled forwards off the neutral position. For the purposes of this assessment, try to make sure you sit where the saddle is placing you rather than where you think you should be or pulled or pushed into. If you are forever squirming around on the saddle, pushing yourself back or forth, this suggests that something is wrong with your set up and this assessment can't happen quickly enough.

After about 10-15 minutes gentle spinning, you will have started to feel a bit warmer. Your cadence will usually start slower than usual, but is now getting close to normal. We need to find a suitable measurement speed and effort level to ensure consistency with everything we do subsequently. My recommendation would be to use a cadence and effort typical of your usual longer ride, club run or Sportive. Note that I have used the term effort rather than speed. This is because turbo trainers can vary widely in resistance and are also affected by tyre choice, pressure and roller loads. A good 'speed' to use is around 20mph (32kph). At this speed, the rotating inertia of the rear wheel can help to smooth out the 'choppy' nature of the turbo resistance, whilst still exposing poor pedalling technique. So try to set the road speed to around 19-21mph (30-34kph) in a gear that gives your usual cadence, then adjust the turbo resistance to give an effort typical of your normal cruising pace out on the road. For those familiar with RPE (Rating of Perceived Exertion scales) where a 1 is no exertion at all and 10 maximum effort, this will be around a 4-5. For those that know their numbers, this corresponds to somewhere around 65-85% of your maximum heart rate or 60-75% of your FTP (Functional Threshold Power).

For the assessment, your hands should be where they naturally reside whilst out on the road.

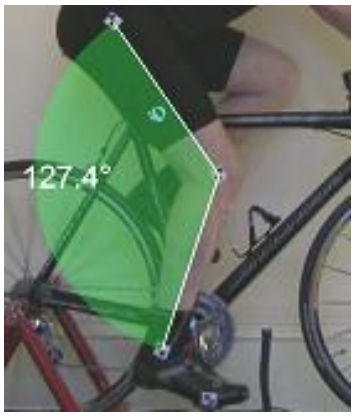
Now is a good time to attach the anatomical markers. See Appendix 2 for details.

Data Gathering - Assessment Parameters

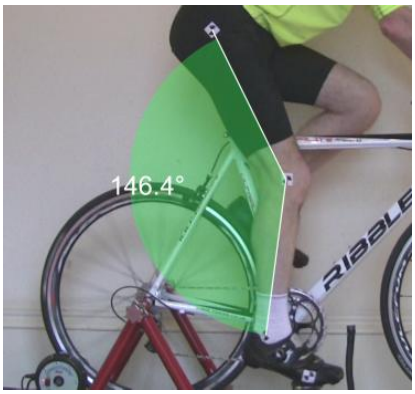
Saddle Height Indicators

We can now start gathering our measurements and observations, starting with the ones applicable to saddle height.

Knee Maximum Angle



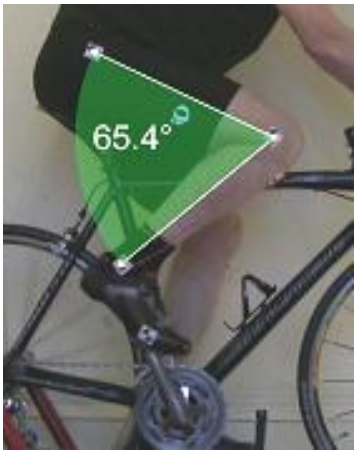
The knee will reach full extension just before the bottom of the stroke i.e. with the crank in line with the seat tube. If measuring statically using a Goniometer, make sure the rider adopts the same ankle posture when holding the leg stationary as when pedalling. Ankle proprioception (the body knowing where it is) is not good when cycling and many people believe their heels to be lower than they actually are. The observer knows best here, so the rider needs to do as they are told and either lift or drop their heels as instructed.



From the riders perspective, is there any sensation that the legs are over-extending, often accompanied by niggles behind the knees? Or do you feel they are under-extending and often seem to get more power when you shove yourself back on the saddle?

The saddle could be considered low if the angle is less than 135^{o} and / or you often shove yourself back on the saddle to get more power. It could be considered high if over 146^{o} and / or there is discomfort behind the knees.

Knee Minimum Angle



The minimum knee angle occurs when the cranks are just before the top of the stroke, again in line with the seat tube. Remember to check ankle postures and replicate if measuring statically. Tight knee angles will feel like you are too squashed up, often compromising climbing ability and encouraging you to get out the saddle early on even gentle climbs.

The saddle could be considered low if this angle is less than 68^{o}. More than 74^{o} would indicate a high saddle.

Caveat - Cleats too far forwards or cranks that are too long could also give tight minimum knee angles.

Ankle Posture as the Foot Passes Over the Top of the Stroke

View the ankle posture as the foot passes forwards over the top of the stroke.

If the ankle looks to be strongly dorsiflexed, i.e. the toes tipped up towards the shins(typically an angle <100^{o}) The saddle could be considered low. A very toe down posture, (> 120^{o}) would indicate a high saddle.

Caveat - Forward cleat positions, a lack of knee joint articulation, or very tight quads could also give a toe down posture.

Ankle Posture as the Foot Passes Through the Bottom of the Stroke.

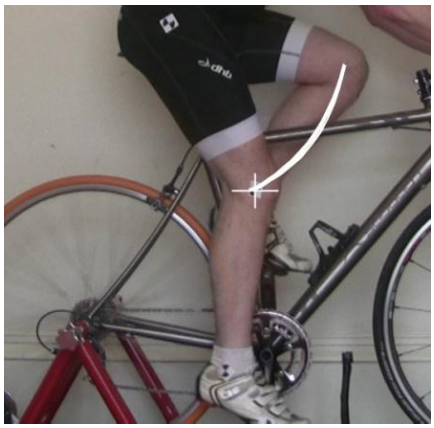
View the ankle posture at the same point as knee maximum extension

The saddle could be considered low if the foot is relatively horizontal, the heel is lower than the fore-foot, or the ankle angle is <110^{o}

A very toe down foot would indicate a high saddle (>137^{o})

Caveats - If the cleats are too far forwards, the foot may be excessively 'toe down'.

Deceleration of the Knee Marker at the Bottom of the Stroke.



This one will be quite tricky for a novice observer, so don't worry if you find it hard to make any sort of assessment. The marker at the knee joint should have a smooth pendulum type action with a gentle change of direction at each end. If the saddle is too high, there will be an abrupt deceleration of the marker as the leg straightens, often accompanied by a fore-aft 'kick' of the shoulder and 'wow wow' noise from the turbo trainer.

Symmetry of the Knees Either Side of the Bike.

The rider should look down at their knees while the observer views from the front. Are both knees the same distance from the frame. Does one knee occasionally brush against the top tube? The result of this observation needs to be taken with care, but significant asymmetry is often associated with not only the saddle being too high, but one leg being shorter than the other. The shorter leg will be over-extending sufficiently to require the hip to be closer to the crank. This is achieved by the hip coming forwards on this side only, twisting the pelvis and pushing the knee in towards the bike and the other knee further outboard.

Caveats - asymmetrical hip or hamstring flexibility and a low saddle can sometimes give a similar effect, so please don't assume you have a definite leg length difference.

Difference Between Power Output on Hoods and Drops.

This is one for the rider to judge. Pedal normally at the agreed assessment speed on the hoods or your default hand position. Monitor the speed and 'tune in' to the effort required to hold that speed. Move your hands to the drops and assess whether it feels easier or harder to hold the speed. Don't be fooled by an initial small burst of speed as this will be due to your body dropping down and temporarily pushing the pedals harder. Look to see if the easier or harder impression is sustained. Don't be distracted by a change in comfort, we are only interested in more or less power. The observer can support this assessment by watching for any change in speed and listening to the sound of the turbo trainer.

The lower position should be more powerful as the increased forward inclination of the pelvis offers biomechanical benefits to the glutes. If there is no increase in power, the saddle may too high and the hamstrings over-extending. The saddle could also be too low, lifting the knees too high into the chest and preventing the pelvis from leaning further forwards. At this moment we are not sure, so this is just a baseline against which to compare further changes. If your bike has straight bars and no drops, try to simulate this change in position by leaning further forwards - preferably by rolling forwards at the hips.

Stability of the Hips.

Observe from behind the rider. A couple of chalk marks on each side of the pelvis (just below the waistband) could help to show how much the hips are rolling. You could also see if there is any asymmetry by unclipping one foot at a time and pedalling slowly backwards. Does the hip lift as the foot comes over the top of the stroke (possible low saddle or excessive crank length) or dip as the leg extends (saddle maybe too high). Although rocking hips are usually associated with a high saddle, this is not always the case as a low saddle can have the same effect. Poor core strength and cranks that are too long can also give rocking hips. The observation here is to establish a baseline to compare against subsequent changes. I suggest using a 5 point scale. High numbers indicate the saddle height is wrong whereas lower numbers are good.

Excessive Rocking	High Rocking	Rocking	Gentle Rocking	stable
5	4	3	2	1

Upper Body Movement.

Observe from the side, particularly at the shoulder marker. Is there a strong fore -aft motion, a vertical 'bobbing', or is the shoulder relatively steady? Again this is a baseline to compare against further iterations. Use a 5 point scale from highly unstable to stationary.

Highly unstable	Unstable	Noticeable movement	Gentle movement	Stationary
5	4	3	2	1

Orientation of the Pelvis.

When viewed from the side, does the pelvis seem happy to roll forwards, giving a smooth transition into the lumbar region, or does it seem reluctant to do so, with a noticeable hinge at the lower back? A low or high saddle can create a hinge, as can poor core strength, so again this is more of an observation.

Saddle Fore-Aft Indicators.

We can now look at factors pertaining to your fore-aft location.

