

The Science Behind the Football Boot

Transcript of public lecture on "The Science Behind the Football Boot" by inventor and ex Liverpool soccer player Craig Johnston at the Royal Irish Academy in Dublin on 13 November 2007, as part of Science Week.

The Science Behind the Football Boot – Part 1

Craig Johnston: "OK, if you support Manchester United please put your hand up... OK, Chelsea?" [general banter with audience before the lecture proper starts, about the teams they support]. "This isn't a football evening as such, it's about science and football, and I guess that's why I'm here. When I was a little kid I wanted to be the best soccer player in the world and I failed miserably. However, I got into soccer boot and soccer boot development and developed The Predator and apparently I am the 'world's leading expert' on football boots so we're going to talk about the science of the football boot tonight.

Ger Gilroy (Newstalk broadcaster, and MC for the night): "We're going to talk a lot about that actually. I think it's interesting that the first thing you do is collect data, because I think that's one of the hallmarks of your career. And I also think you're being a little bit modest when you talk about failing as a footballer, because you held your own on the greatest team Liverpool Football Club ever put out, over the best part of half a decade. But at the very start, when you came to England, you had a tricky enough beginning."

Johnston: "Well, it's a pretty well told story, but I better tell you it now because it looks like there are a lot of children below 14 years old here. Would that be right? If you are below 14, quickly put up your hand. Wow, look at that.

"When I was 13 I was a skateboarder. And me and my mate skipped off school because we wanted to ride our skateboards in Sydney. And somehow we ended up in King's Cross which is like the bad side of town, so we thought: Well, look, we should just go in and see if we can see a movie and then go home because home was about 50 miles away.

"So we found this movie and it was called 'The Giants of Brazil'. It was about the great World Cup winning Brazilian team of the '70s. Jairzinho, Rivelino, Tostão. I guess the older guys and girls will remember them.

"I was very good at school and my mum was the local schoolteacher, so my mum wanted me to be, basically, an architect or a surgeon. But when I saw Pele and the Brazilians playing football in this movie, I said: 'That's it – all I want to be for the rest of my life is to be like that man'.

"And he scored this unbelievable goal, a header, against Mexico. And it was the closing slide on the film – Pele jumping up and going like that [fist in the air]. I said to my mate: 'Let's watch it again'. It was like a one and a half hour movie. So we watched it again.

"So anyway, four or five hours later we missed the train home and I got the flogging of my life. My dad set about me for the first time with a stick and when I'd finished crying I said: 'Dad, I know who I am. I know what I want to be'. So he said: 'Yeah, but there's one problem, you're not very good'.

"And I said: 'Yes, I know, but I can get good'. And he said: 'Well, no, you're not even in a school team'. I said: 'I'll get in the school team'. I was about thirteen at this stage, and my mum was very clever and my Mum said...I hope this is not too long..."

Gilroy: "No, go for it."

Johnston: "This is how I got into soccer... the honest truth. My mum said: 'OK, you want to get into soccer'. And I started creating all these skill drills I would do in the back yard.

"When my dad was young he wanted to be a soccer player. He was Australian and he went to Scotland but he went when he was 20 and he was too old because when he got there all the kids had practised their skills and they were better than him. So he said: 'If you want to be a footballer, you can't do this in Australia – you have to go to England'. And I said: 'OK, how do I get to England?'

"And my mum overheard the conversation and she said: 'Well, if you come first in science, maths and English, we'll pay for your fare'. And I was a middle table student but I studied like no kid had ever studied. A year and a half later I came first in science, came first in maths, came first in English and Mum had to pay the fare. Probably she didn't have the money; my family didn't have the money, so they sold their house to pay for the trip."

Gilroy: "So, no pressure then."

Johnston: "No pressure. So, from being a 13-year-old kid and seeing this Pele movie and then reading all the books on soccer to studying, I now was ready to go to England."

Gilroy: "And that's all well and good, but when you get to England are you going to fetch up at the door of a football club and say: 'Excuse me, I'd like to play for you?'"

Johnston: "Well, my mum and dad wrote to Chelsea, they wrote to Manchester United, they wrote to one other team and that was Middlesbrough because Middlesbrough had been touring Australia and Jack Charlton was the manager.

"Middlesbrough were big in Australia and they said: 'Well OK. Is he any good, your son?' And they (my parents) said, 'He's good by our standards'. So anyway, what they (Middlesbrough) said was: 'Well if he pays his fare over and board and lodging, he can stay for a month and we'll give him a trial'.

"So they'd moved into a much smaller house, in a much worse part of town, and I was in the cold north of England. And, by the way, I was a surfer so I had bleached blond hair, you know like one of these Californian kids.

"I had no idea how cold and miserable and wet it was going to be and how the apprentices that I was about to meet, how keen they were that I wasn't going to take one of their jobs. So it was not a good scene."

