



## **DESIGN BEHIND THE BIKE**

### ***FRAME DESIGN***

#### **V.O.**

The design of bicycle frames over the years has changed in subtle ways within set parameters. Bikes have remained recognisable while the intricacies of design have focused on weight, performance, geometry, aesthetics and materials. Frame design is now a very technical, computer-aided process.

#### **PHIL HAMMILL, BRAND DIRECTOR, GENESIS**

The design process starts off with pretty much a review of last year. We also look at the market as a whole. What are the new trends? What's coming on. What sort of price points we need to hit. What materials are coming in. What's the latest technology?

#### **ALBERT STEWARD, GENESIS PRODUCT MANAGER**

In terms of designing a bike from scratch. Basic geometry is normally drawn up in bike CAD whereby it will then be transferred to a 3D CAD programme where you're able to then mock up the tubes, get 3D visibility, check clearance of the tyres, chain rings, that sort of thing and then typically that's then transferred back to a 2D drawing, which is then given to the frame maker, which they then use to produce the frame.

#### **BEN SPURRIER, HEAD OF DESIGN, CONDOR**

The nuts and bolts of the process from our end are that we will come up with a basic principle that everybody is loosely happy with and that will then get built into an Adobe illustrator file, which will be a basic layout of the bike frame. So it will show a side on, top and front and rear elevation and it will show three quarter angles just to really describe in every last detail all the elements that are expected of that bike. Everything we do is empirically tested. In as much as we will simply build something and test it by riding it. Having a professional team means we can give the product to guys who will test something further, faster, harder than any of us will ever be able to ride a bicycle.

#### **GEOFF GIDDINGS,**

By sponsoring a team the research and development moves on at a faster pace so we have professional riders out there pushing the bikes to extreme circumstances. If we were to design a new bike today that we wanted our team to ride professionally on we would have to pass that through the UCI to seek approval for that particular frame design.

## **2 - DESIGN THROUGH THE YEARS**

### **TERRY BLACKWOOD**

Forty years ago the design principle was very much the double diamond, large triangles, very strong construction. What changed that was partly mountain bike influence, but mainly as materials improved we were able to get the same strength and stiffness levels but without having to have such big triangles.

### **PHIL HAMMILL, BRAND DIRECTOR, GENESIS**

Road frames really started with steel and within steel there are lots of different construction techniques such as lug, and braze, and tig and those have been developed through the years and each development has helped reduce weight. Titanium is a really great material, really super light but also a little bit flexy so you don't get the stiffness but you get really good weight and also good durability out of it. Aluminium offered the opportunity to use much bigger tube sets for increased stiffness, also created quite a new look for bikes and then came carbon fibre which is pretty much revolutionised the whole road bike industry because that allows designers to achieve shapes and weights that was never possible with aluminium or any other material before that.

### **V.O.**

On a lugged frame, steel tubing is fitted together using external sockets that slide over the ends of the tubes, increasing the strength of the join. A diamond frame typically uses 4 lugs at the seat, the upper and lower head and the bottom bracket. Lugs can be brazed onto the tubes with a silver or brass filler. TIG, or tungsten inert gas welding, uses a tungsten electrode to weld the frame. This technique gives the operator a greater control over the weld and is often used for thinner metals.

### **ROGER HAMMOND, FORMER PROFESSIONAL CYCLIST**

Initially bikes were flat top tube, triangular shape. That was in the days when bikes could be hand-made and made to measure. So you went to a bike shop and they measured your inside leg, length of your limbs and then said right this is the size of the bike. Basically it was carbon fibre that changed the world really. Because it's hugely expensive to set up the carbon fibre bike. You have to buy a mould, which in the early days was round about a quarter of a million pounds for each mould at the start. What they found was by sloping the top tube down to the seat tube you could then with different length stems, you could pretty much fit everybody onto 3 or 4 different sizes of bike.

## **3 - FACTORS INVOLVED IN FRAME DESIGN**

### **V.O.**

When it comes to frame design, there are a variety of considerations to factor into the process, such as weight, shape, geometry and the limits of the technical processes. The final

design is achieved by balancing and prioritizing these factors with current trends also playing a role.