Knee over Pedal Spindle (KOPS)

This should be more accurately defined as Tibial Tuberosity over Pedal Spindle and can be assessed using either video / photo evidence or taken statically with a plumbline. If the latter, care should be taken to ensure the ankle posture in the static position is the same as during pedalling. The rider needs to do what they are told by the observer again and tilt the foot accordingly. In both cases the cranks should be horizontal and a vertical line dropped from the bony lump at the top of the shin, just below the knee cap. Ideally this line will pass straight through the centre of the pedal spindle. If doing it with a plumbline, you might need to hold it off to one side to clear the foot. If the line falls in front of the pedal spindle, the saddle could be considered too far forwards and vice versa if too far back. The huge flaw with this process is that the fore-aft location of the knee is also controlled by the saddle height. If too high, the leg will be straighter and the knee further back. So this test is only valid once the saddle height is somewhere close.

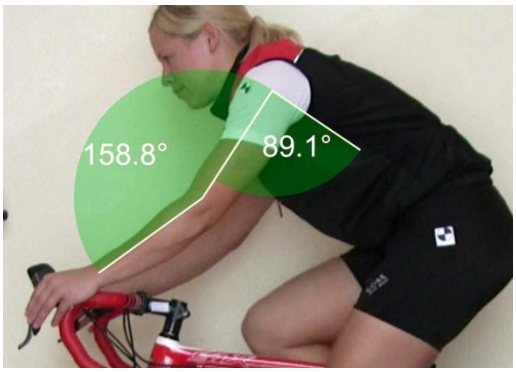
Hip Marker Alignment to Seat Tube Axis.

Looking from the side, imagine a line (or draw one on your video / photo) straight along the seat tube axis up through the rider's body. The rider should come to rest with the cranks horizontal and the foot nearest to the observer forwards (as per the KOPS assessment). Where does the hip marker sit relative to this line. If in front, the saddle could be considered too far forwards or the saddle tipped too 'nose down'. If behind, the saddle is either too far back or 'nose up'.

The good news about this assessment is that it is largely independent of saddle height. Moving it up or down does not change the saddle fore-aft relative to the seat tube axis.

caveat - if the saddle is very high, people will tend to shift forwards off the neutral position.

Balance



KOPS and hip marker alignment are a good start point, but what is actually important is how well balanced you are. With the cranks stationary and horizontal, can you hover your hands just above the handlebars. You will need to brace your legs, use your core strength and may find yourself sliding forwards on the seat. Is it easier or harder to do so if you push yourself back or forwards on the saddle. If moving from the hoods to the drops, can you move both hands together, or prefer to do one at a time? The ideal fore-aft location is where you are as far forwards as you can be without tipping forwards and putting too much weight on your hands. This can be quite tricky to establish and can be compromised by an excessively low or high saddle height. Don't worry if this is ambiguous - it probably will be!

In simple terms, if you struggle to hover your hands above the bars, the saddle is either too far forwards or nose tipped down at the front.

If easy, the saddle is either too far back, or tipped back.

Weight on Hands

This is another way to assess the 'balance' question

Whilst pedalling - how much pressure is on your hands. Is the pressure evenly distributed across the palms or concentrated at pressure points. A lot of weight on your hands would indicate the saddle is too far forwards, or tipped down at the nose.

The question you may well be asking is 'How much is a lot'? Unfortunately this is tricky to define and what might be considered a 'lot' to some is quite gentle to others. Too much weight will usually be accompanied by hand, arm or shoulder discomfort, locked elbows and a tense upper body. If you are comfortable on the bike, without any of these issues, your fore-aft location is probably fine. If the handlebars are set too high, it can be too easy to lean on them rather than let your core strength take the load. Counter-intuitively, lowering the bars can actually take weight off your hands. Taken to extremes, if the bars were so far away you could not reach them, they would not have any weight on them would they?

Caveat - Out on the road, the pressure of the wind on your chest will help to reduce weight on your hands. The turbo can make this feel worse than it actually is.

Handlebar Position Indicators

Default Hand Position

Where do the hands fall naturally on the bars. Do you have to stretch forwards to reach the hoods. Having to stretch to the hoods suggests the stem is too long or the bars are too low.

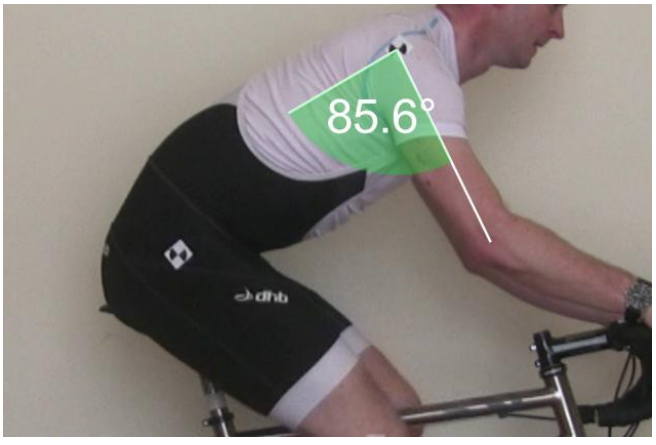
Are the Elbows Locked or Soft.

Locked elbows suggest the reach is too long, but can also be indicative of too much weight on your hands and a lack of core strength.

Torso to Horizontal Angle.

Measure the angle between the horizontal and a line drawn from the hip marker to the shoulder with your hands in their default position. This will typically be between 40^{o} and 50^{o}. 40^{o} is considered an aggressive 'racing' posture whereas 50^{o} is a more relaxed. A good start point is 45^{o}. The hip moves with pedal rotation, so always place your feet with the cranks horizontal when measuring torso angle.

Torso to Upper Arm Angle.



We need to be careful how we measure this angle. It should be to the upper half of the Thoracic spine where the shoulder blades attach. Taking it to the line between the hip and shoulder markers can give a false reading as it does not take into account the curvature of the spine. An angle in excess of 90^{o} would normally be considered too stretched out, whereas less than 80^{o} too 'on top' of the bike.

Difference Between Power Output on Hoods and Drops.

I know we have done this once already. As well as being indicative of saddle height, this comparison helps us to establish how low the drops can go before you start losing power. This will become more relevant once the saddle height has been established and the handlebar position is being set. If less powerful on the drops, the handlebars are probably too low.

Out on the Road - How Much Time Do You Spend on the Drops

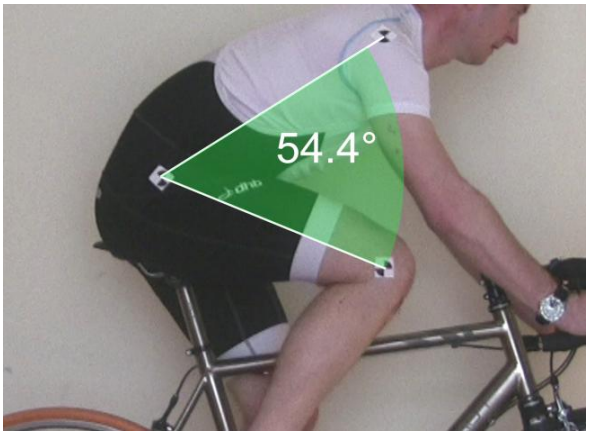
Some people never use the drops because they don't feel stable, or their riding style has no call for it. In this case one could consider a weight saving opportunity and saw them off! I believe the use of the drops should be encouraged, primarily for the performance benefit, but also to give improved stability and brake lever access whilst descending. On the assumption that you actually want to spend at least some time on the drops, how much time do you think you do so?

Less than 5%	5-30%	30-50%	50-75%	Nearly always

If less than 5%, the drops could be considered too low for you, probably compromising power deliver and almost certainly uncomfortable. If more than 50%, the bars may be too high. You will appreciate the performance benefit on them, so choose to lean forwards. Ultimately, all day riding comfort is likely to be better served with your hands on the hoods rather than drops. Lowering the whole bar assembly down with give the performance benefit and improved hand comfort.

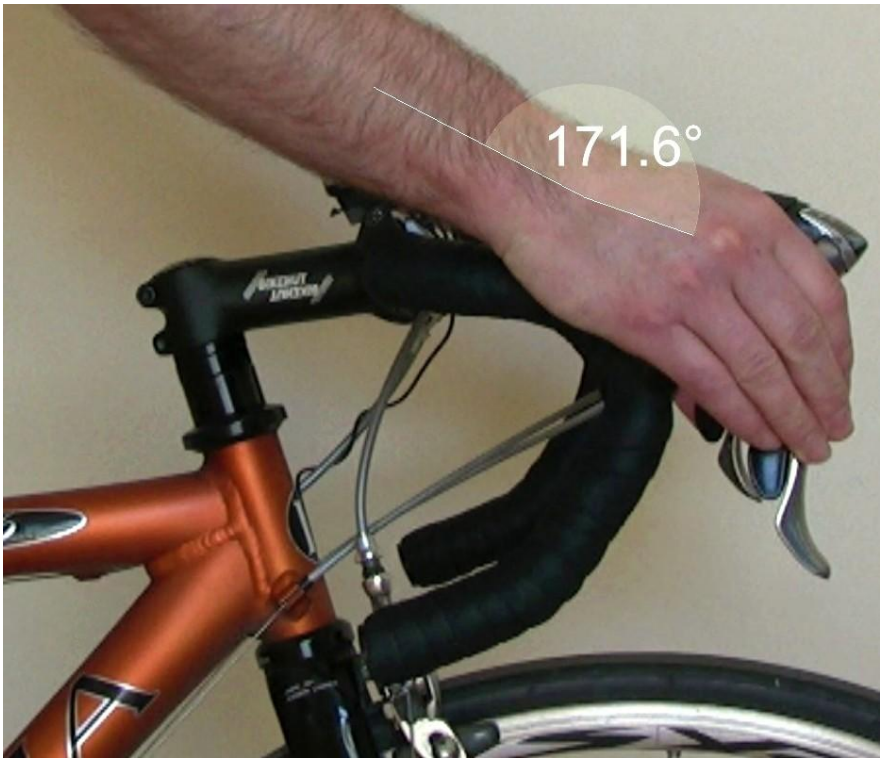
Minimum Hip Angle

Minimum hip angle occurs a few degrees later than minimum knee angle and will coincide with the knee being at its highest point. This tends to be more relevant to Time Triallists and Triathletes trying to get into very aerodynamic positions. As a rule, most people, male or female should be able to cope with a minimum angle of around 50^{o}. The most flexible men could be in the 40-45^{o} region and very flexible women may even go below 40^{o}. As discussed earlier, if measuring this statically with a goniometer, ensure the ankle posture is correct.



