A User Manual for Today's Modern Fit Bikes

Imagine a massage therapist trying to engage in the trade without a massage table. This is analogous to the hurdle bike fitters face who've converted to the idea of dynamic fitting. We've got plenty of systems nowadays used by bike fitters, and many of these systems assume the use of a fit bike. There are how-to manuals that describe, step-by-step, how these processes work. But there is no manual devoted to the most important tool a fitter uses. That's the purpose here.

The manual is system-agnostic. Yes, I'm writing from the point of view of the F.I.S.T. Bike Fit System, to which I am attached. But it's a big world, and it's the fool who tries to pretend it's small. F.I.S.T. is my system, but it's one system, and just a portion of the world of bike fit.

Also, I prefer to separate systems from tools. Sauce for the goose is sauce for the gander: If I believe that a tool is its own discrete purchase decision – separate from the choice of fit system, protocol or school – then tools like fit bikes (or motion capture systems) should have their virtues extolled and use described apart from their attachments to particular fit systems.

That's what this manual is. Here's what it is not: I'm not going to replace the user manual, assembly instructions, cautions, maintenance requirements that attach to each individual fit bike. Shimano, GURU, Purely Custom and other fit bikes each have their own user manuals or, at least, instructions or best practices; this manual does not replace any of these.

Fit Bike Families

I prefer to segregate fit bikes into two families: angular and X/Y. Angular means the tool itself vaguely looks like a bike, with tubes that form seat and head angles, just like bikes. The familiar orange and then gray Serotta fit bikes up through the early 2000s, along with the Waterford Fitmaster (below) and Calfee Sizer and others like them, are obviously *angular* (though the Serotta is an interesting mix of angular and, in the front, X/Y). It has been my observation that these bikes are not optimized for a dynamic fit process if such process includes expansive adjustments in fit coordinates (e.g., cockpit distance, handlebar elevation) made real-time as the rider is pedaling.

Rather, angular fit bikes seem to work best as determiners of bike geometry along with micro-adjustments in position. A rider's fit coordinates might be established through a static fit system, using what the Italian C.O.N.I. Manual (1972) calls "segments," such as inseam, torso and arm length, femur length and so forth. The angular fit bike is adjusted to match the fit coordinates prescribed by body segments (KOPS is also the use of body segments). The rider then hops aboard the fit bike and pedals, and micro-adjustments are made to suit. This final fine-tuning of the position is the one dynamic element to this process. He hops off, voila, there's the rider's bike, with seat and head angles, top tube, head tube, all there for the fitter to read.

If you read Waterford's website documentation, it champions the Fit Kit system, by which fit coordinates do not require the use of a fit bike. Waterford calls its Fitmaster (pictured above) a "fit verification tool," by which you ride the position after it's been generated through a static process.

The value of this kind of *angular* fit bike is that when this process is over the geometry underneath the rider's fit coordinates – top tube, head tube, seat tube – is established. You simply read it off the fit bike, valuable to custom bike makers in particular.

Angular fit bikes perform admirable service when paired with a static fit system (like Fit Kit) and when typical bicycle geometry (top tube, seat angle, head angle, head tube, but *not* Stack and Reach) are desired. The downside:

1) Tuning a fit coordinate (such as handlebar elevation or cockpit distance) in a single axis (height or length) is best achieved by any fit bike that can easily, quickly adjust in just that desired axis (X or Y). Angular fit bikes were not designed with this in mind.

2) The output of an angular fit bike is *bike geometry* rather than metrics that can port into a calculator to deliver a list of production bike solutions. To be clear, Waterford's user manual provides a pathway for use with stock frames a retailer sells, and it even shows how to measure Stack and Reach as well as Handlebar X and Y off the Fitmaster. Still, this is the difference between angular and X/Y fit bikes: One gives you bike geometry yet you can divine X and Y; the other X and Y and from these you can divine geometry. If your business, psyche, vendors and brain prefer bike geometry as an output, an angular fit bike is what you want.

So on the one hand we have the *angular* fit bike. On the other we have pedantic, uncreatively named X/Y-style fit bikes, because they all adjust in an X/Y axis. Feel free to call this style of bike (like the one Shimano makes, pictured above) by a sexier name than the one I chose.

Why make bikes that adjust in an X/Y axis? Because of the 2 chores angular fit bikes don't perform:

1) X/Y bikes are generally better at isolating a specific fit parameter for adjustment;

2) They lend themselves well to production bike sales because they port out X and Y metrics easily translated into complete bike solutions. (I'll describe that process later.)

There is one reason defensible reason why a fit bike might want to be angular in the rear (where the saddle is) and X/Y in the front (upholding the handlebars). As you raise and lower the saddle one would assume the saddle set-back should scale accordingly, that is, as you raise the saddle you might want to increase the set-back at the same time. I'm sympathetic to that view but I'm still not persuaded. There is yet another argument for an X/Y design in the rear of the bike, and you'll see this further on. All X/Y fit bikes as of this writing are entirely X/Y, front and rear.

Honestly? The majority of those I know in the bikes business would be more comfortable with an angular fit bike, the very kind of bike *not* covered by this manual. Moving from angular to X/Y is like moving from pricing guns to point of sale software. Retailers get that now. But they didn't when POS systems were young.

If you can bend your brain around the use of X and Y as an alternate method to get the ball into the end zone, then a bike that immediately, accurately outputs X and Y metrics will probably suit you better. This is the style of bike this manual will help you use.

Types of X/Y Fit Bikes

There is a theme that I hope will run through this manual, which is that fit bikes are like cars. Cars have windows, seats, gear shifts, steering wheels, brake and gas pedals. There are many car makers, and cars might cost $20,000 or $200,000. Still, they all run pretty much the same way. If you know how to drive one you know how to drive them all, after a little bit of familiarization.

It's the same with fit bikes. Now, to be sure, if you can't drive a stick then the learning curve is tougher when you move from an automatic. You might then broadly differentiate between cars with automatic transmissions versus manual or stick-shift transmissions. Likewise there are 2 kinds of X/Y fit bikes.

In 2003 I introduced the terms *Stack* and *Reach* to the world of cycling. These metrics had always been in plain sight. Unknown to me at the time, Cervelo's Phil White and Gerard Vroomen were already using these metrics as bike design inputs. Others may also have been. My contribution was simply to describe a way to measure a bike frame for fit purposes that normalized all bikes, without caveat, without asterisk, and then to name the terms.

What I had in mind was to construct a database of all bikes made, comparing them all to each other. I could not do this using top tube length, because two bikes could share a 54cm top tube yet be different lengths if they had different seat angles. Same with head tubes. Are they really a measure of a bike's height? What if two bikes have the same head tube length, but one bike has more BB drop than another? This is why Stack and Reach were needed before a system comparing all bikes could be developed.

The first fit bike I designed and had built featured vertical and horizontal gradations outputting Stack and Reach as metrics because, after all, these were the metrics I was looking for. Once a rider was positioned, and I had his fit coordinates established, I could simply read the Stack and Reach of the bike that fit up underneath the rider, go to a table or database of all production bikes and, voila, find the bikes that would fit.

There are at least two fit bikes today that are built in this fashion: the Retül Müve and the fit bikes made by Exit Cycling. You bolt a stem on that sort of fit bike, bolt on some handlebars, turn handwheels and so forth using whatever fit protocol you want and at some point a rider's desired position is reached. Once the fit is optimized, you simply read the Stack and Reach off the bike, find the bikes that match, presto, done.

What stem to you put on this fit bike before the fit is executed? It's up to the fitter. If it's a road race fit and the rider is 6'2", probably a 120mm or 130mm stem rather than an 80mm stem. If it's a 5'5" rider, then the shorter stem.

The other kind of X/Y fit bike is like that built by Purely Custom, GURU or Shimano. These bikes do not use a stem. Look at the GURU below. See any stem on there?

There is just a 31.8mm clamp, you put a handlebar in, and you execute the fit. These kinds of bikes also produce an X/Y output, just, instead of reading Stack and Reach off the fit bike this other, newer kind of fit bike tells you the X and Y from the BB to the center of the handlebar clamp, where the bar passes through the stem.

(Let's stop: Are you certain you know what Stack and Reach are? No? Don't fret. We'll get to that precise definition, with pictures, later. Are you fuzzy on all this X and Y talk? Suffer through another half-page and then we'll explain fully.)

Using these *Handlebar X/Y* bikes like the GURU there is, then, a formula – simple high school trigonometry – that allows you to calculate the Stack and Reach of the bike you're looking for. Using this formula, you type in the front end of the bike you desire: stem length and pitch; total height of spacers and headset top cap; and the calculator resolves Stack and Reach.

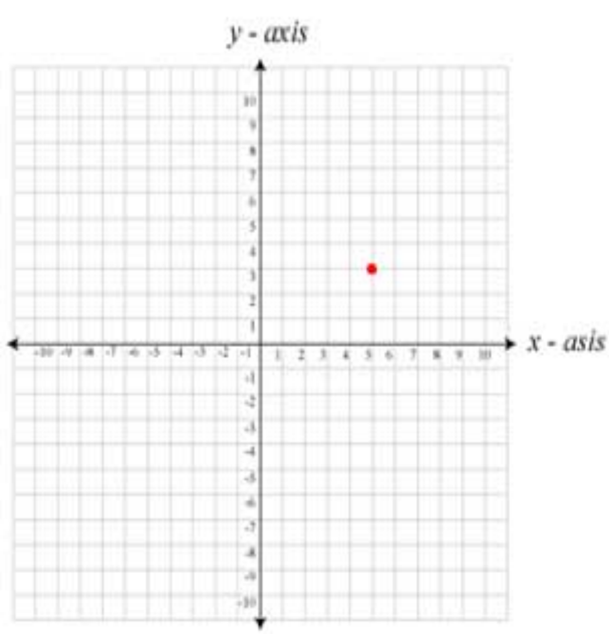
Isn't this an extra step? Why complicate matters? Because this latter kind of fit bike allows you to *virtually* place any number of front end configs on the bike, each generating a new necessary Stack and Reach in order to satisfy the rider's fit needs. It's quicker. Plus, you don't need a big inventory of stems.

Either kind of bike will work. Both with generate the same solution. I can use, and have used, both types. They'll both work. I'm just explaining how these tools differ.

Alrighty! Now you know in broad strokes the fit bike landscape. You may still be just hanging onto some of these concepts, and you might still be asea as to how the sausage is made. That's okay. You'll get there.