Gilroy: "So what happened when you got to Middlesbrough? You travelled three quarters of the way around the world; your family are kind of reliant on this being a success. What happens?"

Johnston: "They get the triallists – there's a lot of Irish kids there, a lot of Scottish kids there, a couple of kids from America, there's me from Australia – and then you play a trial game.

"And funny enough, this day – it was a place called Hutton Road in Middlesbrough – I was jet-lagged, my hair was long and almost Rastafarian and we were getting beat three nil at half time. Anyway, Jack Charlton was there and he saw the whole thing.

"So at half time the coach of the triallists was being nice, and Big Jack stormed in with his big, you know, personality, and he had a go at everybody in the dressing room and said what a disgrace and a sham it was and that we were the worst set of recruits he's ever seen.

"Then he picked on me and he said: 'You, where are you from?' And I said, 'Australia', like that. And he said: 'You are the worst footballer I have ever seen in my life. You better hop it back to Australia and I don't want to ever see you again'.

"So I did what you do in these situations and I burst into tears, you know, and all the other lads went 'Wow'. Anyway, he said: 'You're not even going to play the second half', so I got my boots and I went home and then I was psyching myself up because I have to tell my mum.

"So I got back to the digs, dumped my stuff and back then – this is 1975, even making a phone call to Australia is difficult – so it was reverse charges, and mum got on the phone and said: 'Craig, Craig, how was your big trial? How did Jack Charlton like you?'

"And I said: 'Mum, he said I am one of the finest footballers he's ever seen and he wants me to stay'. And I hung up. And I burst into tears again. So what I'm saying is, you should never tell lies, especially to your mum, but there's nothing else I could do. There's no way I could say, you know, 'I've just blown it'. And, you know, the most interesting thing about the story is that Jack Charlton wasn't wrong, I was actually that bad."

Gilroy: "Now I think that's really interesting because I think from that moment we begin to see some sort of pattern emerge from your approach, not just to football but to the idea of creation and innovation which I think we're going to see replicated when you tell us how the Predator boot actually comes into being. How you rescue this situation is like a massive turning point in your life. What exactly did you do?"

Johnston: "Well, you know, I did the only thing that I could do. You know there I was, just 15, stuck in a cold place where I wasn't supposed to be."

"A couple of the professionals there actually heard about what happened to me and they said: 'Well look, you need somewhere to stay, if you clean my boots and my car I'll give you some money'. And then I could actually pay to stay in the board and lodgings. Then what I did. I would clean the players' boots for the professionals and do the jobs the apprentices didn't want to do for money. So then I could actually feed myself and I had somewhere to stay."

"So, the interesting part of this is when all of that was done I would then actually go and spend three or four hours a night by the street lights in a car park that was next to Ayresome Park in Middlesbrough."

"The fact is that if Jack Charlton says: 'You can't play football', you say: 'OK, what is football?' Well the fact was – some of you kids will appreciate this – I couldn't dribble, I couldn't pass, I couldn't control the ball, I couldn't shoot. But boy could I run. And boy did I try hard. So that's what I had."

"So then I thought, 'OK, I've got a problem. How do I get some skill?' So I would watch the players and the reserves train and I'd say: 'OK, that's how you pass the ball. OK, that's how you dribble'. So in this car park I set up skill drills as I called them and then I had, if you like, jobs to do every day. You know you have homework, maths and science and all that stuff, well I had soccer homework."

"And I created this thing where I would mark myself out of 10 at how good I was and then I painted a goal on the brick wall and I painted crosses in the corner and I would have to hit each one 20 times with my left foot, 20 times with my right foot, before I could move on."

"And if I concentrated, that exercise would take me about an hour. If I didn't concentrate I'd be there for two hours. Then I'd move on to dribbling and I got garbage cans and I put them 18

yards long, two yards apart, nine of them, then I would dribble around them left foot, right foot, and if I hit them it wouldn't count, I'd have to go back to the start. Again you have to concentrate. Again if I did it correctly it would take me an hour.

"So, yes, I was spending four and five hours a day in a car park with a soccer ball, but you know what? In a wink, that's five fives are twenty five, at least twenty five to thirty hours a week in a soccer park, left foot, right foot, OK, over a month that's four thirties, what's that?"

Gilroy: "120."

Johnston: "So all of a sudden when the ball came to me I could control it and one or two apprentices, that also wanted to be recruited, came out with me and we would have games against each other, then we'd start passing the ball.

"And all of a sudden, you know, if you spend that long doing something, it starts to gel. And that basically is what happened. And everyone used to call me, right, and say: 'Jack Charlton's coming', so I used to hide behind the cars in the car park. And he used to come in late and leave early and everybody knew that Big Jack was coming and I had to hide, the kangaroo has to hide. That's what I did for a year and a half."