Wrist Posture - Neutral or Tipped Up or Down

Imagine your wrist posture whilst shaking someone's hand. This should be close to a neutral posture, neither tipped up or down or flexed in or out. Are your wrists neutral when your hands are in their default position. Can you reach the brake levers comfortably when on the drops.



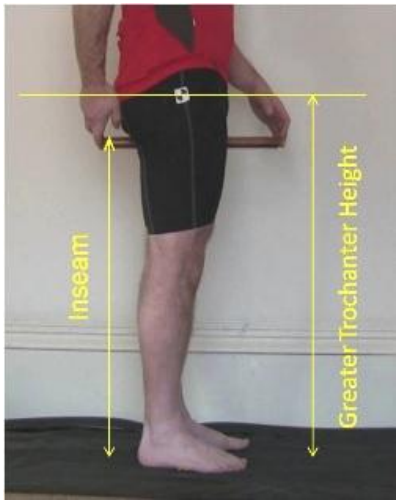
Data Gathering - Calculators

Inseam to Ground

Inseam is one of two leg length measurements that combine to help predict where I would expect your saddle height to be. This one is measured from crotch to ground in bare feet whilst standing with straight legs. The person should be wearing their normal cycling shorts and the measurement should be taken to the top of a 25mm tube (or similar) held snugly against the crotch.

Greater Trochanter to Ground

Inseam is not always the best way to define leg length. People can have either a deep or shallow pelvis, with the hip joint at varying heights above the crotch. An alternative leg length measurement is to the top of the Greater Trochanter (GT), which is a reasonably good estimation of the centre of the hip ball joint. You should have a marker on the GT from the earlier measurements, but you need to be careful as that was a sitting rather than standing position. You will need to have another prod to confirm the correct location.



As a sanity check, the difference between the inseam and GT height will usually be between 6 and 12cm (GT higher). If much more or less than this, it might be worth checking your measurements.

Best Correlation to Predict Optimum Saddle Height.

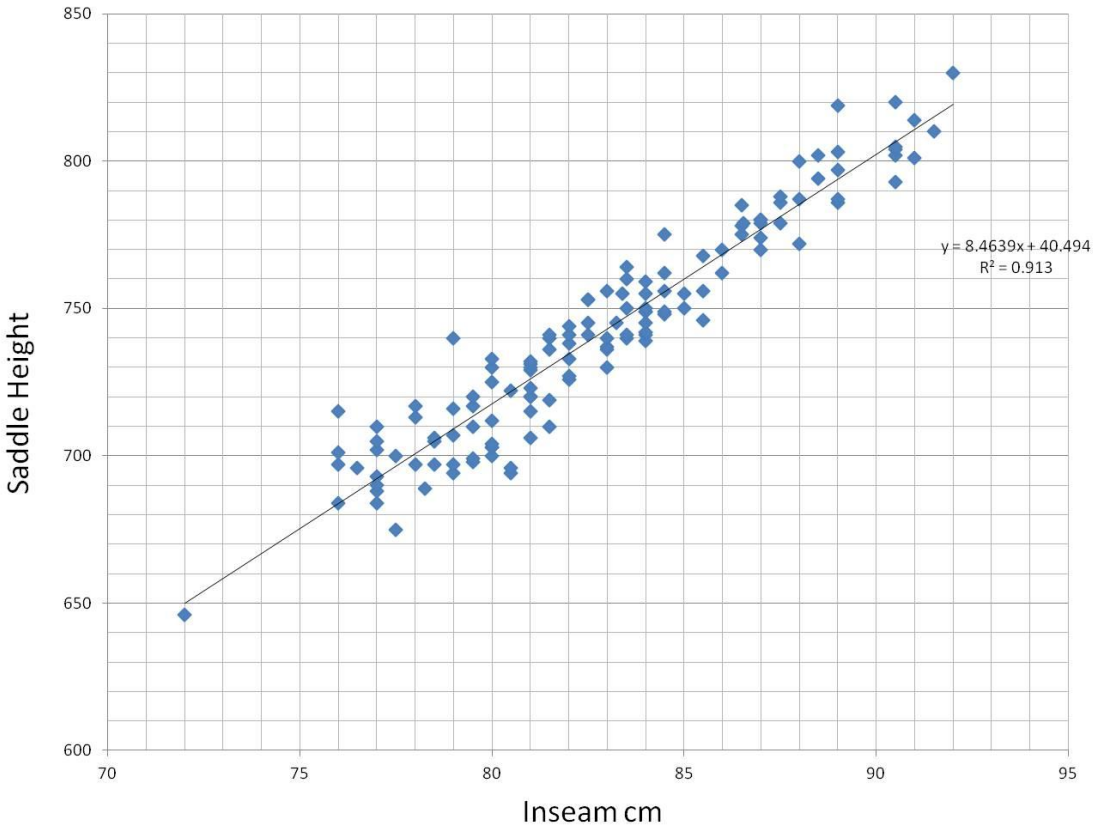
Correlations between saddle height and either inseam or GT height are a good start point, but there can be some large discrepancies. For those than know their statistical terms the R^2 values are around 0.91-0.92. The best correlation is to use a sum of both inseam and GT which gives an R^2 of 0.9526. Not ideal, but better. The first two graphs are the correlations for Inseam and Greater Trochanter height respectively. These may be of interest to you, but I suggest you use the third graph or the formula :-

Saddle Height (mm) = 4.4808x- 43.3 where x = Inseam + Greater Trochanter Height (cm)

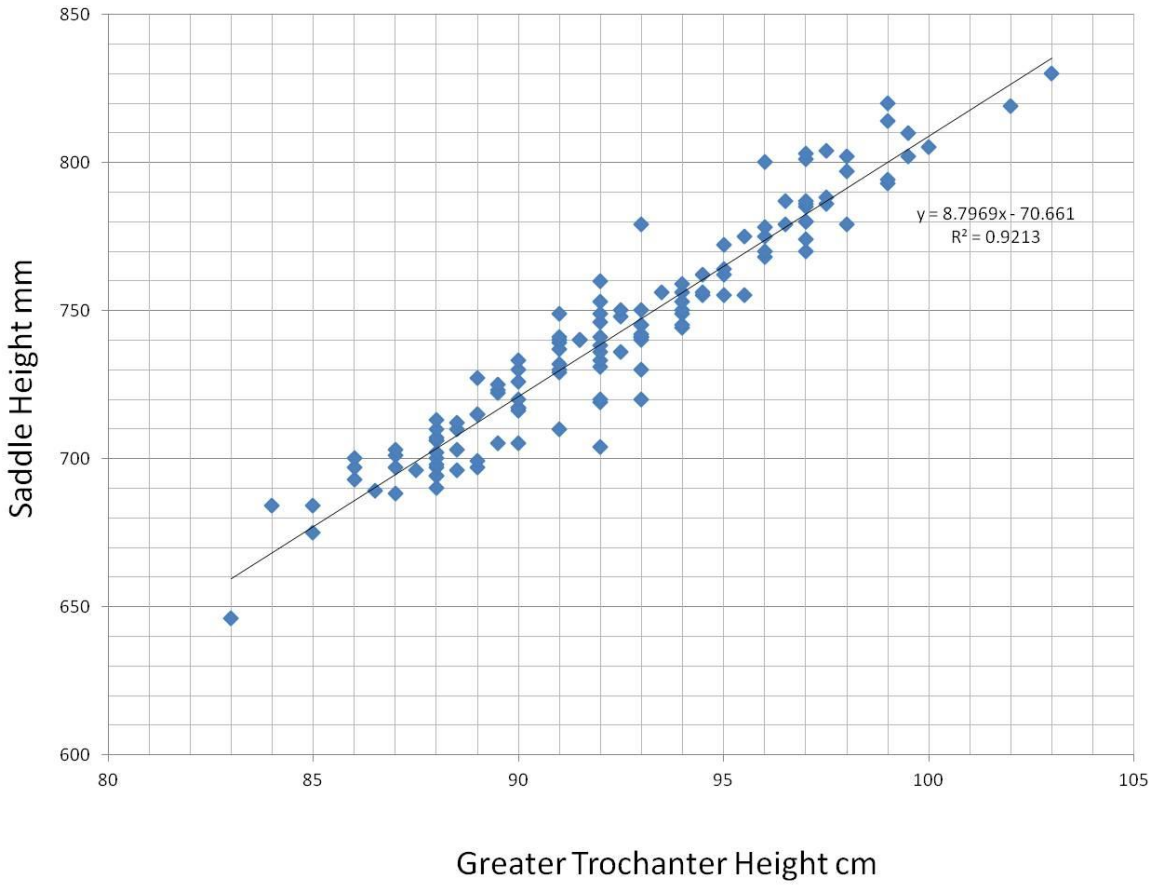
Or visit this webpage and input your measurements - http://bikedynamics.co.uk/965ll.htm