Basic Fit Bike Metrics

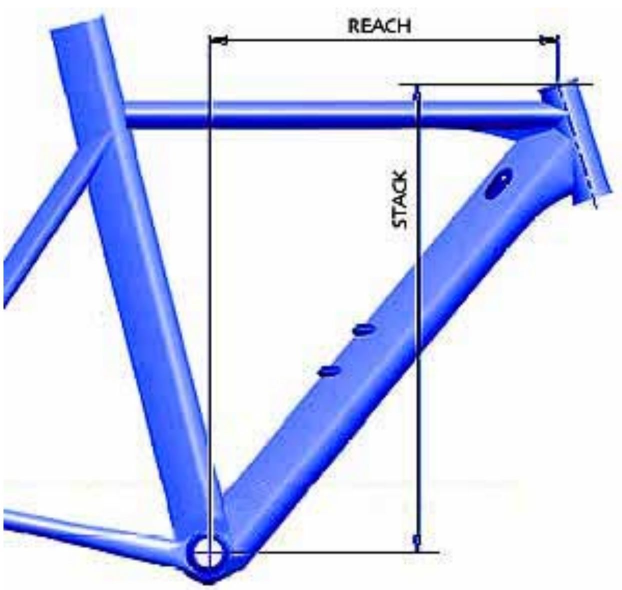
There are 4 numbers common to all fit bikes. Just so we're clear here what X and Y are (in my parlance), this is from basic high school geometry. Yes, some of you were smoking dope under the bleachers during that class; and others were discovering your girlfriends (or boyfriends). Meanwhile I was in class. A part of me wishes now I'd have been doing what you were doing then. One by-product of my staid and workmanlike high school existence is that I can write this manual for you. But I'm still rueful that I got geometry while you got the girl.



Cartesian graphs. (0,0) is, well, zero. Dead center. The fulcrum. The beginning of everything. The point where measurements begin. The place where the two lines adjacent intersect. If you move out, horizontally, in front of center, it's measured in some way. In inches, centimeters, cubits, whatever.

Likewise, if you move up or down. When we go out horizontally it's in the X axis. Vertical, that's the Y axis. A point out there in space that we say is (5,3) on a Cartesian graph is 5 cubits or yards or miles or inches out from (0,0) and 3 units up. That point is where the red dot is on the graph above.

For the purposes of bike fit, the bottom bracket is (0,0). We want to locate, in space, the head tube top of the bike. Everything attaches to the head tube eventually, that is, the handlebars to the stem, the stem to the steer column as it protrudes above the top of the head tube. So, the head tube top is the magic spot, telling us (for fit purposes) whether the bike is tall or not, and whether it is long, or not.



We need to locate this place – the head tube top – in space relative to the bottom bracket. So, we say it is some distance out in front of the BB in length (the X axis), and some height above the BB (the Y axis). Let us say that this frame's head tube top was (400,577), and we're pretending this is on a Cartesian graph. That's 400 units out along the X axis, and 577 units up the Y axis. The units in this case are millimeters, and I just told you how far the head tube top is in front of and above the BB in a 58cm Cannondale Supersix EVO, size 58cm. This is one bike in my garage.

Were you to take the handlebars and stem off that bike in my garage, place it on an Exit Cycling or Retül fit bike, also stick in there, on that fit bike, under the stem, the same amount of spacers and top cap as I have on my Supersix EVO, and were you to recreate on the fit bike exactly how I fit aboard that Supersix EVO of mine, what you'd read off these bikes were a Reach of 400mm and a Stack of 577mm.

The image below is of an Exit Cycling fit bike outfitted with a Purely Custom adjustable stem. You could place any stem on this bike. The graduated numbers etched in white on top of that black plate display Reach. When you're finished with the fit, you simply read Reach (though you can't make out the numbers clearly in this image). The Stack of the bike you're looking for is etched into piston at the lower left (but the laser etching is hidden from this view).

Now, let's say you reproduced my exact fit on a GURU, Shimano or Purely Custom fit bike. They have numbers too that you can read. But you wouldn't read 400mm in the X axis and 577mm in the Y axis. You'd read 625mm and 510mm. These are the X and Y distances from the BB to the handlebar clamp.

On the Exit bike, or a Müve, you'll read to the upper right hand point of the red shaded triangle in the image below. That's from the BB to the head tube top. Those numbers are Stack and Reach. On one of these other X/Y fit bikes, these slightly larger numbers they produce are to the upper right of the green triangle. These Handlebar X/Y fit bikes measure from the BB to the handlebar clamp rather than to the head tube top.

But we still need to eventually end up with Stack and Reach, even with these other (Handlebar X/Y) fit bikes. We need to use some tricky math to do this.

On my Supersix EVO that it is in my garage I have a 120mm stem, -6° pitch, and a 5mm headset dust cover under it (and no other spacers). If you use trigonometry (while I was in this class you were having even more fun under the bleachers), you can divine the length and height, that is, the X and Y distances, between the head tube top and the handlebar clamp. In other words, I want to know the absolute length, just the horizontal distance, from the head tube top to the handlebar clamp. In the image above that's the long arm of that green triangle. The height from the head tube top to the handlebar clamp – just the vertical component – is the short arm of that green triangle (we don't care about the hypotenuse).

If I can figure out those height and length values, and subtract them from the X and Y to the handlebar clamp, what remains is Stack and Reach.

In this case of my bike, that 120mm stem of mine only gives me an absolute length from the head tube top of 110mm.   That green triangle's short arm, the height, that's 47mm. Subtract 47mm from 625mm and you get 578mm, which is the Stack of the ideal bike I'm looking for. Surprise! It's the Stack of the bike I'm riding, which is a Supersix EVO in 58cm (or it is within 1mm) Subtract 110mm from 510mm and you get 400mm, exactly that Supersix EVO's Reach. But it's not a concidence. If I'm positioned correctly aboard the fit bike, and I divine the Stack and Reach of the bike I need, then – damn! – I'm going to go find it! That's how I ended up with that Supersix EVO. Well, plus I wrangled an employee purchase (don't tell on me).

What about all that math? The trigonometry? Don't fret. You got the better end of the deal in high school. You don't need to know the trig. Calculators do all the work for you, and I'll explain this in more detail.

Okay, so the GURU, Purely Custom and Shimano fit bikes measure from the bottom bracket to the handlebar clamp. We call these numbers Handlebar X and Y or, for short, HX and HY. You'll see this on the computer monitor when you're performing a fit on a GURU fit bike. HX is the distance in millimeters the handlebar clamp sits in front of the BB. HY is the height of the handlebar clamp above the BB.

Now, let's say that instead of a GURU fit bike you have a Purely Custom fit bike. Where's my HX? It's not on a computer monitor any longer. Why? Because that bike is mechanical, not computerized. That bike has HX right on it, just, it's on a blue (or red, depending on the model) tape along the base of the bike. Reading HX off this tape is the same as reading HX on the computer monitor of a GURU fit bike. The only difference is that the GURU bike always knows where the handlebar and saddle is, because it's got sensors. The image at right is a close-up of the base of a Purely Custom's front pedestal on which the handlebars move back and forth via a handwheel. The bike is set up so that the handlebar clamp is 51cm in front of the BB.

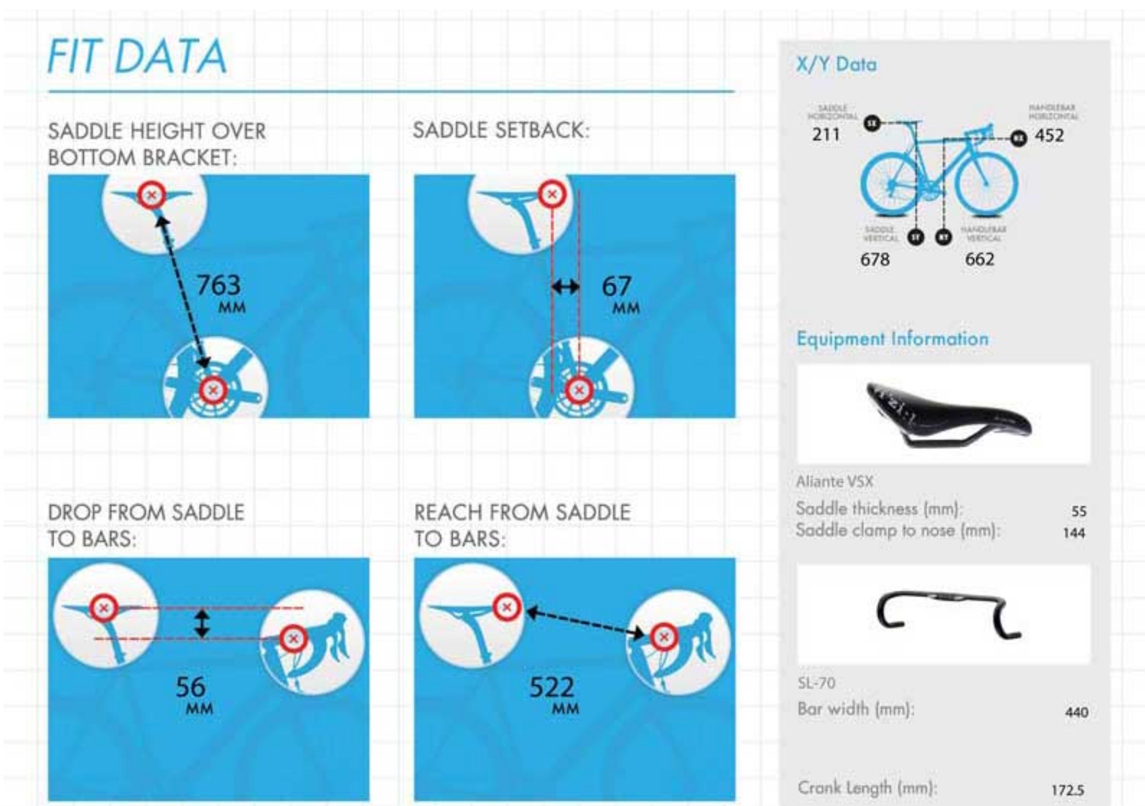
The Shimano bike is somewhere in between. It isn't motorized, like the GURU. You change the position of the saddle and the handlebars – up and down, back and forth – turning handwheels just like on the Purely Custom (or Exit Cycling, or Retül), but the GURU has motors. Wooooo.