Gilroy: "It was incredible hard work and a real dedication and success, ultimately, against the odds.

"But I think one of the key things was understanding that here was something that if you spent time with it you were going to be able to understand and control and develop an appreciation of. And that in turn means that you got to understand exactly what the football was about and I think maybe you might have had an obsession with the football and it's a lifelong thing with you."

Johnston: "Ger, you're bang on the money. It was an obsession for the football and the fact that the football didn't like me and wouldn't do what I asked it to do.

"And have you ever seen the shape of a football? It is a perfect object that is designed to roll away from you. And your foot is shaped that way [makes an arc in an n-shape] and the ball is shaped this way [makes an arc in a u-shape] – they're opposites, so the frustration was other people could control the ball and manipulate it and I couldn't. So I was obsessed.

"And I came to this realisation one day, in the deepest, darkest middle of winter when it was freezing and all the apprentices were in the digs, eating beans on toast, watching Coronation Street in front of the fire and four hours later, here's the idiot kangaroo, drenching wet, counting up and giving himself marks for how good he was for that day. It sort of impressed me that the football is a perfect object and it doesn't make mistakes. The person using it makes the mistakes and the more you use it, the less mistakes you make.

"So it was that realisation that made me say: 'Well, hang on a sec, I feel like I'm wasting my time here, but if I can be a better player tonight than I was this morning when I woke up, then I've won, and if I can do that every day... '

"So therefore I set about a target for the skills and actually I did get better on a daily basis. I'm not sure that the kids these days think about their game like that, but that's what I did.

"And you're right; I'm fascinated by the football. But you know what? So is Thierry Henry. So is Wayne Rooney. So is David Beckham. Football for me is about a man's or a woman's or a kid's relationship with that perfect object. Because the beautiful thing about the ball, it doesn't change.

"Funnily enough, I've got one here. Look at that, look at that. So that believe it or not –you can call it a football, but it's actually a truncated isohedron. It is. That's the scientific term for it. It has 32 panels, OK? Does anybody know how many of them are hexagons? No? How many?"

Audience member: "All of them?"

Johnston: "Not all of them. Twenty are hexagons, which have got six sides and 12 are pentagons, which have got five sides. So, does anybody know how many stitches are in the ball? 720. So that's the scientific term, and, of course, the isohedron is not round. It's actually got square faces. It's the butyl bladder that, when expanded, makes it a ball.

"But when you think about it, I know lots and lots of Irish people that cross the Irish Sea every week to see Man United, Liverpool, Chelsea, whoever – Aston Villa some of them [points at Gilroy]. He supports Aston Villa. That's got to say something about a person!

Gilroy: "It's Paul McGrath's fault."

Johnston: "Paul McGrath. Now there's a man, Paul McGrath. So my point is we're all fascinated by the football. Who played on the weekend? Was it Arsenal and Man United?"

Gilroy: "About 10 days ago."

Johnston: "10 days ago. So that's what they were fighting over. When you think about it, those 22 players on the field, plus the subs, were fighting so they could get this ball, this object, then manipulate it in a particular way and put the ball through that goal.

"Anybody know what the dimensions of a goal are? Sorry? [Muffled words from the audience] Eight? Almost right, almost right. It's eight foot tall by eight yards wide. Eight by eight, imperial measurement. And of course, that's standardised all over the world."

Gilroy: "That's the thing about it; the standardisation of the sport allows the appliance of your ideas from that car park in Middlesbrough to be the basis of one of the most successful football boots in the history of the game."

Johnston: "The most successful."

Gilroy: "The most successful."

[The Science Behind the Football Boot – Part 2](#)

Ger Gilroy: "Not that many kids, maybe, would go through that process of being in the car park. It reminded me of two people in particular – Johnny Wilkinson and David Beckham before he became the celebrity icon.

"When he was just a young footballer he used to spend hours practising his free kicks and Johnny Wilkinson tells almost the same story, you know, left foot, right foot, left foot, right foot, marking a system in his head. And it's kind of ironic that both of those ended up wearing your football boot.

"And I just want to understand exactly how that circle gets squared? How does the football boot come into being? When do you start thinking, you know: 'I've used my body and my brain as much as I can, but my football boots, they could get better.' When did you start thinking like that?"

Craig Johnston: "Well, funny enough, we didn't do the part, and maybe we should, about going to Liverpool. And maybe we'll do that a bit later. But when I retired, I said to Liverpool I would never play football again. My sister got very sick when I was 27 and basically I had to go back to Australia and look after her. So I had to retire early. And I said I would never play football again. And I never did. And I never wanted to be involved in football again.

"Then, funny enough, minding my own business in Australia, some kids rock up to the front door, ball under the arm, and reminded me of my skateboard story. They said: 'Mr Johnston, we're the local soccer team, but we're not very good. Can you come and coach us?'