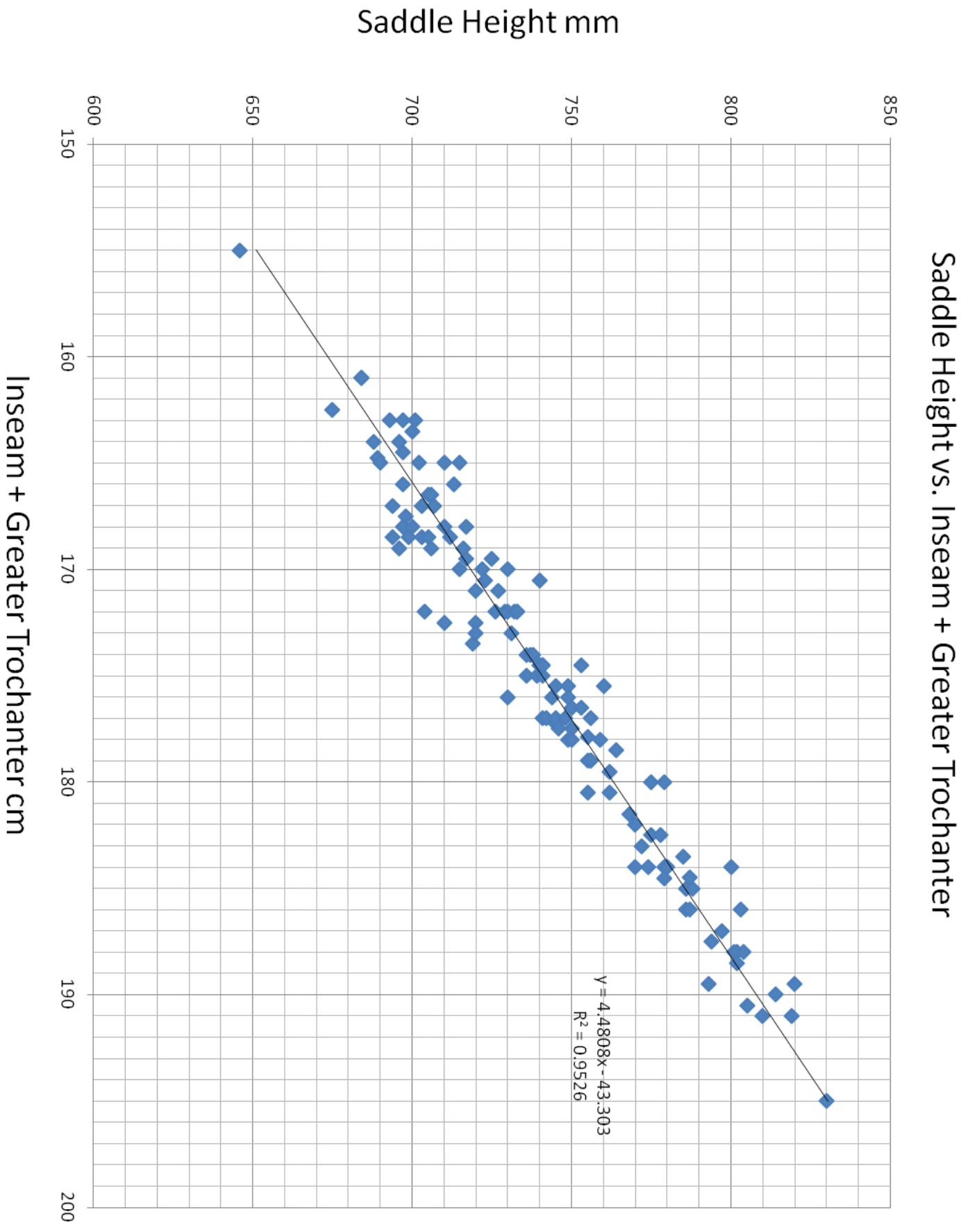
I know I am mixing my metrics here, but centimetres are good for measuring legs whereas we need millimetres for the fine tuning of saddle heights.

All of those data points are from customers who underwent a similar optimisation process here at BikeDynamics, but more importantly have confirmed subsequently that their position is working well for them with no discomfort and good power delivery. Note how some of those data points are a good 10-15mm away from the 'average', which is a big margin and why we need to look at other indicators as well as simple formulae. The correlation shown is derived from a sample of men, but a similar survey of women gave a close enough result to use here.



Saddle Height vs. Greater Trochanter Height





Saddle Height vs. Inseam + Greater Trochanter

Chapter 5

Analysis and Position Development

Saddle Position - Height

We have a number of interrelated parameters and observations that are indicators of saddle height, plus predictions based on leg lengths and actual measurements.

Summarising these in a table.
Assuming you are using a hard copy, I suggest you tick the boxes and write the actual numbers in. I'm sure those reading this electronically can improvise somehow.

		Suggests the saddle is
Parameters		High - Inconclusive - Low
Maximum knee angle		
Minimum knee angle		
Ankle posture at top		
Ankle posture at bottom		
Deceleration of Knee marker		
Asymmetry of knees		
Observations		Wrong - Inconclusive - Right
Difference in power between hoods and drops		
Stability of Hips	Rating	
Upper Body Movement		
Orientation of Pelvis		
Measurements mm		High - Inconclusive - Low
Predicted Saddle height	mm	
Actual Saddle Height	mm	

Saddle Position - Fore-aft

	Suggests the saddle is		
Parameter	Forwards or nose tipped down	inconclusive	Back or nose tipped up
Kops			
Hip Marker			
Balance			
Weight on hands			

So by now you should have an indication on both the height and fore-aft location of the saddle and we can go through a number of iterations to put it into the correct location.

Before we start optimising the saddle position, we need to make sure the cleats and saddle tilt are now fixed with no expectations of major changes to come, though there could well be some fine tuning. If still unsure about the longitudinal position of your cleats, now is the time to shove them right back. If they feel fine, great, leave them alone. There is little justification for the saddle to be anything other than level (or very close to level). So if it is noticeably tilting up or down, set it to horizontal. If you have made any big changes here, it might be worth running through the parameters and observations again.

When you get into the modification phase of this process, you will need to be able to judge how far you are moving the saddle. I find the best means to do so is to wrap some masking tape around the seat-post at least 20mm above the clamp. If your predicted saddle height is significantly below your actual, you may need to give plenty of room for adjustment, so, place the tape 40, 50 or even 60mm above. The process works best with relatively quick changes in saddle height so you can more easily feel the differences. It will be worth ensuring that your Observer, whose role is now becoming one of Chief Mechanic, can easily get to and adjust the clamp and the seat-post slides up and down easily. To facilitate this, the rider needs to stop pedalling, stand up on the pedals and lean forwards out of the way. With a bit of practice, the observer will hopefully be able to lean in and make an adjustment in just a few seconds. We don't want to make any actual changes yet , so if you have practiced moving the saddle, ensure it is back where it started.

Height Development - Coarse Tuning

The rider needs to get back on the bike and warm back up for 5 minutes or so. You can't help but be aware of how your predicted saddle height compares against you own, but try not to jump to any conclusions about what might happen when you adjust it.

Once warmed back up, spend some time 'tuning in' to how your legs are developing their power. Is there any sensation of being over-extended at the bottom or squashed over the top. Keep moving between hoods and drops and notice any differences in how easy it is to generate that power. Do you feel smooth and consistent, or erratic. Keep an eye on your speed, cadence or power measurements and try to correlate the subjective impression to your objective data. Don't worry if you have moved your cleats back and it now feels harder work to hold the speed. This does not suggest you need to move them forwards again, it just tends to confirm the saddle is too high and you will retrieve that power as the saddle comes down.

Once fully tuned in we need to make our first adjustment and for this I suggest setting the saddle height to somewhere close to the prediction. If the parameters all suggest the saddle is too high or low and contradict the prediction, trust the parameters and move the saddle 10-15mm in the appropriate direction.
Work out by how much the saddle needs to go or down and make the change as quickly as possible as the rider stops pedalling and leans forwards out of the way. They should then get back up to the assessment speed and consider just one thing - is it easier or harder to hold the speed. If ambiguous, go up and down a few times until you are sure. Be careful to not just 'want' it to be better and wrongly convince yourself. To help draw a conclusion, the observer should keep an eye on the measured speed as well as listening to the sound of the turbo and watching the upper body movement. Now also check for the difference between hoods and drops. Ideally you will feel more powerful on the drops.
There are three possible outcomes to this test, worse, better or ambiguous.

If it is worse, your ideal saddle height is closer to your start point than the new location. My recommendation here is to split the difference, so if you went down 10mm and it was worse, now try going down only 5mm. If still worse, try going up 5mm.

If better, then try going another 5mm in the same direction and keep doing so until there is no more improvement to be seen. If noticeably better, don't worry about keeping to the assessment speed decided earlier, re-establish a new baseline.

If ambiguous, try a number of 5mm increments both up and down.

Saddle Fore-Aft Adjustment

Some people may consider that looking for a saddle height 'sweet spot' is too wide using 5mm increments, and they would be right, but it is not worth getting too carried away quite yet as the fore-aft location still needs to be established.

You will have assessed your fore-aft position earlier and drawn some conclusions on the requirement for change. This needs to be re-assessed now that the saddle height is hopefully somewhere close. KOPS especially can be compromised by either a low or high saddle, so reassess this along with the Hip marker location and your balance / weight on hands.

Move the saddle back or forth on its rails to suit. The balance / weight on hands criteria can be ambiguous, so if in doubt prioritise the hip marker location as this tends to be the most reliable. Ideally the saddle clamp will be within the range markers on its rails. Being at one extreme end or the other suggests you need a different set-back on your seat-post or the saddle is either too wide or narrow for you.