The GURU, you tell the motors what to do and the motors do it. In this case, it's like a motorcycle and a bicycle, one is motorized, the other is not, but they otherwise work similarly.

Anyway, the Shimano bike, pardon the digression, is mechanical like the Purely Custom. It adjusts via handwheels. No motors. But, like the GURU it knows where the handlebar is and where the saddle is in space, versus the bottom bracket. You read HX and HY off an LED display.

Nevertheless, the Shimano, Purely Custom (any Purely Custom model) and the GURU function pretty much the same way in broad strokes. They all are X/Y fit bikes. They all adjust up/down and back/forth, both the saddle and the handlebars. They all output HX and HY and from there you can derive a number of important solutions. This image at left is, again, the piston on the Purely Custom bike where the handlebars sit. Where the piston disappears into the stanchion, this is HY, in this case 60.7cm or 607mm.

These bikes all also output SX and SY. One guess as to what these numbers are. SX , the S is for sss, sss, saddle!



On the GURU fit bike you read this on the computer monitor. You can see HX/HY and SX/SY on a screen shot of GURU's report at right. It's on the upper right of that report, along with other relevant fit coordinates adjacent on the left. See HX of 452mm? HY of 662mm? See SX of 211mm? What does that mean? The center of the saddle's rails, right where the fixing bolt is on the GURU fit bike, is 211mm behind the BB. Here's a hint. From the center of a typical road saddle's rails to its nose is about 145mm, so, the nose of the saddle in this case is sitting about 66mm behind the BB.

On the Purely Custom fit bike SX and SY are read on a vertical and horizontal pair of tape measures affixed to the bike behind the BB, pretty much like you read HX and HY in the images above. On the Shimano, yes, it's on a digital readout.

In each of these cases, the SX and SY is the distance from the BB back, and up, to one of two places. With Purely Custom and Shimano it's to the bolt where the seat post hardware (the rail grabber-thingers) sit. On the GURU fit bike it's to a point on the saddle's rails that sit dead nuts center on the fit bike's saddle rail hardware. Functionally, it's about the same place on all 3 bikes.

What significance is SX and SY? It has some for custom bike makers, otherwise, not much. There isn't too much that any current fit system does with SX and SY. But can be an aid to fitters during a fit session. In fact, our own F.I.S.T. system pretty much ignored these metrics until very recently, and how we've adopted their use, as will be shown later.

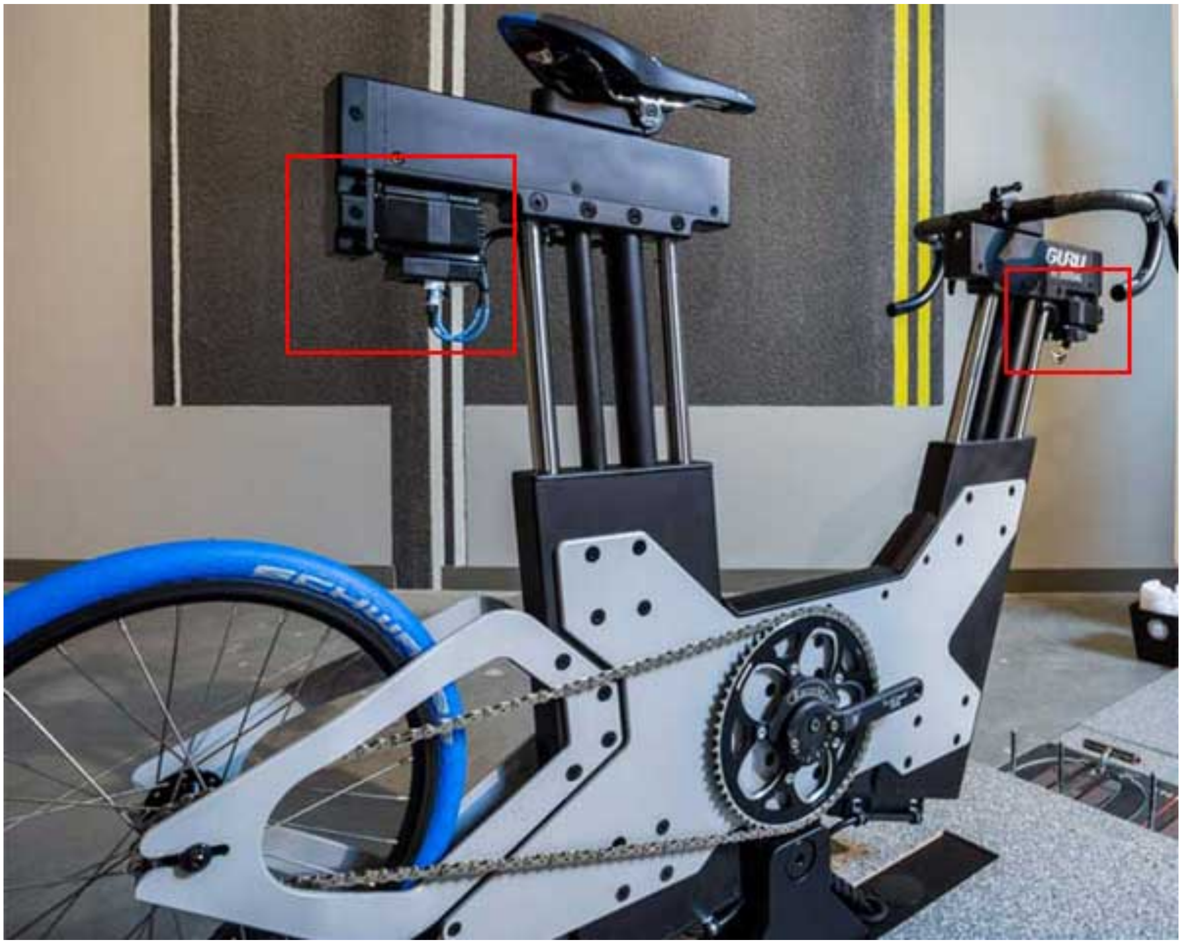
Motorized Fit Bikes

The obvious motorized bike is the GURU, both the Gen 1 and Gen 2. These bikes feature 4 and 6 motors respectively, per bike. This is the only motorized fit bike, although there is a company called Apex that makes fit bikes and I believe at least one of its products is motorized. I know very little yet about this company's bikes. So, there is this caveat.

In the image below it's easy to see where 2 of the motors are, controlling fore/aft for handlebars and saddle, they're inside the red rectangles.

Purely Custom uses handwheels to move its elements fore/aft. It uses motors, kind of, to raise and lower its elements. It's got a thumbscrew you turn for micro adjustments and it's got a hole in the center of these thumbscrews the exact size of a 6mm Allen wrench. If you have a handheld drill with a 6mm Allen key in it, set to its hi-torque, low-RPM setting, you've got a motor (kind of) raising and lowering the pedestals aboard which sit the saddle and handlebars.

Is it as cool as a GURU? No. Is it clever? Yes. Is it better than just a handwheel? Probably not, although it takes up less space.



The Practical Use of these Bikes

I'll count my effort a success to this point if we can agree on the following:

1. Fit bikes come in 2 styles: angular and X/Y.
2. Angular fit bikes are often mated to *static* fit systems, such fit systems using limb length and body segment systems to prescribe bike geometries or fit coordinates. Then, the position is tested aboard the angular fit bike and, if okay, the bike geometry is read off the fit bike and delivered to a custom bike maker, who makes the frame.
3. Bikes that adjust in an X/Y axis are made for *dynamic* fit systems, that is, systems that find a rider's fit coordinates while the rider is aboard and pedaling the bike.
4. These X/Y fit bikes also port out X/Y metrics to the fitter once the fit is concluded, such metrics used to generate a list of production complete bike solutions.
5. The X/Y fit bikes come in 2 styles: those you put stems on and that output Stack and Reach; and those you don't put stems on, and that output Handlebar X and Y.

What this means is that if you have an old Serotta, or a Calfee or Waterford, these are fine fit bikes, but they aren't ideal for dynamic fit systems. I have other uses for these bikes. Just not dynamic fitting. (I like to use them for point-of-sale contact point product demo tools, but that's beyond the scope of this manual.)

All the X/Y fit bikes are usable for all the various dynamic fit systems. They are just tools, just like motion capture systems are just tools. If you are trained by Retül, of course they would like you to use Retül tools, but there is absolutely no reason why you couldn't step right into fitting using an Exit Cycling fit bike and a Dartfish motion capture system, assuming you were properly taught the art of fitting.

If you were taught how to fit at a F.I.S.T. Workshop, you should be able to use any of these fit bikes described herein, as long as they're X/Y fit bikes. You could use a goniometer, Retül, Dartfish, übersense, or any other body angle measuring device whenever F.I.S.T. protocols rely on body angle measurements as drivers or confirmers or double-checks of a particular fit coordinate (such as knee angle when divining saddle height).

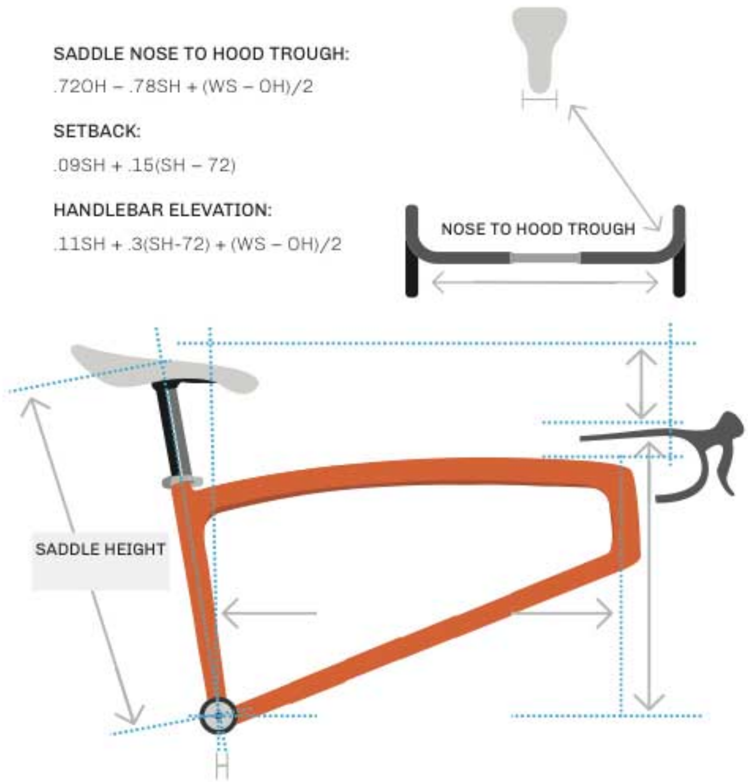
So, where you begin a fit session with one of these fit bikes depends on the fit protocol you're using. The F.I.S.T. system says, hey, we're going to start you shallow, laid back, relaxed, and move you successively forward until you (the subject) cry uncle and say, "That's too far forward!" Or, that's too steep, or, I've got too much weight on my hands or elbows (depending on if it's a road or tri fit). If you liked forward more than rearward in every successive step along the way, we'll eventually reach "too forward." We know the step or trial just prior to that is your best place aboard the bike, assuming we nailed all the other fit coordinates (handlebar elevation, cockpit distance) during each successive move forward.