**TERRY BLACKWOOD, RALEIGH UK PRODUCT MANAGER**

When it comes to bike design and what materials we use there are quite a few choice we have to make. Budget is usually the principle one. We'll then look at what the rider actually needs so what are the balances between comfort, stiffness, and durability. We'll then start to play with geometry, so the geometry is right for the rider.

**KEITH NORONHA, REYNOLDS**

It's fair to say from what we've heard from some of the riders, absolute stiffness like a sprinter isn't what some of them want, they want something indeed that can be used on a long ride, would feel comfortable and for example on some of the roads we ride on the ability to soak up bumps from potholes and some very rough surfaces. That could be as important to them in the way they buy their bikes and therefore they won't necessarily look for absolute lightness being the most important factor in a frame choice.

**TERRY BLACKWOOD, RALEIGH UK PRODUCT MANAGER**

When it comes to deciding factors, particularly on the high-end performance bikes, carbon fibre starts to have some great advantages to it. We can make a small diameter tube stiff by using a higher modulus material in it.

**GEOFF GIDDINGS**

Everything has gone from standard round tubes now to aerodynamics so, so it's gone through a full circle of small tubes, large tubes, aerodynamic tubes and different materials.

**TERRY BLACKWOOD, RALEIGH UK PRODUCT MANAGER**

If you're looking at the bikes that are currently being ridden on the tour, they very much have horizontal top tubes and that's because aero dynamics are becoming more important than comfort or the stiffness element of the bike.

**ROGER HAMMOND, FORMER PROFESSIONAL CYCLIST**

The engineering on bikes now is so good that they can actually build in stiffness in one direction and energy absorption in another, which is basically making it not quite so stiff.

**KEITH NORONHA, REYNOLDS**

The idea of butting a tube is, if you can imagine a pipe of tube, and we call it a constant outer diameter so for example if you looked at a tube along the outside you would have a constant diameter like for example 32mm, the big thing about butting is that you can actually vary the wall thickness along the length of the tube so for example the longest length, the two ends for

example might be .9 of a mm but the middle section could be .6mm. So what the butting process allows us to do is concentrate metal where it's needed at the ends of the tube in this case but take out weight which is metal from the middle bit.

By taking out this extra weight in the middle which isn't really needed you could drop the weight of that tube by about 30%.

#### **4 - FUTURE OF FRAME DESIGN**

##### **V.O.**

Frame design is regulated by the UCI to favour the diamond frame that is still based on the safety bicycle. Views differ as to whether this is holding back progress or whether the diamond frame is indeed the very basis of good design. So as the science surrounding the sport of cycling moves on, what does the future hold for the design of the bicycle frame?

##### **ALBERT STEWARD, GENESIS PRODUCT MANAGER**

Over the coming years I think we will see bikes getting lighter and lighter. I think we will probably see the UCI drop their weight limit for a race bike. I think we will see bikes continue to get lighter and will see a larger level of componentry integration into the frame.

##### **TERRY BLACKWOOD, RALEIGH UK PRODUCT MANAGER**

If we used carbon fibre the way we want to do it and not with the restrictions of the rule makers we would see some very interesting bike shapes coming along. Because carbon is so flexible in what you do with it, we would almost certainly move away from diamond shape, lose the two triangles, we would be more aerodynamic by taking the seat tube out and we would have some very interesting shape bikes.

##### **PHIL HAMMILL, BRAND DIRECTOR GENESIS**

I can see a point in time where a designer or a brand will be able to send out to a customer a design for a frame that's custom made for him so he gets the file, prints it out on his machine and he's got a frame that's custom built for him. I certainly see that as being the future, as 3D printing becomes more established and cheaper and more cost effective.

##### **ROGER HAMMOND, FORMER PROFESSIONAL CYCLIST**

Research and development is really governed at the moment. I think you know there has to be some sort of governing on it because otherwise bikes by now would be unrecognisable. Is it restricting bikes being pushed forward into the future? Definitely, a little bit, but that's the compromise that we have to accept I think.