Saddle Height Fine Tuning

With the fore-aft location now settled, we can look to do some very fine height tuning and find a 'sweet spot'. Moving the saddle back will usually increase the effective saddle height, whilst going forwards reduces it. So you may need to re-optimise the height anyway.

The rider should get settled in again and warm back up. Once re-tuned in to the efforts involved in holding the assessment speed, adjust the saddle height to compensate for the saddle fore-aft change. It depends on the inclination of the saddle rails, but moving the saddle back or forth 10mm could be the equivalent of raising or lowering it 3-5mm respectively. Check that this compensation actually feels better. Once again, all you are interested in is whether it feels easier or harder to hold your assessment speed. If easier, or you feel no change, great, leave it where it is for now. If it now feels like harder work, you may have over or under-compensated, so try an extra 2-3mm in either direction.

Hopefully, you are now somewhere close to your ideal saddle position. It might be worth doing a quick 'sanity check' and running once more through the assessment parameters, observations and measuring the new saddle height. Alarm bells should be ringing if the actual height is more than 20mm away from the prediction, there is plenty of room for error, but it might be worth checking your measurements and conclusions one more time.

Hopefully by now, the rider is quite well tuned in to how the bike feels and we can try some very fine tuning. This is best achieved with very quick changes to the saddle height so the rider can get an almost instantaneous comparison between two conditions. Conventional adjustment via the seat-post will take too long. A very simple technique to achieve the same effect is to insert and remove an approx. 2mm pad between rider and saddle. This could be made from thick cardboard, foam rubber, even a tea towel folded once or twice. The image below shows 'old faithful' that I have used for years, now moulded into a saddle shape and very easy to slide in and out betwixt rider and bike. Inserting the pad may take a second or two, but taking it out just needs the rider to lift enough body weight off the saddle to whip it out in no time. The quicker the change, the more able the rider will be to detect small improvements. If the saddle is still far too high or low, then you will not detect any change with the pad. The difference between being 10mm away and 12mm is hard to quantify, but going from 3mm to 1mm away is often very noticeable. Keeping your hands in their default location, if the bike feels better i.e. easier to achieve and sustain your assessment speed with the pad in, nudge the saddle up 2mm and try again. If worse, go down 2mm and re-assess. Hopefully you will eventually get to a point where either inserting the pad or dropping the saddle down 2-3mm makes things noticeably worse, in which case 'well done', you have found your sweet spot.

Hold the celebrations though, because you have found your sweet spot for the torso angle associated with your default hand position. You may find that the saddle needs to be 1-2mm lower when on the drops. This is because your hamstrings are stretched by both leg extension and your torso leaning forwards. So you may need slightly less knee extension to permit the pelvis to roll forwards without putting a hinge into your lumbar region. So continue to compare the hoods and drops power output, with and without the pad, and decide if you need to make any compromise between the two. As a rule it is 'safer' to be at the lower end of your 'window' as this will allow for shorts with thicker pads, winter tights, or days when your hamstrings may be a bit tight.

Handlebar Height and Reach

Hopefully by now you will be satisfied with the relationship between your feet, shoes, pedals, cranks, crank centre-line and saddle position. You may have noted that at no point during the setting of saddle fore-aft or height did we take into consideration where your hands fell naturally onto the bars. This is because the bars should **not** be allowed to influence the saddle position in any way.

If you had been monitoring your natural hand position on the bars, you may have noted some interesting changes. It may seem counter-intuitive, but one of the most significant influences on where your hands naturally 'fall' is the height of the saddle. A low saddle, possibly in combination with long cranks will bring the knees high up towards the chest as the feet pass over the top of the stroke. This can tend to push the pelvis back into a posterior tilt and give a relatively upright torso angle. Many people who come for a fitting do so because they can't reach the bars and expect me to fit a shorter stem. They assume that raising the saddle would make things worse, but doing so actually tips them forwards, with no stem change required. Alternatively a high saddle gives over-extended hamstrings. As these attach to the rear of the pelvis, it is again pulled back into a posterior tilt, compromising the reach to the bars and giving lower back pain. Lowering the saddle is often enough to let the pelvis roll forwards and the hands to move along the bars onto the hoods.

Before getting into too much detail on stem lengths and spacer stacks, it is worth considering where the shifters are attached to the bars. Most manufacturers are now fitting them in what I believe is a sensible manner, which is with a smooth flat platform along the bars and onto the skirts of the hoods. A common error is to have the shifters too far 'up' the bar bends, giving a deep 'v' into which the palms must rest. This will give two pressure points across the palms and often be quite uncomfortable. A flat platform spreads the loads over the palms and will usually give a neutral wrist posture. Flexing the wrists away from the neutral (handshake) posture can give various hand discomforts including carpel tunnel related numbness and tingling.

The flat platform along the bar tops onto the hoods will usually be horizontal, or just a few degrees above or below. Rolling the bars up can reduce the reach to the hoods, but will compromise the brake lever access on the drops. Rolling the bars down favours the drops, bringing them closer to you with good lever access. I suggest you start with the platform horizontal, fine tuning up or down when the stem length and height has been established.

Before the saddle position was established, we looked at seven parameters that help to define handlebar position. Given the possible changes to your saddle position It is time to review these again.

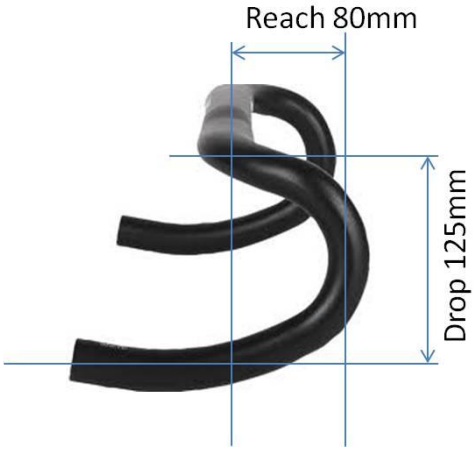
	Suggests the bars are Too far away / low Inconclusive Too Close / High
Natural hand position	
Arms locked or soft	
Torso angle	
Upper arm to torso angle	
	Too low Inconclusive Too High
Power difference hoods to drops	
How much time on the drops*	
Minimum Hip angle	

* As still on the turbo, you may need to consider how much time you 'think' you will now spend on the drops.

You will note how the first four are indicative of both height and reach, whereas the last three tend to be just height. This is because the first four are more concerned with the proximity of the hands to the hoods, whereas the last three relate to the drops. The ideal hood position could be defined as a relatively small area with a tolerance of less than 10mm, whereas you can place your hands in a number of locations along the drops, so reach is less important, accepting that you still need to be able to reach the brake levers and shifters.

Hoods Position

Ideally your torso angle will be suitable for your style of riding, your upper body relaxed and elbows soft. The upper arm to torso angle will be approximately 85^{o} and the hands should fall naturally to the hoods. The hoods are the ideal default hand position because they are designed to spread loads over the palms, keep the wrists neutral and give easy brake and shifter access. If this is not the case, the first choice would be to change the stem length, but the height is also relevant. Referring to the figure below, if one considered the upper arm rotating about a pin at the shoulder marker and keeping the arm to torso angle within the preferred range 80^{o}-90^{o} range, the hands could be anywhere along the prescribed arc. So the stem could be long, provided it is also high with lots of spacers or a long head tube. Conversely, a low stem would also need to be short. This gives a choice of valid stem length and height options, so what to choose? The likely scenario is that your bike geometry makes this choice for you. In my view, a stem length of 100-110mm gives a good combination of stability with responsiveness. I personally prefer not to fit stems shorter than 90mm unless absolutely necessary and the customer made aware of the possibly 'twitchy' handling.



One other option to shorten an excessive reach is to use 'Compact ' handlebars. Figure left shows the geometry of compact bars with a typical reach of 80mm and drop of 125mm. Standard handlebars would usually have a reach closer to 100mm and drop of 150mm. The top tube length difference between adjacent frame sizes is often less than 20mm, so fitting compact bars could feel like a significantly smaller bike.

Bike Fitters will have a range of stem sizes or fully adjustable gadgets to facilitate the selection process, but I fully appreciate how this may not be the case in the DIY environment. One approach may be to make a 'best guess' before buying a replacement stem, or borrowing a selection from cycling friends or a local bike shop.

Drops Position

As discussed earlier, you can place your hands anywhere along the drops so the reach is slightly less important than for finding that nice hoods position. The key aspects of the drops position is for it to be comfortable enough to spend some time on them, and to be able to reach the brake levers. The increased leverage available when pulling back on the brakes in the drops position means that you can stop quite effectively using just one finger and long descents will be less fatiguing. Braking from the hoods is fine for gentle speed checking but will be very hard work if you need to use the brakes a lot. Small hands can often struggle to reach the brake levers, but fortunately manufactures are now offering mechanisms to bring the levers in closer. One alternative means to bring them closer is to roll the whole bar assembly down so the top platform is off the horizontal. Be careful that this does not compromise wrist posture on the hoods.

The optimum height of the drops can be established using the test we have done a couple of times now, assessing the power difference between hoods and drops. You should always feel slightly more powerful on the drops, or at the very least the same. If less powerful on the drops, there will be no incentive to use them. For a performance orientated fit, keep lowering the bars until you feel less powerful on them, then come back up slightly. Double check your saddle height as going down 1-2mm may retrieve that lost power. For a comfort orientated fit, set the torso angle (on the hoods) to 45^{o} to 50^{o}, ensuring that the bars are not so high that you lean on them rather than supporting weight via your core.

Chapter 6

Error states

Saddle - Insufficient Fore-aft Adjustability.