"And I said: 'Well, how not very good are you?' And I went down and saw them play and I soon found out they were dreadful, which again reminded me of myself when I was young. So that was it. I was back in football.

"I was coaching them one day and I was actually saying to them: 'This is how you swerve a ball'. And in order to swerve a ball you have to get grip on the ball and you have to give it

effect, like a table tennis bat with a ping pong ball. And they said: 'That's fine Mr Johnston, but it's raining and our boots are made of leather not rubber and they're all slippery. That's why we can't swerve it'. And I went: 'Oh, they're right'.

"So when training was over, I rushed home and I pulled the tape off the tennis bat and I stuck it on my boot and tied it up with gaffer tape, went back out onto the road and kicked the ball. There was this dreadful squeal, like a pig and it was the rubber engaging on the ball and cutting through the water. And I thought: 'What a great idea'. "And I got a patent on it and started designing different shapes and remembered when I was in the car park and I wanted to bend a ball. We all know how to bend a ball, or do we? Well there's a science, believe it or not, behind bending a ball.

"Beckham's goal against Greece that got England into the 2002 World Cup finals been analysed time and time again. He was wearing Predators by the way. It's been advertised, and now it's sexy, but when I was doing it nobody had looked at the mathematics of what a swerve is.

"So just to answer your question about how does a soccer player then start designing soccer boots? Well, once I had the idea and the patent and the designs, I actually said: 'I need to take this to an Adidas, or a Reebok, or a Nike, because I've spent a lot of money on this.' I mean a real lot of money.

"At the time, because I've got a really weird mind and I think of strange things, believe it or not I had a television show. That was going really well. It was called 'The Main Event'. And actually it was on here, it was on in Ireland as well. It was called 'The Main Event' and the host was a guy called Chris Tarrant, you know, he went on and he did, what was it called?"

Gilroy: 'Who Wants To Be A Millionaire?'

Johnston: "Yes. Yes, but he actually was the host of the programme ['The Main Event']. That actually made a lot of money. And that money I took and I spent on the boots. And when I talked to Adidas they said: 'We like the idea, but it will never work'. I took it to Nike. I took it to Reebok. And they all said it will never work. And then I remembered when my teacher said: 'Well, you're not very good at soccer,' and my dad said it and Jack Charlton said it. And I thought: 'Right, I'm going to prove that it works'.

"So I went to Germany, and I went and I looked up Franz Beckenbauer, who was a very famous German player, right, for Bayern Munich, and I said: 'Please Mr Beckenbauer, my career and my life depends on this. I've got these new soccer shoes, can you please try them on, OK, and give the ball a kick?'

"It was in January, in Munich. It was about minus 15 degrees, and snowing. So himself and his coaching staff Karl-Heinz Rummenigge and Paul Breitner, the three of them put the shoes on and started kicking, and said something. And I had a camera, because I'm a mad camera freak, and I filmed what they said, and I had no idea what they said, because they're very particular, German people, when they're talking about something like this.

"So then I took that tape, I went back to Adidas and said: 'Remember me, Australian guy, you've never heard of me, blah blah blah, but I've got this tape for you,' at a board meeting. They looked at the tape, they all went, 'What?' and they all stood up and started clapping like this, 'Yes, yes!'

"They said we've got to do a deal immediately. And I said: 'What did they say? What did they say?' And they said: 'Never mind what they said, we have to do a deal'. And to this day, they've never given me the tape back and they never told me what they [Beckenbauer, Rummenigge and Breitner] said. But they [Adidas] said: 'How much did this cost you to develop?' I said: 'Half a million dollars'. They said: 'We'll give it to you straight away, before you leave. But don't go anywhere else'.

Gilroy: "Tell me about the science of the football boot then, because it's one of those things where there must have been a lot of cynicism and scepticism about: here's someone who thinks they know better than a hundred years of footballing tradition. It's hard to overcome that sometimes."

Johnston: "Well, this was the point. They just didn't believe me. At that stage, I called it the Super Boot – it was never called The Predator [when it was in development]. It had studs, special studs that are now called traction. Have you heard of traction? Well that was my invention too. And the upper was this table tennis bat material. So I took 'Das Super Boot', as it was called in German, and I said: 'That's it, the upper and the lower,' because, you know, studs need redefining as well.

"I said: 'But what we've got to do is prove to people that it's a better shoe, that it swerves the ball more, that when you kick it you can kick the ball faster and further and when you touch it you can feel the ball better'. So that was basically the scientific evidence that I was talking about.

"This is me talking to Adidas now, because I'm now a part of them. I said: 'To sell this, we need to take the human element away'. They said: 'Well, what do you mean?' I said: 'We have to create a robotic leg that actually kicks the ball on the inside, on the outside and replicates the human movement. Then we have to try different types of rubbers, polyurethanes and different types of grooves and all that stuff.'"