I know good fitters who don't do it this way. They start with their best guess as to where the rider is likely to end up, then they move away from this – shallower, steeper, handlebars up and down, cockpit longer and shorter. Nothing wrong with this, but it influences how you set up a fit bike prior to asking a rider to hike his leg over the saddle and hop aboard.

These are details. The point of the fit bike is to allow you to make the changes quickly; and to make them when a rider is aboard; ideally as he is pedaling. This is the value of a fit bike built for dynamic fitting: The rider's fit coordinates are identified as he pedals. You absorb his pedaling action and sense of comfort and power into the finished product. When the fit session is over the bike outputs metrics that can be used to prescribe complete bike solutions.

One Example

Moving target this, but, below are some equations used by the F.I.S.T. system. Don't freak out. You'll find they're not as hard as they look after I explain what's going on.



In the case of the equations above:

OH = overall height of the rider
SH = BB to top of saddle, midway between tip and tail, in a direct (angular) line
WS = rider's wingspan, fingertip to fingertip, as he's pretending to be Vitruvian.

The 3 equations above can serve in a number of ways. The equations give you a fair representation of how a rider's bike might be set up after a road fit is completed. It's a rough approximation. It's a mean.

It can also be the basis for a static fit system. Just, a mean, an average, has its limits. It's like saying, "The mean shoe size of a man 6 feet tall is size-11." Does this mean that men 6 feet tall can order shoes mail order in size-11 and be confident in the fit? No. This is an absurd analogy, but I hope you get the point.

It may also act as a set of equations that drive how you set up a fit bike prior to a fit session, but only if you begin your session with the bike fairly close to what you expect the finished fit to look like.

Let's take me as an example. I'm 186cm tall. My saddle height, BB to top of saddle, midway between tip and tail, is 76cm (for my road bike). My wingspan equals my height. Therefore, one would assume by the above equations that:

SADDLE NOSE TO HOOD TROUGH: .72(186) – .78(76) + (0)/2 = 74.7cm
SADDLE SETBACK: .09SH + .15(SH – 72) = 7.5cm
HANDLEBAR ELEVATION:.11SH + .3(SH-72) + (WS – OH)/2 = 9.6cm

The above works out fairly well for me, except I have a lot more saddle setback than that. It's about 8.5cm, not 7.5cm. Otherwise, these equations work out okay. But, don't put much stock in them. In the F.I.S.T. system these aren't drivers, they're confirmers, just as a guide to make sure you didn't royally screw the pooch during your fit session.

In point of fact, here is the equation for initial bike set up pursuant to a F.I.S.T. road fit session:

SADDLE SETBACK: .1SH + .15(SH – 70) = 8.5cm

In this case, beginning my F.I.S.T bike fit session, the bike is set up consciously more laid back than I ought, on paper, to end up when we're done. Why? Remember, the F.I.S.T protocol begins shallow or laid back, relaxed, and then moves the rider forward through a series of progressively steeper or forward postures relative to the bottom bracket. The rider self-selects whether each progression is an improvement. If the answer is yes in each case, then each is an improvement over the prior. At some point a forward move ceases to be an improvement, which means what we tried just prior is the ideal.

We must rule out too shallow, too steep, too high or low, everything else, otherwise a rider won't know whether he might like it better in a shallower or more laid back position. In my case, you can see this is a good caution, because I happen to like my saddle quite far back. One would expect someone with my saddle height to have a final saddle setback (nose of the saddle behind the BB) of 7.5cm, just playing the averages, but in fact I'm happier at 8.5cm.

The F.I.S.T. protocol begins with a rider hiking his leg over the saddle what the saddle sitting fairly rearward, and with the handlebars correspondingly a bit higher. The system doubts you'll finish with this as the preferred position. If I might resurrect the prior absurd analogy, it might be like starting that 6-foot tall man with a size-10 shoe. If it's too small, then we'll try size-10.5. Better? Great. How about 11? At some point, maybe around size 12.5, the shoe's too big. We then know that size-12 is your perfect shoe size.

But this isn't a treatise on F.I.S.T., rather on how to use these new and modern fit bikes. Your preferred fit protocol might differ. Your starting point for a road fit session might be with the saddle such that KOPS is achieved. Great. Fine. For the purpose of this manual, we're no respecter of systems.

Here is what I'm trying to say: You've got to have a system, a process, some kind of step-by-step method of discovering a rider's proper fit coordinates (saddle height, cockpit distance, handlebar elevation). Otherwise it's like owning a bicycle power meter, you know its basic functions, but you have no idea how to integrate it into your training. These fit bikes really do need drivers who know where they're going. They're marvelous tools, but they don't drive themselves.

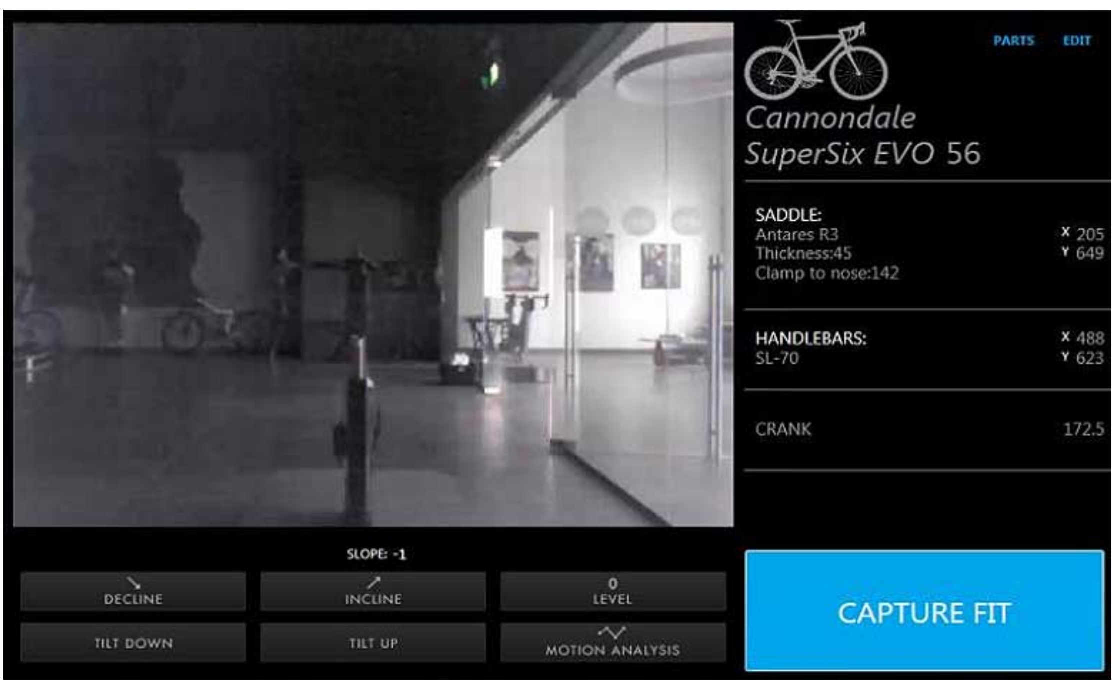
Noting and Archiving Fit Coordinates

Using a dynamic fit process – anybody's process – to find a proper position aboard a road bike is like, well, dating. You settle on a set of coordinates – saddle height, saddle setback, handlebar elevation, cockpit distance – that you can live with. But do you want to marry these coordinates? It's hard to know unless you have something to compare them to. These kinds of fit bikes are like speed dating. You can date a lot of possible bike positions very quickly.

But, look, let's say after you date a half-dozen prospective mates, and after it's all done it turns out you have a real fondness for the second person you dated, not the sixth. Did you have this person's contact information? Did you remember to archive it?

Some fit systems work this way. F.I.S.T. works this way. There is a number of ways these fit bikes, or systems that use these bikes, "remember" prior sets of workable fit coordinates. The GURU fit bike automatically remembers each set of coordinates. You simply save them, name them, takes just a moment. (You press the CAPTURE FIT button in the image below). Want to go back to a prior saved set of fit coordinates? With the click of one button the bike's motors start a-whirring and stop when the prior remembered set of coordinates is achieved. It's like having all your prior dates on speed dial.