There might not be enough saddle rail adjustability to enable the hip marker to be aligned with the seat-tube axis and you may still feel too far forwards or back. This would tend to suggest that the saddle is either too narrow or too wide for you, or the seat-post 'set-back' is incorrect. You will sit quite far back on a narrow saddle to place your sit bones onto the wider section. A wide saddle will push you forwards as the thighs have to pass the sides as the hips articulate. If you are comfortable with the saddle choice and loathe to change it, one means to achieve the correct fore-aft location is to change the seat-post for one with more or less set-back. Typically the set-back (difference between clamp centre and seat-post axis) will be around 15-20mm, but these are available from 0-35mm. A 0mm offset is often described as 'inline'. So if you can't get the saddle far enough forwards, you will need an inline post, whereas if it won't go back far enough, try one with more offset. It is generally a good idea to have the clamp mid way along the saddle rails as this can offer more compliance and help to soak up some higher frequency road vibration or shock loads.

Saddle Height - Can't Find a Sweet Spot.

Hopefully you will not have spent 2-3 hours becoming increasingly frustrated at being unable to find the elusive saddle height 'sweet spot'. There are a number of reasons why you may find it difficult, but the usual suspects are a leg length difference, overly long cranks and poor flexibility. In all these cases, the saddle is effectively both too high and too low at the same time. In the case of a leg length difference, the longer leg may be over-compressed because the saddle is too low, but the short leg is over-extending and can't permit the saddle to go any higher. Long cranks will both over-compress and over-extend the legs, so it never feels 'right'. One might imagine a 'window' of saddle height acceptability and for many people this window is quite narrow. Tall, symmetrical, flexible people with relatively short cranks can have a 10-15mm window, whereas for most people this window will be just 2-3mm wide or less. Unfortunately for some, the window does not exist and the saddle height is always a compromise.

Leg Length Difference

One way to assess for a leg length difference is to lie on your back, legs straight and have your observer check the alignment of the medial malliolus (ankle bones). Then bend the knees with the ankles aligned and look for a height difference of the knee caps. Doing this can be fraught with error because there might be a 'functional' rather than actual discrepancy, often caused by a twisted pelvis. Trying to correct a functional difference with cleat spacers can just make things much worse. If you do suspect a real leg length difference, I suggest you get this confirmed by a Physiotherapist, Osteopath or Chiropractor and find a reputable Bike Fitter to establish the best means to apply a correction.

Crank Length

If unable to find your sweet spot, check your crank lengths (appendix1). I can't stress enough how important it is to get the right crank length. In my opinion it is the second most important dimension on your bike after saddle height. Ignore internet forums suggesting that crank length is irrelevant and that 2.5mm is 'tiny' and 'comparable to wearing thicker socks'. The key thing to consider about the cranks is that the length affects both the top and bottom of the stroke. Shorter cranks will often permit a higher saddle, giving a double whammy of more room over the top of the stroke. The main problem with changing cranks is the expense, but I believe this to be a small price to pay for comfortable and efficient cycling.

Cleats

If you have not done so already, move your cleats as far back as they will go. This effectively increases saddle height but does so by more at the top of the stroke than the bottom (the hip to foot distance is shorter at the top).

Flexibility

If your crank lengths are theoretically ok, it might be worth seeing a local Physiotherapist to assess your flexibility. As mentioned earlier, flexibility checks are important, but a bit beyond the remit of a DIY Dynamic Bike Fitting guide. A tight hip or knee joint for instance will hinder the smooth movement of the foot as it comes up and over the top of the stroke and call for a high saddle. Tight hamstrings will inhibit leg extension and so call for a low saddle.

Can't Reach the Hoods.

If the saddle position is correct, you have 'Compact' bars, rolled up towards you and a short stem, but still can't comfortably reach the hoods, we may have to accept that the bike is too big for you. To be more precise we could hypothesise that the bike 'Top Tube length' is too long for you. Refer to Appendix 1 to check if the bike size is appropriate for your height.

Body Proportions

If the bike size appears to be suitable, then the most likely explanation is that you have unusual body proportions, typically long legs and a short torso. The long legs will call for a high saddle that lifts you up and away from the bars. Unfortunately the short torso means that the reach to the hoods becomes excessive. To test the long legs theory, divide your inseam measurement by your height. An answer in excess of 0.475 would support the suggestion, whereas less than 0.45 indicates short legs for your height. If this is ambiguous, also compare your span (fingertip to fingertip with arms outstretched) to your height. On average, these dimensions will be within 1-2cm of each other. A span more than 3cm shorter than your height is indicative of relatively short arms.

I tend to see far more 'long legged' than 'short armed' people and as a rule they will end up with short stems, often flipped over to gain as much height as possible. One option could be to use a smaller frame size, but these will also tend to be lower, so counter-productive. An alternative approach is to buy a bike marketed as having 'Sportive' geometry as these will tend to be have shorter top tubes but longer head tubes.

Compromise your fore-aft location.

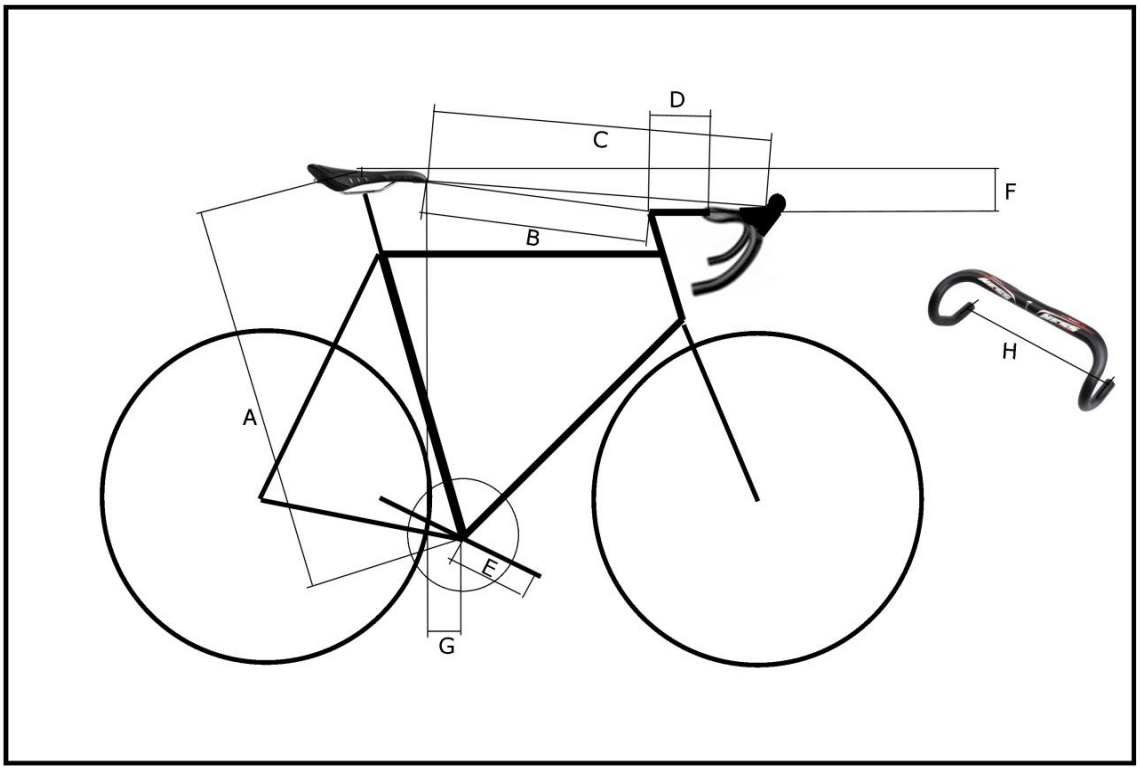
As an absolute last resort, you could consider compromising your fore-aft location to get your hands into a more suitable location on the handlebars. Moving the saddle forwards may reduce the reach to the hoods, but we also know how it spoils your balance and puts weight onto your hands and arms. This is best assessed over a few rides out on the road. Remember that the saddle height may need to be raised to compensate for it moving forwards. Look for any changes in neck, shoulder, arm or hand discomfort whilst monitoring your natural hand location and elbow posture. Only you can decide if this is a worthwhile compromise.

Chapter 7

Recording and Replication.

Once you have established your ideal position, record it for future reference and to enable transfer onto other bikes. The dimensions marked * are what you want to replicate across other bikes whereas 'stem length' and 'saddle tip to head bolt' will tend to be only relevant to that bike. See Appendix 3 for a detailed description of each measurement.

You will note how many of these dimensions relate to either the tip or top of the saddle. An alternative saddle may be of a slightly different shape or you may sit on it in a different location. What this means is that these dimensions are only truly applicable to the saddle used during the fitting process. They can be used as a start point though, but be prepared for some subsequent fine tuning if the bike feels different.



		Measured mm
A*	Saddle top to crank centre	
B	Saddle tip to head bolt	
C*	Saddle tip to hoods	
D	Stem length	
E*	Crank length	
F*	Saddle to bar drop (bar centreline)	
G*	Saddle set back (tip to crank centre)	
H*	Handle bar width (centre to centre)	

Chapter 8

Adaptation and Post Fit experience.

Many people assume that it may take a few rides to adapt to their new position, but customers often write to me after their first ride with very positive feedback. As a rule, the bigger the changes made during a fitting, the quicker the benefits will become apparent. A change in crank length can sometimes take a while to settle in but a saddle height error of more than 10mm will be noticed immediately.

Before going out on the road, ensure the bike is safe and all the fixings set to the appropriate torque.

When assessing you new position out on the road, I suggest you start with the feet and work upwards. I would expect most of you to have at least some 'float' in your cleats, so check that your heels can move both towards and away from the bike without immediately hitting any end stops. Feel how much your ankles and knees articulate and whether they are over-compressed or extending through the range of motion. Think about where you are sitting on the saddle and if there is any desire to slide forwards or back. Is it any easier now to roll forwards at the hips with a straighter lower back? Where do the hands fall naturally on the bars and are the elbows soft? You may find there is actually less load on your arms out on the road as the pressure of the wind on your chest at anything above 15mph will be noticeable. Can you get down onto the drops comfortably and do you feel more or less powerful? How does your speed, cadence or heart rate compare against previously?