Gilroy: "Did you know about all this stuff before you started doing it or was it like just this massive learning experience curve, 'I need to make this better. I need to get information on how to make it better?'"

Johnston: "You know what? It was all of those things. I didn't know it then but I know it now. What I was doing, we were doing, was trying to quantify and analyse the kick of the ball. It's about the mathematical equation and reverse engineering it so that we can get the best rubbers and the best materials."

"If you want to swerve a ball like that [makes spiral motion] you have to grip it and spin it like that. And the spinning through the air, if you think about it, there's air rushing this way [towards him]. All you see is the ball going through the air but really it's hitting this force. So as it spins it creates high pressure and low pressure as it's going forward."

"This side [outside] because it's spinning is hitting this wall here [outside front] but this side [inside] is spinning the same way as the air is coming so there's high pressure [outside] and low pressure [inside] and that's why the ball starts to move [swerve]."

"You know an airplane has got a flat bottom on the wing and a curve like that and the air has to go over there and flit that way which creates lift? So it's exactly the same as an airplane wing. When you kick the ball and swerve the kick, that's why the ball goes like that [curls in]. So it's high and low pressure and it goes like that."

"And what we did was look through the research and this effect is called the Magnus Effect. And it was called after a German physicist years ago who was looking at why bullets in the World War would go astray because they were spinning and the same principle works for anything spinning through the air."

"And I'll tell you what the other interesting thing is. Have you ever tried to swerve a ball into the wind? You have. And you see it's much better when you swerve it into the wind, it bends twice as much whereas if you swerve it and the wind is blowing from behind you it swerves half as much. Have you ever noticed that? And that's because there's more wind coming this way [towards him]."

"There is an optimum way to swerve the ball. Put up your hands if you saw the David Beckham goal against Greece in 2001. Great, great. OK, so I'll propose to you now, that goal put England through to the World Cup. I just realised that you may not be happy about that. The English were delirious. I personally was extremely happy because he was wearing The Predator."

Gilroy: "It didn't end very well for him but..."

Johnston: "Yes well at least they got there. Just think about the mathematics if I'm David Beckham. The back of the wall there is how far away he was from the goal. Then he had to get the ball up and over the wall standing there. He had to calculate which way the wind was blowing and at what speed. He had to then look at the ball and say: 'What part of my foot do I put on what part of this ball?' in a millisecond. He has a millisecond to transfer. Just think about what the guy is doing, right, calculating this maths. 'Is it there? And if it is there it will have lift and drag like that. Is it there? It will have topspin and much more speed but it won't get over the wall. And what part of my foot? The inside? The outside? And how am I leaning? And what effect will the follow-through have on the way the ball behaves in the air?'

"And by the way, you have a goalkeeper there calculating the maths the other way: 'OK, I know David Beckham. I know he is a free kick expert. I know he's going to do this and that. I know the wind is coming'.

"Believe it or not, this is all going through a player's mind. Ask them to explain it, they can't. But Beckham will do that seven out of 10 times. To say he's a scientist or a genius mathematician – well he actually is, there's no denying it. And this was the fascination for us then."

Gilroy: "To be able to measure what goes on in his head, you kind of have to remove him from the equation to see the impact of the football boot. To take this back to the lab you mean?"

Johnston: "We were backwards and forwards to players, trying to actually talk to them in these terms, trying to get them to understand. But they talk about feeling, and for most people the feeling is the thing that really speaks to them at the end of the day.

"Our task was basically to look at the science of a kick and reverse engineer it because we wanted the best materials and the best geometry. And it was a process and procedure which I actually created called 'vast'. I call it 'vast technology'.

"The weird thing is when goalkeepers complain. Did you see the last World Cup in Germany? Did you see how the goalkeepers were struggling with the power of the ball? That was actually the velocity of the ball. And that's because they used a different football. It wasn't this one, which is your classic World Cup football for the last 80 years. It actually had different panels on it.

"And basically, do you know that a football never, ever accelerates? From the moment it leaves your foot, it's decelerating and because it was going like this [up and down] the players have understood that if you put less spin on the ball and hit it cleanly, then it goes straight through and it creates a laminent flow versus a turbulent flow. Swerve creates turbulence, which creates pressure, but a laminent flow has pockets where it goes like this [up and down] and the keepers are disorientated.

"The other reason it was going like that [up and down] was because you see those panels? Yes, the 32 panels. Well there were only six panels on the ball [for the 2006 World Cup finals], so therefore there was less drag because the drag is created by the corner pockets."

Gilroy: "And presumably the very best players, the elite players, can still do different things with the ball that they would always have been capable of doing. That marked difference is still there?"