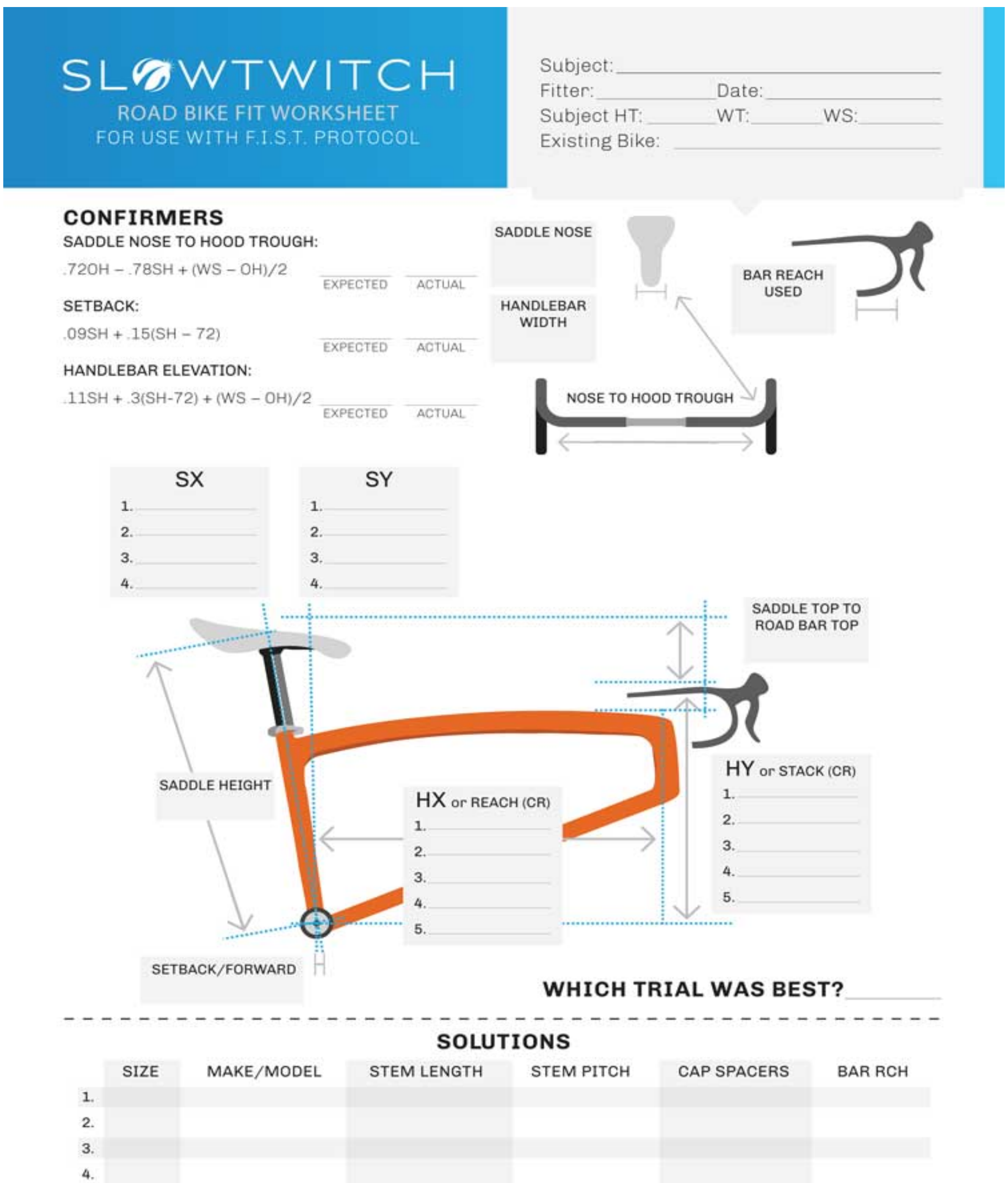
The GURU is a *smart* bike, in that sense. This becomes handy when a rider is undecided between two ways to ride the bike that are hard to choose from. The feedback using a GURU bike is instant. With a click you're riding in position A, then B, then A again.



If you don't have this bike, you've got to note sets of fit coordinates that you want to remember. This is where SX/SY has relevance. Yes, at some point a fitter should ought to deliver to a rider recognizable coordinates in a way the rider can measure. What are these? Saddle height, handlebar elevation and so forth. But this does not really need to be done after every break in the action. All one really has to do is archive enough so that the position can be recreated if the need arises.

In the F.I.S.T. process we execute what we call "trials" and these are discrete optimizations of fit coordinates at each successively steeper seat angle. This means recording the placement of the saddle and handlebars after each trial. Rather than having the rider hop off the bike, with a measuring of every fit coordinate, a fitter can simply note where SX/SY and HX/HY are after each trial. Once the fit is over, SX/SY and HX/HY are recreated for the desired trial, and then all the fit coordinates are measured.

Below is a fit report that we're now using for F.I.S.T. road bike fitting.



This report is designed both as a tool that a fitter uses to archive the position of the fit bike after each trial and as a finished fit report that can be handed to the customer, with the final set of fit coordinates and a set of complete bike solutions (at the bottom of the report).

This is included to show the sorts of data that a fit report might contain. Certainly one can break this up into two separate documents: one for the fitter to use during the fit, and one to present to the rider when the fit is finished. Retül's report includes a list of the body angles achieved during the fit. This makes sense, since the body angle is a driver in Retül's system.

A fitter (i.e., you, if you're a retail fitter) may want to generate his own fit report, with his own branding. He might want only a report that is digital and can be archived online, and emailed to the rider. GURU's fit report is like that.

There is no best method, just, in almost every case there is a way to capture the points in space of the saddle and the handlebars at various points in the fit process, and the enterprising fitter has strategized in advance how this is to be done.

Resistance Units

It has been my observation and experience that Computrainer makes a reliable, dependable resistance unit for fit bikes. It is mandatory that the resistance unit offer variable resistance and I have not found mag, fluid or wind units up to the task. Every time I've tried a resistance unit other than Computrainer for fit bikes I've been disappointed.

That established, there has been an explosion of resistance units from CycleOps, Wahoo, Tacx, Elite and others that seem to me to be candidates, and I'm teachable.

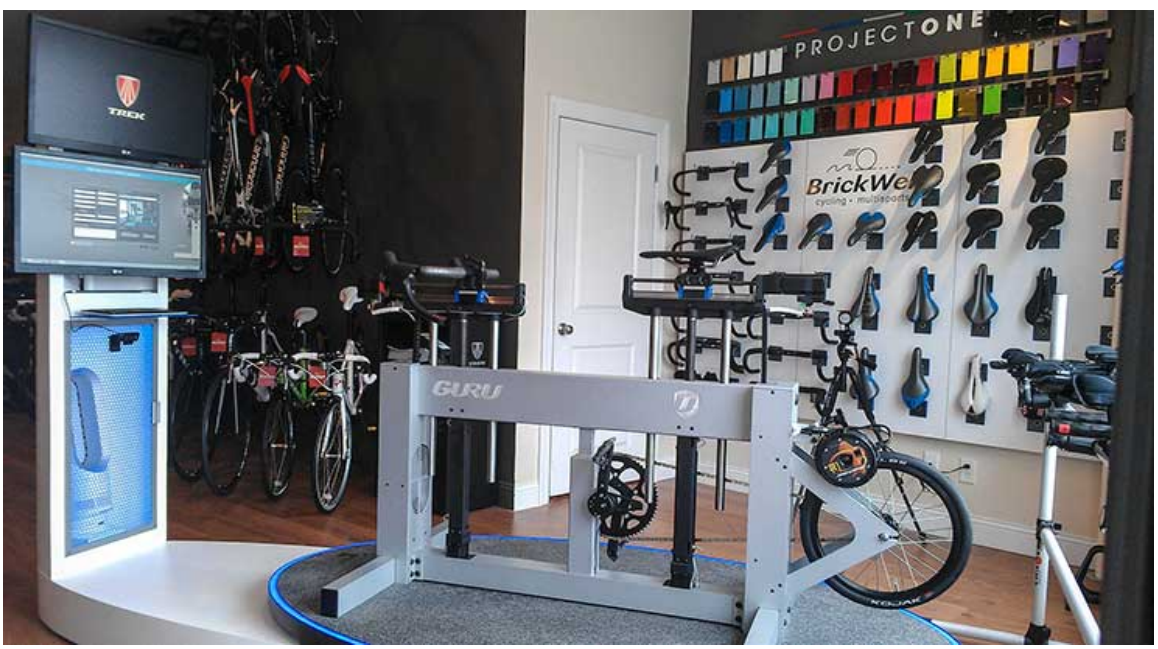
Purely Custom Models

This company makes, broadly speaking, two kinds of fit bikes. The Fit Bike Pro uses a reduction gearbox instead of a bicycle wheel, and pulleys and belts in place of a standard chain ring, cassette cog and chain. It's higher grade. Nice. There's a picture of the drive train on the next page. I've got one of these. Very durable and well made. There is a pick of the drivetrain below.

The regular Fit Bike (not Pro) relies on a 20" wheel and standard bicycle drive train. Prior to last year this came with a mag or fluid resistance unit. Last year I asked this company to build me a hybrid: that lesser-expensive bike with a Computrainer resistance unit. Purely Custom made this, and it's a nice bike. I like this better. Why?

First, I found it difficult to spin the cadence high enough on the Fit Bike Pro to get the Computrainer to 25mph, it's required speed for calibration. This new hybrid fit bike allows me the freedom to gear the bike however I want. You must be careful with the Fit Bike Pro not to use pedals with extra threads, that are made for washers that space out the pedal's stance width. If you don't use these spacers, the threads protrude through the pedal eye in the crank, and nick the belt on the other side of the crank. Little niggling things like this make the cheaper (by almost $3000) Fit Bike + Computrainer the better buy, in my opinion.

GURU has 2 bikes in production: Gen 1 and Gen 2. Gen 1 is very similar to the first GURU fit bike made, which is red. We call the red a Legacy bike. We can a gray version of this a Gen 1 bike. I've got one of these too. Very nice tool. A Gen 2 GURU is really a fabulous bike, with 6 motors rather than the original 4, the final 2 motors for incline and decline (we'll get to this). There's a look at a nice Gen 1 bike below at Brickwell Cycles in New York.



Bolts and Other Parts

Almost all these bikes use parts that can and do wear out. You don't think about this on your own bike because you're not changing handlebars and saddles multiple times per day.

Bolts that do need to be replaced are:

- Handlebar clamp bolt on Purely Custom. This is a M5x25mm cap head bolt.
- Saddle fixing bolt for Gen 1 GURU: the bolt that tightens seat post hardware.
- Same saddle fixing bolt for Purely Custom
- Saddle tilt bolt for Gen 1 GURU: you get to this 5mm Allen bolt from the rear underneath of the saddle
- Hub bolts keeping the 16" wheel on the Gen 1 GURU tight in the dropouts.
- A pair of 4mm Allen head bolts in each side of a Computrainer adjustable crank. Purely Custom makes the best adjustable crank, but Computrainer makes a good one too, and it's in use on a lot of bikes.
- Computrainer DIN cable
- Computrainer power supply

The enterprising fitter determines what hardware gets a lot of use ahead of time and has replacements for whichever bike he's got. Remember, these bolts are in constant use. An M5 Allen head cap bolt requires a 4mm Allen wrench. How many times do you think you can loosen and tighten this before you round the bolt head? These are specialty bolts, and if you find yourself in the middle of a fit, with several more fits on the schedule, and a bolt fails, you'd better hope you have a replacement at the ready.

I have 3 fit bikes in my teaching studio, they all have Computrainer resistance units. Notwithstanding its robustness, I have back-up resistance units, head units, cables, power supplies.

In the bike industry Wheels Manufacturing has a lot of these replacement bolts and parts. In the general world of machine parts McMaster and other similar sellers of these products will have parts like this.

