The Science Behind the Bike
Technology

Sarah Storey OBE
Paralympic Multiple Gold Medallist
Technology in cycling is huge. It's almost getting to be like a Formula One style with the amount of changes and wind tunnel testing and you know there are things that you can change on a bike – there's so many different components that you can work with.

Rebecca Romero
Olympic Cycling Champion
The implications of science, the difference that's made to – to – um the bike itself – um to the equipment that we use um it's overall effect on speed and performance.

Presenter
Technological advances and research from the Formula One and Aerospace Industries over the past twenty years have helped to develop the traditional steel tube bike into a high tech aerodynamic piece of science influenced design. The carbon fibre Lotus bike in 1992 heralded the advent of this new wave of development.

Chris Boardman MBE
Olympic Champion and Bicycle Designer
The Lotus bike came from a guy called Mike Burrows who is his original idea and he just said well wings is what people use in other industries to cut through air so why do we make it a collection of tubes? We've got this wonderful new material, carbon fibre, that we can shape it however we like and it will still be structurally sound.

Gerard Vroomen
Innovator and Cervélo Bicycle Designer
When we started out and we were looking at making aerodynamic tubes out of steel there was always so much that you could squeeze around the tube into an aero shape before you would start to see cracks and things like that. The aluminium got a little bit better so you could make perfect shapes on a tube before as where you joined those tubes together you were still quite limited. There were just certain shapes that would come together and then you – you weld it. And now with carbon also the joints and every part of the bike you can shape it in whichever way you want more or less and then just have to figure out how to make that shape strong enough so that you can ride it.

Chris Boardman
The material itself, carbon fibre just opens up so many possibilities for construction.

Gerard Vroomen
Well I think with carbon fibre you combine a couple of advances. The first one is it's very light for its specific stiffness and strength so you can make something that's very strong. It's very stiff so all the power you put into the bike goes into your propulsion instead of deforming the frame and yet it weighs very little so that's the one major advance. The other one is the form freedom. You can make any shape you want so now its possible to make tubes very aerodynamic instead of round or almost round. And when you look at the Periodic Table you see that there is no element left that could do a better job of this so there is not really any reason to move to a different material.

Presenter
The use of this revolutionary material necessitated the introduction of computer aided design software to facilitate the creation of technologically advanced light, stiff but workable bikes.

Gerard Vroomen
When you look at computer simulation you simulate for stiffness and strength. You can simulate what the weight will be. You can if you have a carbon fibre because a carbon fibre frame consists of say between two hundred and five hundred pieces of carbon so small pieces that you lay on the frame in certain directions. So there - if a certain tube has ten layers you want to test what happens if we change this layer or that layer. So there's a lot of computer simulation that you can do to really speed up the development process.

Chris Boardman
And with the aid of computer modelling you can tell the computer how many layers of this type of carbon fibre you've used, what resin, it will computer simulate the shape and bend it and say yes, this is strong enough and stiff enough.

Gerard Vroomen
Its performance is directional so you have the fibre and in the direction of the fibre the performance is very different from perpendicular to that fibre. So if you have a piece of carbon fibre and all the fibres are laying in a certain direction it makes a lot of difference whether you put the piece on the frame like this – or like this. It completely changes the stiffness and the strength. So the only way to do that properly is on the computer so that you get a ready ninety or ninety five per cent to the final design and then you make a prototype. You test it, you find out things that the computer missed.

Chris Boardman
Bringing together several different technologies has been just revolutionised bicycle design.

Presenter
With the combination of new materials and design software producing highly innovative bikes research focused on the position of the rider to create a unit giving maximum performance as a whole. To this end computational fluid dynamics and wind tunnel testing were introduced from other industries where aerodynamics is of prime importance.

Simon Smart
Bike Aerodynamicist and Designer
The year that I worked in Formula One the experimentation became very, very important and that was because we were looking for really small incremental gains all the time. And I think that skill was probably the most important skill that I brought across to doing aerodynamic development in the bicycle industry.

We fitted many – people now in this wind tunnel over two hundred and fifty amateur and professional riders and the one thing that always comes home is that ultimately it's the - the achieving the position is the fundamental requirement.

Presenter
In achieving the optimum position both speed and comfort are considerations. However, with maximum performance as the ultimate goal one must take precedence over the other.

Gerard Vroomen
I think when we're talking about you know top performance sport comfort is not really a consideration. So obviously there if you can be faster in an uncomfortable position – you'll take it. So with power basically set by your lungs and your heart it then comes down to what position can you get the most aerodynamic in and is it at all possible to hold that position for whatever time that the event is.

Sarah Storey
Barney and I spent a huge amount of time at home in our garage which is ultimately a process Chris Boardman went through ironically of looking at what I'm doing; taking photographs, using a mirror and deciding what looks to be the most aerodynamic and then ultimately we can take that out every Wednesday evening in the summer onto a time trial race on the same course and test it. And ultimately the conditions do change a bit with the wind

but we can actually test out new positions, work out looking at power trials, looking at the time overall whether the position has changed and helped or whether it's actually hindered.

Rebecca Romero
When I was training we used the wind tunnel looking at finding the optimal position for each rider and the interaction with the bike itself. You might have a very aerodynamic bike that you've produced but the interaction between the bike and the rider is the most important thing and that can have implications between me winning a gold medal and not winning a gold medal.

Presenter
With continued investment in the science of the sport of cycling what does the future hold for bike design and performance at a lead level? And where will these ideas be drawn from?

Gerard Vroomen
I really see a trend towards further system integration so I rally see that the components and the wheels and the frame all come together and are designed together. We already started doing that so that when we design a frame we talk to the wheel manufacturer and see what they're working on so that we know for sure that in the end all those things work together nicely both from an aerodynamic and from a structural point of view. So we see a big trend towards that and the other big trend is electronics. We see that in shifting. We see hydraulics in brakes so there's just some new technologies, not necessarily new in the world but new you know to the bike industry that will start to take over certain functions of the bike.

Chris Boardman
There's a lot of learning from people who have parallels so as you mentioned the aerospace industry, the Formula One industry, people who face similar challenges. I don't know about bikes but there is common ground expertise. But also you can also look for stimulus in the natural world because there's billions of years of evolution there that has arrived at designs and we don't know why. So for example we know in the last four or five years we're exploring shark skins for hydrodynamics and you know is the scaly denticle skin when you put it under the microscope is that for replacement factor or is that actually to do with micro vortices that help – help hydrodynamics, you know. So it's all being explored. So there's a lot of good ideas just come out of the natural world if you look.