Johnston: "Yes, well it always will be. Pros are pros and they've got a magic. And I've talked about how you can improve yourself but there's no doubt players like Thierry Henry and Wayne Rooney have a magic that's a gift. No matter how hard you try, some of the things they do with the football... you just think about again – what's going through their head to actually calculate how to play football."

[The Science Behind the Football Boot – Part 3](#)

Audience member: "Can I ask a question?"

Ger Gilroy: "Yes, absolutely."

Audience member: "Could you explain a little about what happened, how did you get out of the car park and onto the pitch in Middlesbrough?"

Craig Johnston: "Well, again it was a defining moment. John Neal had been at the club, I don't know, six months. And when he got there he said, 'Who's the idiot in the car park?' And they said, 'Ah that's the Aussie bloke, the kangaroo, or Roo for short.' And he said, 'Well is he any good?' And they said, 'No, he's crap.' So still, after a year and a half, I was still the boot cleaner. And he said, 'OK, fair enough,' so I spent another couple of months there.

"And then one day, it was towards Christmas, and of course all the people in the digs go home for Christmas, the Irish go home, the Scots go home and blah blah blah. And basically I couldn't go home because I couldn't afford it still. And the team was short for a reserve game. It was Whitby, Whitby Town away. And they were going to forfeit the match to Whitby because they didn't have enough players. And they said, 'Well, what about the kangaroo?'

"And the funny thing is, and I was talking to the kids before about dribbling, kicking, passing, shooting. And I thought, 'A currency in football...', again my own conclusion, '...is about goals. I have to be able to score.' So, I'd set up this elaborate routine where I'd chip the ball onto the crossbar, and because it was cement, as it bounced back I would volley at one of the crosses. And then it would come off and then I would control it. And then I would shoot. So I had a

chip, a volley and a cross. So I had done this for months. And remember when you're kids, everyone goes, 'It's Johnny Giles on the ball, beats one, beats two, chips, aw, shot, aw, crossbar, aw, brilliant. This guy's unbelievable.' Well, I would pretend that I was Georgie Best or Billy Bremner or Johnny Giles.

"So anyway, I played in this game and they didn't know what my name was. So at number seven on the reserve team sheet, I've got it at home, was 'The Roo', short for kangaroo. They still didn't know my name. Anyway, we beat them three nil. I scored a volley, a chip and a shot."

Audience member: "It often seems to be the case that what separates the really top player is speed of thought, speed of action, but speed of thought particularly. Were you conscious of that or did you have it innately yourself?"

Johnston: "I couldn't agree with you more. Some players actually think ahead of the game. Kevin Keegan once said it's eight tenths in your mind, and it is. It's all about speed of thought. And the speed of thought now, compared with my day, is much quicker.

"To be honest with you, I did look at it in quite a scientific way when I played. And I would have copious, copious amounts of coffee, up to twenty cups of coffee before a game because I had read in a journal that to have a mind like that actually helps you because if you're trying to kick the ball correctly and figure out what part of the foot to what part of the ball, and then somebody over here is trying to put his studs into your leg and up your backside, you've got to have a quick mind, otherwise you'll get hurt. So it's even small things like that that you have to think through.

"Again, there was a guy called George Whardol and he used to bring ballerina teachers in to teach certain players how to be more nimble on their foot and to think about, 'I know what I have to do next,' but to think about it before they do it. And football is all about muscle memory and the neurological pathways. I said that Beckham had a vision, 'There's the goal, here's the ball.' And there's a neurological pathway that says, 'I've got to connect that with that.' And the more you do it, the more that pathway gets cleared. And that's why you say, 'Practice makes perfect.' Beyond that you say, 'Perfect practice makes perfect.'

"For me football is all about speed of mind. And when you get these footballers that think in 3D, Glenn Hoddle was one of them, David Beckham certainly, I know he's got his detractors, right, but he thinks in 3D. Some people think in 2D, footballers. I personally thought in 1D, you know, one dimension; you know I'd get the job done. But these other players have a spatial mind. And this is what I'm actually quite fascinated by.

"And just on that while I'm talking about the mind, players like Beckham go into a purple patch or a sweet spot zone in their own mind and everything becomes extremely clam. And it

happened to me on very few occasions, but one of them was the FA Cup against Everton, where we won the double in 1986. And the second goal, you know, we quite often talk about it.

“Everton was such a good team then. And the week before we’d won the league at Chelsea. And there’s only two teams this century that had won the double. The double is League Championship and FA Cup in the same year. We were just about to do it. And the score was 1-1. And then the ball came to me at the edge of the box and it sat up and I swear, I absolutely swear, all of a sudden it went into slow motion. And I thought, ‘Hang on a second. Here’s the ball. There’s the goal. Keeper’s off his line. There’s the cop end, full of fifty thousand screaming Liverpool supporters, even though I couldn’t hear them, it went quiet. And you know how you can almost push the button pause on a video recorder? And it was like, really, really weird.