Incline

The GURU Gen 2 fit bike has incline built in. There is only one other bike I know that, as of this writing, offers this, and that is the Exit Cycling bike. It's got a handwheel that grants incline. Purely Custom's fit bikes do not, by themselves, incline, but Purely Custom does build and sell a platform that inclines, on which its fit bikes sit. A Purely Custom fit bike on its incline table is pictured on the next page.

Why is the ability to incline the fit bike relevant? In my opinion, there are 3 reasons this is a vital feature:

1. As fit bikes evolve the improvements include the ability to reproduce what the rider experiences. The closer a fit bike mimics the road, the stickier the fit will be once on the road.

2. Riders adopt different postures and hand positions when climbing. Seated, hands on tops, while rhythm climbing is a typical position and when the fit bike inclines this allows the fitter to not only fit to hoods, but to tops, which is another way to say that the fitter now fine tunes handlebar geometry. If an 80mm reach bar + 120mm stem = a hoods position, a 70mm reach bar + 130mm stem = the same *hoods* position, but a different *tops* position. Seated inclined riding tests the tops position.

3. The most frequent fitter misfire is when determining cockpit length. We routinely see bikes with bars too high and too tight (too close to the BB in the horizontal plane). It doesn't matter the protocol. We see this much too often. The antidote to this is either:

> A) Fitting the rider while riding a much heavier resistance and at proper cadence;
>
> B) Riding on an incline. When a rider is seated, riding up a 7 percent grade, and is asked now to ride out of the saddle, hands on hoods, this exposes the cockpit-too-short (his body weight is well forward; too much weight is on the hands). The rider is now faced

with competing dislikes. When the bike is again made level, the rider now must choose and the inclined experience will bend the trajectory of the fit.

One thing to remember: riding out of the saddle (especially on an incline) requires a lot more resistance than riding seated. What we don't have, yet, is a fit bike that automatically varies the resistance when an incline is sensed. The fitter must do this manually. Be prepared to quickly increase, then decrease, the resistance to the rider as the rider stands, then sits while on an incline.

Incline Tables

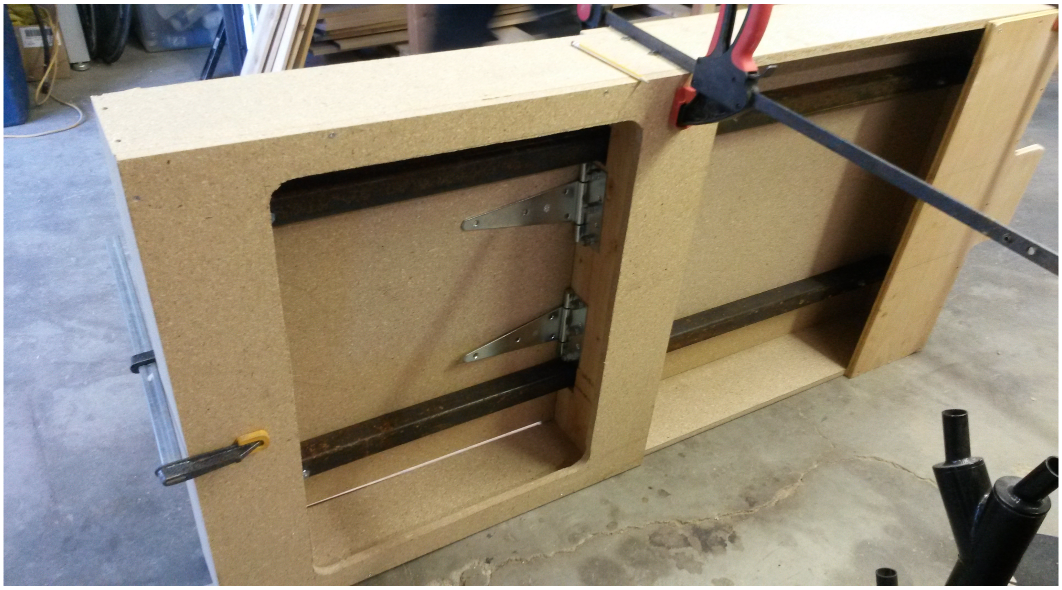
The Gen 2 GURU fit bike just keeps getting better. Of course they do not give this bike away. But it offers value commensurate with its price to a high-volume store. It is a terrific bike and one feature is its built-in incline and decline.

We have a lot of fit bikes currently made, and previously made and out in the field (including GURU Gen 1 bikes), that do not have this feature. That doesn't mean you must do without. You place an incline table underneath a bike that does not incline.

As noted, Purely Custom has this. Further, its table can either be used as incline for its fit bikes or for a rider's own bike on a trainer. However, you won't use this table for both purposes because the fit bike, once on, ain't coming off. It's heavy, and well-made, and it does not need to be permanently affixed to its incline table but I suspect in the normal course of commercial fitting it will be.

You can build an incline table. I've built 3, so far. One is hoity toity, the other is bargain basement. I built them both out of pressboard, but I don't recommend you do this. Build yours out of higher grade, at least ¾", plywood. Mine are out of pressboard because I'm prototyping and pressboard is cheaper.

Included above and below are some photos of what my prototypes look like. One uses an electric linear actuator to incline, as well as a 2" steel pipe rotating around very large bearings nested into pillow blocks.



This incline table (prior page) probably cost, in materials, $700 or $800. The size of the fulcrum and its attendant bearings is big enough to host something much more robust. This fulcrum used for this table is overbuilt. A GURU Gen 1 fit bike sits aboard this table. You can see the linear actuator at right, the table pivots around the 2" steel pipe crosspiece, visible protruding from the side of the incline table.

A Purely Custom hybrid chain-and-wheel Fit Bike + Computrainer load generator sits aboard the bargain version. This might cost $200 in materials to build. The fulcrum is a piece of fir that started its life as a 2”x 8”. It’s attached to the top panel – the lid – using some nice large gate hinges (see those hinges on the prior page). In place of a linear actuator is a trailer jack from Harbor Freight Tool.

This jack is “motorized” by replacing the hand crank with a socket, welded onto the threaded rod. You don’t need to do this. The hand crank is fine. The Purely Custom incline table uses a hand crank. But, as noted, the Purely Custom uses a 6mm Allen key for the raising of its pedestals, so if you weld a 6mm Allen socket onto the threaded rod you’ve got a nifty solution.

But, beware! When you lower this incline table to horizontal, at a certain point the table stops, if your finger is on the trigger of a portable drill, it hasn’t stopped, and something’s got to give. It’ll whip your wrist right around.

One critical design element to these fit bikes is to build them like a single-axle trailer. You want the fulcrum of the platform to be forward, making a teeter totter, not at the rear of the unit (like the first incline table I built). This now means it will take much less weight to incline the bike + rider. It also means the platform will be better supported. Just, you do want some “tongue weight,” just as in that single-axle trailer.

You’ll also want to make sure that there’s a lot of beef built into that top platform in both the longitudinal and transverse axes. The fulcrum placed where it is helps with that transverse axis. Also helping is to bolt the bike down to the platform. Both these incline tables have their bikes bolted to the platforms, so that the incline table uses the rigidity of the bike to make the platform rigid. They also have steel beams underneath, in 1 case a pair of 1”x 2” steel pipe, in the other case a pair of 2”x 2” beams of pretty stout wall thickness.

It’s not just the weight. It’s the oscillation and twisting when the rider is out of the saddle. You’ve got to build these things pretty beefy.

I am giving you some photos and videos of these incline tables in their raw forms. You’ll want to obviously present them with some finish. We’ve got horses here on The Compound and we have occasion to use pretty beefy, thick, rubber mats 6’ by 4’ for these horses to walk on. I’m going to try these mats as my incline table flooring, adhered to the platform. I’ll let you know how it goes.

I'll also publish, as an addendum, the mechanical drawings of these 2 incline tables. Look for videos on these on our Youtube and Vimeo channels:

https://www.youtube.com/user/slowtwitch
https://vimeo.com/slowtwitch

Solutions

Let's recap to this point. You've got yourself a fit bike. You realize – I hope – that all these X/Y fit bikes work basically the same way. GURU, Shimano, Purely Custom work *exactly* the same way, in that they are all cars, with automatic transmission, motors, 4 wheels, a brake and a gas pedal. Some have electric seats and sun roofs. Some are just a dream and a pleasure to drive, some just get you there and back. *But you should be able to drive them all.*

If you don't realize that the basic function of these three bikes is identical, then you didn't read well or I didn't write well.

Now, Exit Cycling and Retül, they are also cars. They have manual transmissions. This is how they differ. You can still drive them. What makes them have manual transmissions while the others have automatics? They do not output handlebar X and Y, they output Stack and Reach. They require the placement of a stem – or an adjustable stem, some kind of stem – onto the bike. I began by thinking this was the best method. I converted to thinking it's not the best method, that having the bike give me handlebar X and Y (HX/HY) is the method that probably offers more utility more often.

What difference does any of this make? It's in how you move to what we might call Part-2 of the fit process, which is, now that I know your fit coordinates, what made by what company matches these coordinates? What bike should you buy as a result of the fit the fitter just performed?

There are a number of software solutions and databases that use the high school geometry and trigonometry that I learned and you didn't (but, as we discussed, your time was probably better spent). What you need to understand is that all these systems use, basically, the same equations. They do the same thing. There is only one way to do the math. They key that unlocks the ability for these systems to exist is the use of Stack and Reach as metrics describing a frame's length and height for fit purposes.

The goal of all these systems is to:

1. Reduce every element in fitting to an X and Y value;
2. Eventually resolve the necessary Stack and Reach of the frame underneath a desired front end.