You may be making better use of different muscles now, so don't be alarmed if there a few new niggles, hopefully these will settle down after a few rides. If there is a negative answer to any of the questions raised above, you may need to go back through the process to work out what is amiss and rectify accordingly. If any new pain persists, stop riding, return the bike to your previous set up and book yourself into a reputable Bike Fitter

Chapter 9

Conclusions and Feedback

Hopefully you have got to the end of this process with your bike set up correctly and relationships with partners and friends intact. Along the way, you may have learned a little more about how you interact with your bike and how your body works. Key conclusions should include:-

Saddle height is key, affecting not just power delivery but how you sit on the bike, your reach, and how much time you spend on the drops.

Crank length **is** important.

A good fore-aft location on the bike is all about being well balanced, with a relaxed upper body.

The right size bike in the first place is critical.

I would appreciate it if you could send me your final list of dimensions using the online form available here.

http://bikedynamics.co.uk/965ll.htm

You may have visited the same site earlier for the online saddle height calculator. With the increased sample size I will be able to dive deeper into the stats and develop better correlations, not only for saddle height but other key dimensions as well.

I would also appreciate any feedback on the document and process. I've tried to make it all as straightforward as possible, but this is what I do all day, so it is bound to be straightforward for me!

Part of the reason for publishing this process on line is to generate some income so I can spend less time Bike Fitting and more time on research. I now have mountains of data on thousands of cyclists, but not enough time to wade through the stats, develop better correlations and explore error states and countermeasures. This document summarises considerable intellectual property that I am giving away very cheaply. If you have found it useful, rather than sharing it with your cycling friends, please point them at my website to buy their own copy. Apparently each PDF is imprinted somehow with the email address of the recipient to deter piracy, but I would rather rely on the honesty of cyclists to help me to help them. I would also welcome suggestions on suitable subjects for further research.

Appendix 1 - Basic Fit and Sizing

The Dynamic Bike Fitting process can only really work if the bike is the right size for you to begin with. Provided your frame size, crank length and handlebar widths are somewhere close, there should not be any major compromises made in achieving a good fit.

Frame Size

Frame size should be reasonably easy to get right and you can probably get away with being one size too big or small if prepared to change a few components. Unfortunately I often see customers who have been sold inappropriate bikes. For more detail see

http://bikedynamics.co.uk/bikesizingbd.htm which contains the following summary table.

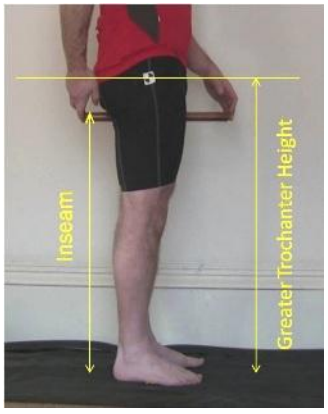
Size	48	50	52	54	56	58	60	62
Height	5'-5'3	5'3-5'6	5'5-5'8	5'7-5'10	5'9-6'0	5'10-6'2	6'0-6'3	6'2 +
Height cm	152-160	160-168	165-173	170-178	175-183	178-188	183-190	188+
Inseam	70-74	74-77.7	76.3-80	78.6-82.3	81-84.6	82.3-87	84.6-88	87+
Seat tube length (c to t)	435-445	455-480	485-500	500-520	515-565	540-580	560-600	580-620
Horizontal top tube	505-520	510-530	520-540	535-550	540-565	560-585	580-605	600-625
Seat tube angle	74-75	73.5-74.5	73.25-74	73.0-73.5	73.0-73.5	73.0	72.5-73.5	72.5-73
Head tube length	100-120	110-140	120-155	120-175	140-190	160-225	180-240	200-260
Reach	355-370	360-375	375-380	380-390	385-400	390-410	395-415	405-430
Stack	500-515	505-535	510-550	520-565	550-590	570-620	600-645	610-660
Crank Length	165	165	165-170	170	172.5	172.5	172.5-175	175
Handlebar width	380	400	420	420	420	440	440	440-460

Crank Length

I would expect at least 30% of you to have cranks that are too long, mainly due to the desire of many manufacturers to fit 172.5mm cranks across as much as their size range as possible. If you are riding a 54, 'M' or smaller with 172.5mm cranks, they could well be too long for you. If riding a 50 and in some cases a 52 with 170mm cranks, again these could be too long. You only need to go back around 20 years to a time when 170mm was the standard across most of a range, whereas this seems to have now become 172.5mm. The excuse often cited is that 'people are getting taller', but I know for a fact that I have not grown at all in the last 20 years.

To a novice rider, you don't really know what the pedalling action is supposed to feel like, so it will be extremely difficult to tell if anything is amiss. Internet forums are often unhelpful as people frequently post on not being able to tell the difference between 170mm and 175mm, so anything will do! This could well be true if you are around 183cm tall (6'0") but unfortunately, the shorter you are, the more likely it will be that your cycling is being compromised by the length of your cranks. My view is that crank length is the second most important dimension of your bike set up after saddle height. The problem is nearly always that the cranks are too long as there is very little downside to short cranks. Excessively long cranks will increase the range of motion at the hip, knee and ankle joints beyond their efficient and comfortable regions. This can give joint pain and especially make it difficult for the quads to extend the knee joint when fully flexed. This in turn gives an inefficient 'stompy' pedal stroke.

The following table shows my recommendation for your ideal crank length based on both your inseam and Greater Trochanter height. Use the same point on the top of the Greater Trochanter as shown in Appendix 2. My recommendation is to fit the appropriate length cranks to your bike prior to the fitting process. Nearly everybody who has come to Bikedynamics and either fitted shorter cranks at the time, or subsequently, has appreciated the change and felt a definite improvement. Obviously they are an expensive component, so you may need more convincing. In this case I suggest you go through the process, but refer to the Crank Length section in Chapter 7 'Error States' which explains what long cranks may feel like and the implications to setting other parameters.



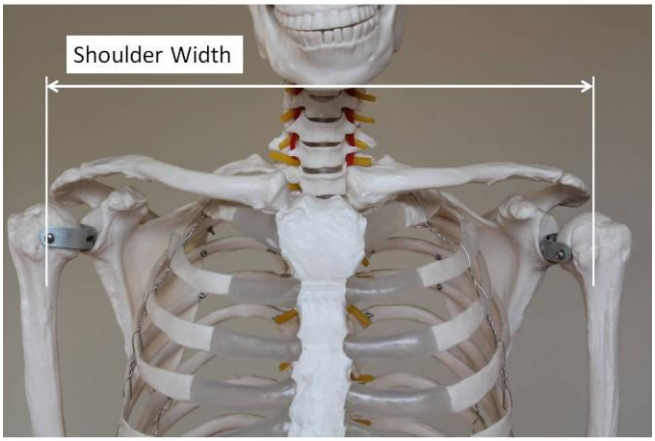
Crank Length Recommendations

Crank Length	Inseam	GT Height	Inseam + GT Height	Height Male*	Height Female*
162.5	77	86	Up to 163.4	Up to 166.3 Up to 5'5	Up to 164 Up to 5'4.5"
165	77 - 79	86 - 88	163.4 - 167	165 - 170 5'5" - 5'7"	164 - 165.5 5'4.5" - 5'5"
167.5	79 - 81	88 - 90	167 - 171	170 - 173 5'7" - 5'8"	165.5 - 170 5'5" - 5'7"
170	81 - 83.5	90 - 93.3	171 - 177	173 - 179 5'8" - 5'10.5"	170 - 175.5 5'7" - 5'9"
172.5	83.5 - 86	93.3 - 96	177 - 182.5	179 - 185.5 5'10.5" - 6'1"	175.5 - 181 5'9" - 5'11.5"
175	86 - 89.5	96 - 101	182.5 - 189	185.5 - 192 6'1" - 6'3.5"	181 - 187 5'11.5" - 6'1.5"
177.5	Above 90	Above 101	189 +	Above 192 Above 6'3"	Above 187 Above 6'1.5"

* Assuming average leg length proportions for your height.

Handlebar Width

You will note from the above frame size table how the width of the handlebars tends to be proportional to the size of the bike. I don't think it too unfair for manufacturers to suggest that large people on big bikes will need wider bars, whereas those riding smaller bikes probably need something narrower. The 'correct' handlebar width is defined by the width of the shoulders, but the measurement of this can be quite ambiguous. The best place to measure to is the ends of the shoulder blades as shown left because this is a good representation of the centre of the shoulder ball joint. We like our arms to be parallel when riding our bikes, which is achieved if the crooks of our thumbs on hoods or drops is the same distance apart as the shoulder ball joints. The shoulder width as defined here should match the 'centre to centre' width of the bars.



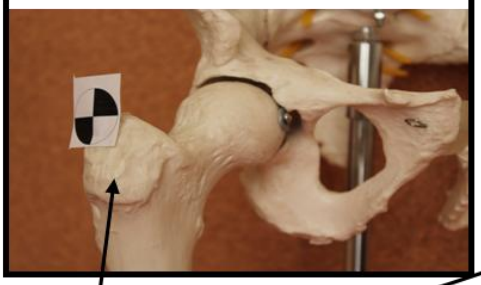
Bars that are to narrow can sometimes be too constrictive across the chest whereas wide bars are less aerodynamic, can encourage splayed out wrist postures and often give neck and shoulder discomfort.