“And I remember I was thinking to myself, ‘You mean all I have to do for World Cup, FA Cup glory, is put the sweet spot here [inside of his foot] on the sweet spot there [the ball], like I’ve done fifty million times in the car park, then I’ll be remembered for ever more, by all Liverpool fans, by my parents watching on television?’ And it was that ridiculously slow. And I thought, ‘Well, yes, I better get on with it then.’ And I just went like that [kicks] and just in slow motion it went in.

“The moment it went past the keeper into the back of the net the place erupted, the noise came back and players were everywhere, all over me, ‘You’ve done it. You’ve done it.’ I said, ‘I’ve done it. I’ve done it. I’ve done it.’ And then I was screaming and shouting at the top of my voice, ‘I’ve done it. I’ve done it.’ But what I was really saying, the players couldn’t understand it, what I was saying, ‘I’ve done it,’ I didn’t really mean scoring the goal. I meant I’ve come the full arc, you know? Again that’s why it was emotional. That was the, ‘I’ve done it.’ And Ronnie Whelan, God bless him, every time I see him he says to me, ‘I’ve done it. I’ve done it.’”

Gilroy: “That’s a bit cruel from Ronnie Whelan.”

Johnston: “He’s a cruel man.”

Audience member: “Just wondering if you were to recommend a career to young people here would it be professional soccer or engineering?”

Johnston: “I’d actually say do both, because you can. Professional football is a very, very tough world. But you know what? Everything’s a tough world out there. Business is a tough world. Getting inventions up is a tough world. Just getting up in the morning and going to work these days is a tough world. Maybe I’m getting old but... everything’s tough. Everything’s tough. You need perseverance. That’s the thing I would say. Everybody will tell you you can’t do something but inside if you can feel something, ‘Yes, I can,’ then ultimately you will. And you know what? If you don’t, at least you’re a happy person because you tried your hardest.

"And let me tell you, I have seen so many footballers who have so much ability and talent, a gift from God, actually get washed aside and pushed aside because they think life's too easy and they're not prepared to work at it. Then I've seen so many footballers that were just in the middle, try so hard and become great footballers because they wanted it so badly. And I'm in the Jack Charlton category, who was lucky I had such a powerful engine and I could run all day. And I had the brains to actually create some systems and processes for myself so that I could get better on a daily basis.

"And you're right Ger, there's a link with everything. When it was really going bad and I'd lost all of my money on the Super Boot, I pulled on the car park experience and said, 'No, hang on a second, I've been here before when everybody said 'You're mad. You're crazy'.' And I think this day and age, life is tougher than we had it. I think we had it in a very, you know, it's very black and white and grey actually when we were growing up. But now, there's so many messages for kids, I think you have to have a real firm commitment to succeed in anything."

Audience member: "Thank you for the talk. I never knew anything about you until this week when I listened to the radio the other morning and I thought you were fantastic, so this has been a great pleasure for me to come here this evening. Loads of questions in my head so I hope number one that you may have written the book, I'm not sure, but if you haven't..."

Gilroy: "'Walk Alone' circa 1988."

Johnston: "Yes. Yes. Funnily enough, I did write a book. I've never read it, but I wrote it, because, you know, because it's a good story and it's a real and true story."

Audience member: "And your sister's accident or whatever happened that time when you were aged twenty-seven, was that a... obviously you gave up your soccer career, if you hadn't would you have continued to play on?"

Johnston: "Yes, certainly. Certainly. Fay never really recovered but we thought she would have, so my only regret is that Fay never recovered. But at the time the only thing that all of us in the family were thinking about was 'How do we get her better?' And the pressure was too much on my parents and after thirteen years - remember I was only supposed to go for the Christmas holidays - so after thirteen years and five League Championships, and FA Cup and European Cup, when your sister's on a life support machine, you can't go then and face a game of football or training with the same frame of mind. You've got to help. And I thought, and we all thought that Fay would get better and recover, and I might be able to come back to football. But Fay didn't recover and I didn't come back to football."

Audience member: "Sorry to hog this, just one last little question but did Jack Charlton ever acknowledge your success?"

Johnston: "You know what? Remember I told you about the 'Crippled Aussie kid, now FA Cup hero'? The quote from Jack Charlton was 'I always knew the kangaroo would make it.' So I saw him once when he was the manager of Newcastle, because funnily enough Bruce Springsteen was actually singing up there at Newcastle. So I ran into him and told him of my displeasure of the way he spoke to me as a youngster. And he said, 'Yes, but you were crap.' And I said, 'Yes, I know, I know, I know. But it was just the way you said it.' And he said, 'Well, you needed a kick up the arse man.'