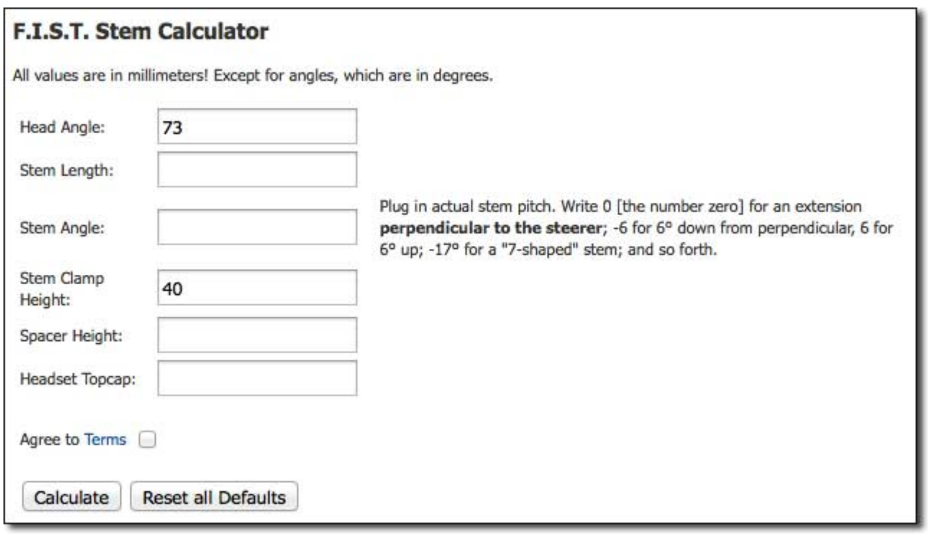
Did I lose you? Let me explain.

Can we stipulate that there's a way to ride your bike? If I ask you, "How do you like your position?" and you respond, "It's dialed," I'm not going to talk you out of this, right? Nor should I. This is you. This is your bicycle DNA. This is your saddle height, setback, handlebar elevation versus the saddle, and your cockpit distance.

Now, let's say your bike is a 56cm Venge. Could you ride a 54cm Venge? Sure. You'd need a longer stem, right? And you'd either need to pitch that stem up, or put some spacers under the stem. This would place the handlebar in the same spot, versus the bottom bracket, on the 54cm Venge as you have on your 56cm Venge, as long as you don't go messing things up by putting a different handlebar on one of these bikes.

Let's talk about you aboard that 56cm Venge. Let's say you ride it with a 10mm headset top cap (dust cover) and a 110mm -17° stem (a stem extension parallel to the ground, like the old days). I've got a little calculator that tells me what the height and length, in x and y dimensions, is of that front end set up.

It's here: http://www.slowtwitch.com/Fit_Calculator/stem_calc.php


F.I.S.T. Stem Calculator

All values are in millimeters! Except for angles, which are in degrees.

Head Angle: 73

Stem Length:

Stem Angle:

Plug in actual stem pitch. Write 0 [the number zero] for an extension **perpendicular to the steerer**; -6 for 6° down from perpendicular, 6 for 6° up; -17° for a "7-shaped" stem; and so forth.

Stem Clamp Height: 40

Spacer Height:

Headset Topcap:

Agree to Terms

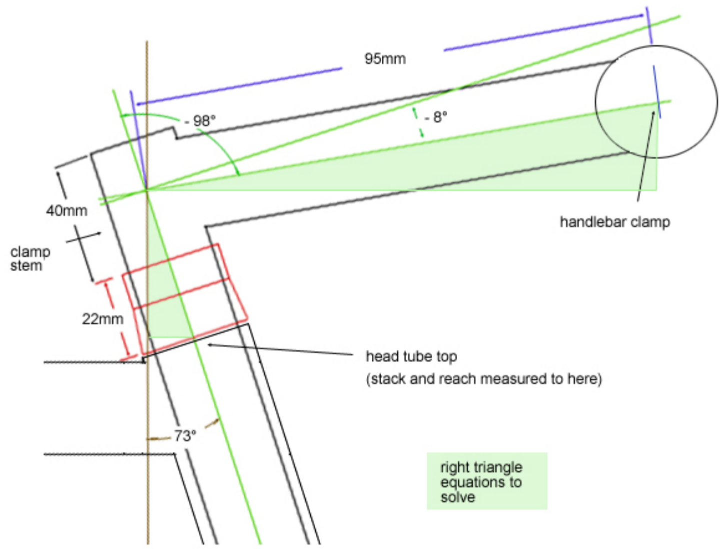
Calculate | Reset all Defaults

If I type in the details of the "front end" of your Venge, that stem length and pitch, headset top cap, and the bike's head angle, here is what I get after I press "Calculate":

Length (x) = 101mm
Height (y) = 29mm

This means that the center of the stem clamp, the handlebar bore, the center of the handlebar, sits 29mm higher in the Y axis than the top of the frame's head tube (midway between its leading and trailing edges). That handlebar clamp sits 101mm in front of that same spot. This ought to be vaguely familiar. We talked about this much earlier, when I showed you that green triangle in the image below, at right. We were finding the long and short arms, remember?

Now, again, what we've determined is that the X distance, the horizontal distance, from the head tube top to the handlebar clamp of a 110mm-long stem, with the extension parallel to the ground, is 101mm. Wait! How can that be?! The stem is 110mm long and it's parallel to the ground, so how come I don't have 110mm of length out of that chosen front end? It's because the stem doesn't start directly above the head tube. It starts at the center of the steer column, angled back, because your bike's head angle isn't 90°, it' declined back to 73° (or thereabouts).



In the image at left, the proximal point of the stem sits at the top of that smaller green shaded right triangle below. The short arm of that triangle is the amount of distance behind the head tube top.

Your Venge in size-56cm has a Stack and Reach of 566mm and 395mm respectively. Let's add the two height elements and the two length elements together, i.e., we're adding Stack and Reach (red triangle below) and front end X and Y (green triangle below):

56cm Venge Stack (395mm) + front end length (101mm) = 496mm
56cm Venge Reach (566mm) + front end height (29mm) = 595mm

What are these two numbers? They are handlebar X and Y. These are the numbers that GURU, Purely Custom and Shimano bikes give you.

Now, let's do 2 things. First, let's calculate the front end needed for you to switch to a 54cm Venge. That Venge has a Stack and Reach of 544mm and 386mm. We therefore need greater height and more length out of the front end of that bike to reproduce your own dialed fit. We know we need a handlbar X and Y of 496mm and 595mm. So…

Handlebar x of 496mm (minus) 54cm Venge Stack of 386mm = 110mm
Handlebar y of 595mm (minus) 54cm Venge Reach of 544mm = 51mm

On the 56cm Venge, you needed a front end 101mm long and 29mm tall to get your handlebars where they needed to be. On a 54cm Venge you need a front end of 110mm long and 51mm tall to perch your handlebars in the correct position.

So, I go back to that same front end calculator and plunk front end configs in until I find something very close to 110mm of run and 51mm of rise. I just keep hitting my browser's back button, sticking different values in, until I find something close. How about this below?

120mm stem, -6° pitch, 10mm headset top cap:

Length (x) = 109mm
Height (y) = 52mm

Pretty darned close. I think we have a winner.

So here's your option, as a rider: Do you want to ride a 56cm Venge, with a 110mm stem parallel to the ground, or a 54cm Venge with a 120mm stem with a -6° pitch? They each grant you the same position. Now, you must as a fitter stop thinking just as a fitter, because your fit problem is solved. You now have to face a handling problem (unless you have a standover height problem to solve). Do you want the Venge with a smaller wheelbase under you? Longer stem? Or longer wheelbase, shorter stem? You choose, you're the expert.

The exercise above is, yes, something you might do in the course of a session. I use that stem calculator a lot. But the point of the exercise is to help you get your arms around the math surrounding this entire industry segment. All the calculators, all the companies, use basically this math.

All these calculators, from all the companies, reduce the front end config of a bike to X and Y dimensions, to pair with the X and Y dimensions of a frame (Stack and Reach) to give you a complete bike solution. I think you can imagine that a computer program that can easily parse and calculate all the front-end X and Y distances of every possible config, matching them with all the Stack and Reach options of every size of every model made by every brand sitting in a database, can quickly give you a set of complete bike solutions that are quite granular.

If you want to drill down to a list of complete bike solutions that appeal to you, then your chosen software ought to have filters. Newsflash: you can probably also ride a 52cm Venge. Maybe even a 50cm Venge. But how long a stem are you willing to ride? How many spacers under the stem? How steep a stem pitch? A program with filters that say, "no more than 30mm of spacers" or "a stem no longer than 120mm" limits the huge output of possible bikes that would theoretically grant you a fit solution.

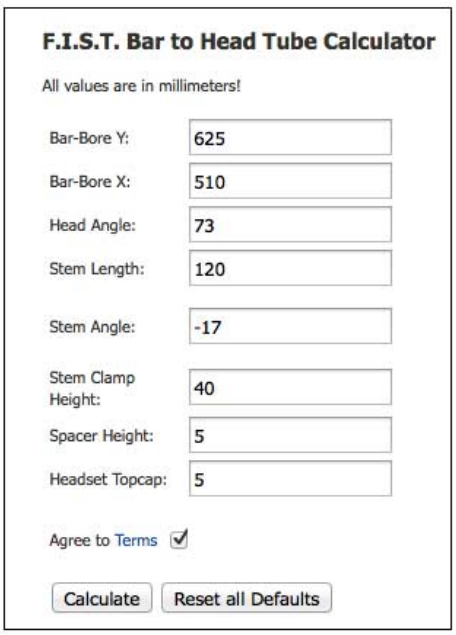
Fit bikes that output HX and HY lend themselves very well to this process. They are tailor made for these calculators.

Let me show you how one calculator works – which we host on Slowtwitch. Let's say that you finish a fit session and you have a handlebar X and Y of 510mm and 625mm respectively (you might remember seeing these numbers, they are my own for road bike riding). Here's a calculator that looks a lot like the one above, nevertheless works somewhat in reverse:

http://www.slowtwitch.com/Fit_Calculator/bar_bore_calc.php

Me, I'm 6'2", so I probably don't want to ride a road bike with a 90mm stem on a road bike. Probably 120mm or 130mm is more like it. I have a visceral problem with a stem pitch steeper than -6°, though it's emotional rather than engineering-based. Nevertheless, it is what it is. So, these are my "filters." That, and I hate spacers which means a max of 20mm of total headset top cap + spacers for me.

I'll plunk into this calculator 120mm of stem length, -17° pitch, 10mm total spacers. That, plus my HX and HY totals after the fit, recognizing that I also very much like ultra short reach bars (70mm), because I like the tops well out in front of me when seated climbing. Were I to change to an 80mm or 90mm reach bar, the length of my bike is now more taken up by my handlebar, and that correspondingly "pushes" my stem clamp back. When I'm fit properly I've got a Handlebar X of 510mm with a 70mm reach bar. I've got an HX of of 500mm with 80mm reach bar; 490mm with a 90mm reach bar. Each of these configurations places my hoods in precisely the same spot.