If your bars are the wrong size for you but you have no neck, shoulder, arm, wrist or hand discomfort, don't worry, they don't really need changing unless upgrading anyway. Discomfort could be due to other reasons, so swapping the bars may not resolve your problems, but I'd be tempted to do it anyway. Note that narrower bars will tend to reduce the reach slightly, possibly affecting your ideal stem length. If changing the bars, it might also be worth considering the choice of compact or standard bars shapes as discussed in chapter 6

Appendix 2 - Anatomical Markers

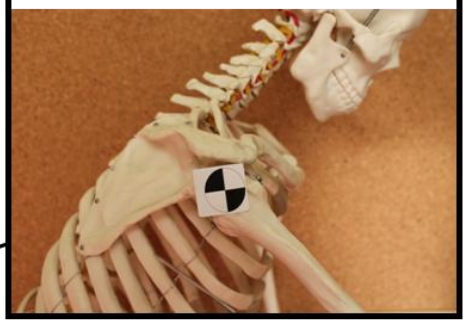
Hip.

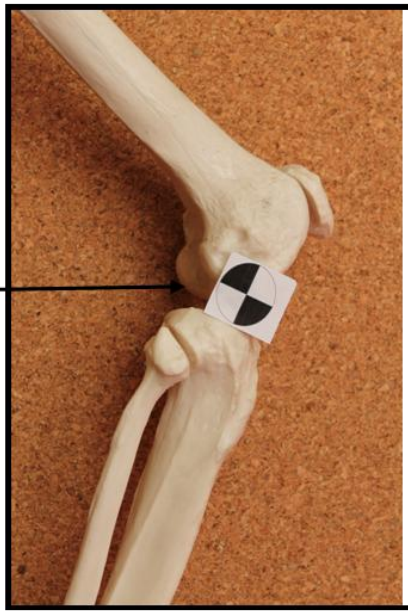
Top of the Greater Trochanter. A good representation of the centre of the ball joint.



Shoulder.

On the vertical face of the shoulder, just below the end of the shoulder blade.





Knee Joint.

Try to find the gap between the femur and tibia. If in doubt, use the centre of the joint.

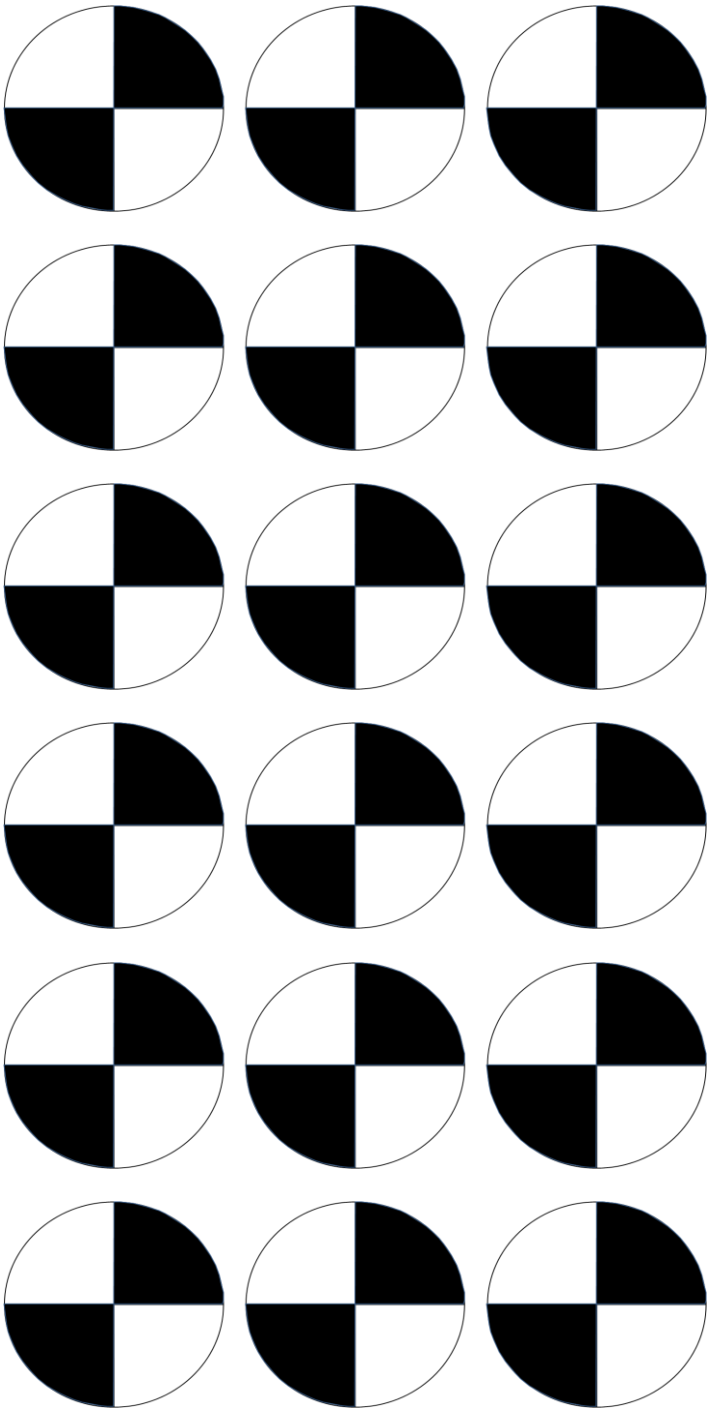
Ankle.

The Lateral Malleolus. Otherwise known as the bony lump on the outside of the ankle.

Pedal Spindle.

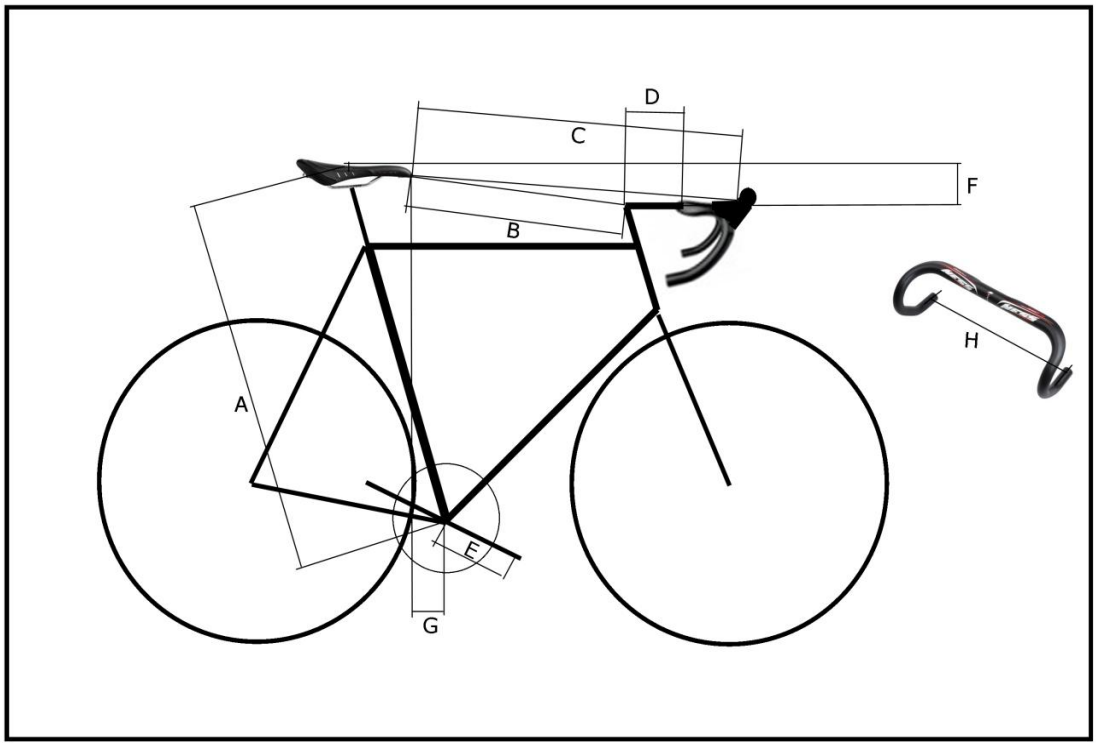
Place the marker just above the sole of the shoe directly above the pedal spindle axis.

Anatomical Markers



Print out onto label paper or use double sided tape to attach to the body reference points.

Appendix 3 - Bike Dimensions



A - Saddle top to Crank Centre

Measure from the centre of the bottom bracket along the seat tube axis to the top of the saddle.

B - Saddle tip to Head Bolt

C - Saddle tip to hoods

From the tip of the saddle, diagonally to the upturn on the hoods where the crook of your thumb would normally reside.

D - Stem Length

Usually written on it somewhere. Otherwise centre of handlebars to centre of steerer tube.

E - Crank Length

Usually written on inside edge of each crank.

F - Saddle to Bar Drop

The height differential between the top of the saddle and the centre of the handlebars

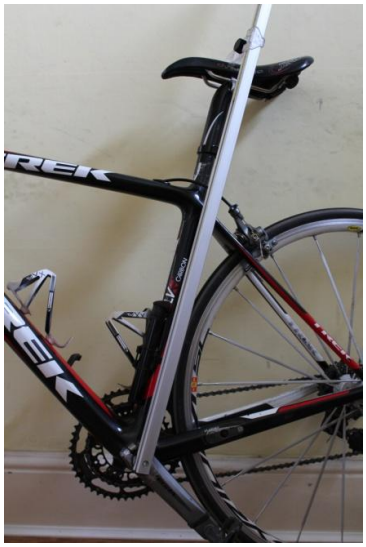
G - Saddle set back

The horizontal distance between a plumbline dropped from the nose of the saddle to the crank centre line

H - Handlebar Width

Centre to centre of drops.

A) Saddle Top to Crank Centre



F) Saddle to Bar Drop.

G) Saddle Set Back