Input

Bar-Bore Y	625mm
Bar-Bore X	510mm
Head Tube Angle	73°
Stem Length	120mm
Stem Angle	-17°
Stem Clamp Height	40mm
Spacer Height	5mm
Headset Topcap	5mm

Output

Stack	596mm
Reach	399mm

You must always realize that the metrics you're porting into these calculators are dependent on the handlebar used during the fit. Why am I so hinky about this? Because I know you guys. You'll faithfully go through this, and discover that – lo! – the rider's a perfect fit on a 54cm CAAD 10! Which I have in stock! And then you pull it out of the box, build it, sit this new bike on a trainer, customer hikes his leg over the top tube, and the cockpit is too long. Why? Because the bike comes spec'd with an OE bar that has a 90mm reach and you executed the fit on a bike with a bar that has 70mm reach. Anyway…

The fit has been executed. We have a target HX/HY we're looking for, and it's 510mm and 625mm respectively, again, *assuming a road bar with a 70mm reach*!

We plunk these numbers into the calculator above with the chosen front end: 120mm of stem length, -17° pitch, 10mm total spacers. Our calculator then tells us we need a bike frame with a stack and reach of:

Stack: 596mm
Reach: 399mm

We go to Slowtwitch Stack and Reach tables: http://www.slowtwitch.com/stackreach/road.php

What do we see. Among many, many other options we find:

Bianchi Oltre 61cm Stack: 601mm
Bianchi Oltre 61cm Reach: 397mm

This bike is too tall (by 5mm) and it's not long enough (but by only 2mm).

If we go back to our calculator, hit the back button, and put in only 5mm (slammed) of headset top cap instead of 10mm, we're now looking for a bike that has the Bianchi's exact Stack and Reach. Bingo, we have a winner. Is this a proper bike to sell a customer having gone through this process? Probably not. If he ever wants to go lower, that's hard, because this bike has a stem parallel to the ground that is slammed.

Trek

Madone7 Madone6 H1	50	506	383	61	574	100	int	71	75
	52	518	388	57	577	110	int	70	75
	54	526	390	56	581	120	int	70	75
	56	549	395	56	583	140	int	70	75
	58	567	400	56	590	160	int	70	75
	60	586	404	56	599	180	int	70	75
	62	606	407	55	607	200	int	70	75
Madone6 Madone3 Madone5 Madone7 Madone2 1Series Madone4 H2	50	535	374	61	575	130	int	70	75
	52	547	379	57	577	140	int	70	75
	54	555	381	56	581	150	int	70	75
	56	577	387	58	583	170	int	70	75
	58	596	391	56	590	190	int	70	75
	60	615	395	56	599	210	int	70	75
	62	634	398	55	607	230	int	70	75
	64	654	401	55	615	250	int	70	75
Madone4 M6WSD M5WSD Lexa M4WSD M3WSD H3 Domane	44	507	360	69	576	110	int	70	75
	47	525	364	63	577	125	int	70	75
	50	542	368	57	578	140	int	70	75
	52	559	371	61	580	155	int	70	75
	54	573	374	58	583	170	int	70	75
	56	591	377	59	580	185	int	70	75
	60	634	398	56	593	230	int	70	75
	62	654	401	55	601	250	int	70	75

Here's Trek's listing on our Stack and Reach tables in miniature, at left. Trek in H2 geometry, size 58cm, is

Stack: 596mm
Reach: 391mm

Hmm. The bike is not long enough. We need a bike with a reach of 399mm to match my fit coordinates. What if I go back to my calculator, keep my original front end spec, just plunk in a 130mm -17° stem instead of a 120mm stem? The stem is now taking up more of the length of the whole unit. If I go back to the calculator and ask it to give me the bike that will fit me with the longer stem, now I'm looking for this bike frame:

Stack: 596mm
Reach: 389mm

Okay! That's much closer.

But remember, I've got a Cannondale Supersix EVO in my garage, size 58cm. It's geometry is:

Stack: 577mm
Reach: 399mm

This is too low. But, I've been looking for the "right" bike assuming it's going to be outfitted with a -17° stem. If I "spec" my bike with a -6° stem, this stem takes up some of the height requirement of the whole unit. Let me plunk into the calculator a 120mm stem, -6°, and only a 5mm headset top cap. Below is the "result," i.e., the frame that fits up underneath a position that must have an HX of 510mm and an HY of 625mm:

Stack: 578mm
Reach: 400mm

This is within 1mm in height and length of my Cannondale and is fact how mine is set up. I can easily ride a Cervelo, a Trek H2, a Venge, a Tarmac, a Felt AR, all kinds of bikes, but in each case the bike will have a slightly different front end to get the bars positioned where I want them.

I have only begun to explain all the power behind these calculators. Just using the calculators I've shown you, this is how I "prescribe" a front end needed to retrofit a customer's existing bike based on the HX and HY generated by a bike fit session aboard one of these fit bikes discussed here.

Mind, this exercise above, a lot of the uses of the calculators do not require a fit bike. This is just math and databasing. I go through this exercise because this is what you do with the data once you've used the fit bike to generate a position and then to simply read HX and HY off the bike. This is what you do with HX and HY.

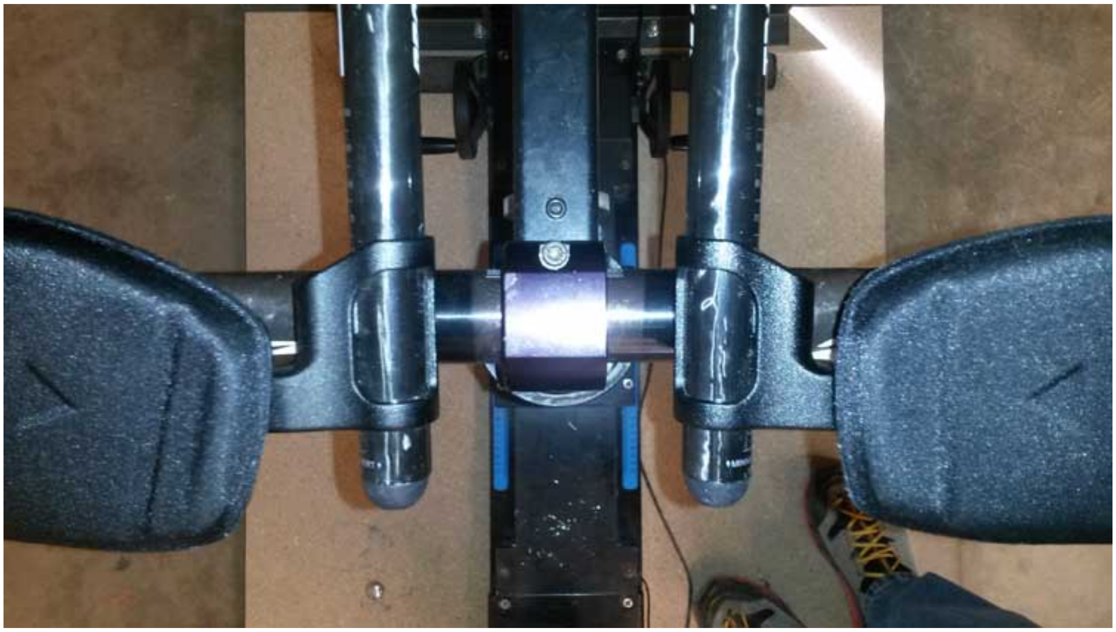
Pad X and Y

Triathlon is a little bit of a tougher nut. There are 2 kinds of tri bikes out there: mortal bikes and superbikes. Mortal bikes, the exercise we've gone through for road to find the bikes that match an HX/HY output is the same. The protocol for deriving the best position is different (the nose of my saddle is 8.5cm behind the BB for a road fit, and even with the BB for a tri bike fit). But the way it all works, the math, the calculators, it's identical.

But the tricky part is remembering that whatever frame this system prescribes for you assumes you're riding that very same aerobar. Same pad height. Same placement of the pad fore/aft relative to the pursuit bar. Same stem length and pitch.

Superbikes offer a new problem, because all these calculators work off the assumption that stems are stems. They can be reduced to mathematical distances, X and Y distances. But how long, really, is a Trek mid/far stem on a Speed Concept? What is the pitch? Unknown. Our calculators won't work.

So we bypass this entirely; we don't use these calculators. We simply ask what the X and Y dimensions are from the bottom bracket to the top of the pad, midway between its leading and trailing edges (i.e., the center of the pad). Then we go to each bike brands pad X/Y calculator, which most tri bike companies have (just ask them) for their superbikes.



How do you calculate Pad X and Y after you've finished a fit? Look down at the top of the pad. Just like in the image above. Find the pad's center. Is it sitting right over the pursuit bar? Then Handlebar X is Pad X. Remember, Handlebar X (HX) is measured to the center of the handlebar, where it passes through the clamp. If the pad center sits right over the pursuit bar, HX and Pad X are identical.

But is the pad center sitting 10mm behind the pursuit bar? Then it's Handlebar X minus 10mm. In the image, I hope you can see that the pad center is sitting behind the centerline of the pursuit bar center. Way below all of this, near the floor, you can just make out the blue rulers that tell you where the handlebar center is relative to the BB. This is HX or Handlebar X. Do you see, then, that Pad X is simply Handlebar X minus the 10mm or 15mm the pad center sits behind the pursuit bar?

How tall is the pad sitting above the centerline of the pursuit bar? 60mm? That's pretty typical. Then it's Pad Y + 60mm. Easy. This is another reason I like bikes that output HX and HY.

There is a lot more I could tell you about how we fit people to tri bikes, how these Pad X and Y calculators are used. But that's beyond the scope of this manual. We teach all this in our F.I.S.T. Workshops, as do GURU and others in their schools and workshops.

In Sum

It seemed to me that we didn't have a good pathway forward for those who were interested in one of these newer types of fit bikes. It's a lot of money to spend on a tool if you aren't really sure how the tool works; what it does; and what makes one of these tools different or special.

This manual represents my first crack at helping answer these questions. The name of this file ends with Vx, x equaling the version number. Depending on the number, you'll see how many times I've already had to go back in this manual's young life and make changes. I'm sure that number will grow, and that's fine. It means I'm getting feedback. One place for feedback might be our:

Fitter's forum hosted on Slowtwitch: http://forum.slowtwitch.com/gforum.cgi?forum=10;

Please don't be shy with your criticisms. Let me know what is confusing; what is missing; what is badly written. Thanks for reading, and for getting all the way to the end!