"All right then, and funnily enough, his son, John Charlton, became a friend of mine. He was living in Australia. I've seen him several times since and in fact when Ireland was in the World Cup in 1990 in Italy and 1994 in America, I hung out with John quite a bit and got to know Jack a bit better and I just think he's a wonderful, inspirational coach. And I never said he was wrong with what he said, it was just the way he said it to a young kid was wrong and he'd get put in jail now for talking like that to anybody. But he's a clever man, and didn't he do well for you guys? So, all's well that ends well."

Gilroy: "Who's got the next question?"

Audience member: "Hello Craig. Can I just ask you about your thoughts on the metatarsal injuries that are prevalent today in soccer? What do you think about the present day boot, including your own? Does it need strengthening to protect, or what do you think?"

Johnston: "Well, I've got very strong views on this. Every time there's a competition of international importance, be it the European Championships or the World Cup, either Beckham or Rooney gets a major, major bone broken in their foot, and it's usually the metatarsal, as you've correctly identified. And always, the boot manufacturers come out and say, 'It's nothing to do with the boots.' And always I say, 'Rubbish! It's directly to do with the boots.' I mean, whose fault is it? The pie seller in the crowd? The centre forward that was nowhere near him?"

"It's the physics and the power that goes through both of the people, through their body, and now has come to a stage, and the misthought in the process is what you've said. People think that there's not enough protection in the boot. There's actually too much protection in the boot. And there's nowhere... like in our days boots were made of kangaroo leather or a synthetic, now they're made of stuff that doesn't give and the studs are too long and when they engage in the pitch, the pitches are too well maintained and also have a weave in them, so there's no release for the stud. So what you've got is these studs penetrating like that [claw shape directly downwards], you've got the metatarsal on top like that [at an angle on top of the studs], and when he goes to take his foot out of the turf, and turn the other direction, it doesn't give and the grip's too good. Because for fifteen years we've been trying to get better grip so that the players don't fall over, so something's got to give, and it's that bone.

"Hello! It's the football boots. The studs are too long. And has anyone ever figured out that it's always coming up to a big event? And you know why that is? It's because players have been playing on muddy pitches in the winter with long studs, and come the summer, right, the grounds dry up more and the studs are sticking more, so they should have a smaller stud on. So I've said many times, it's only a matter of time before a player actually sues a boot manufacturer for a badly designed product. And I will stand by that."

The Science Behind the Football Boot – Part 4

Audience member: "What was your favourite drill skill and why?"

Johnston: "Well, I called it 'The Georgie Best' because whenever you watch football, what's the bits you love the most? I hope that, you're probably the same as me, lots of people will say it's the bending free kick, but I love when a player gets the ball and he beats one and then he beats two and he knows exactly where he is and he knows where the ball is and he knows what he has to do next and it's magic. And that's what Georgie Best used to do.

"So I had this drill where I would get these, originally it was garbage cans and then I would put one, two, three, four like that and I would dribble around. But what I used to say was, 'Every time my foot moves, I have to touch the ball.' Do you know what I mean? So just to show you, this is a quick one. One, two, three and if you turn you'd have to turn like this. And every time you took a step, you'd have to touch the ball. So my thinking was that now the ball would never be out of your touch.

"Next time you see a footballer, watch that every third or fourth step he will touch a ball. And that's always when he loses control. Watch Thierry Henry, when he steps round people, he takes two steps for every touch. And again, my favourite skill drill was trying to be Maradona or Georgie Best or one of those guys. I highly recommend it."

Audience member: "Two questions. One, I've heard that Ronan O'Gara, when he gets his boots made for matches, he gets them a size too small so that he can have better feel for the touch and I wonder do soccer players do that and what you, how would you react to that? The second question, my son asked me to ask you, why do Adidas only make narrow boots? Because he can't fit into The Predators."

Johnston: "Well the two questions are linked. First of all, and I think I've said this tonight, a footballer's touch is fundamental. You can talk about all the science in the world and it will go in here [one ear] and out there [the other ear]. But if they feel they like something, that's what they'll go with. When I was an apprentice, even when I moved to Liverpool and I had

apprentices cleaning my boots, it was a done thing that you would give your new boots to the apprentices who had bigger feet than yours. You would give them your boots so that they could wear them in for you so that they'd get the blisters and not you. Honestly, honestly, honestly.

"And the other thing you'd do when you got new boots, you'd go and sit in the bath with them. You'd put your pair of boots on, with a pair of socks, maybe two pairs of socks and you'd sit in the bath. And that's because they love that feeling. And that's why kangaroo leather has been the preferred material for years and years because it's the softest kid leather. I personally have a thing against it because I'm Australian – killing those kangaroos!

"And the second thing is because if you've got a wide last, it's called, the boot moves around on the foot and that's what it is. And I've often said the same thing. Ladies' feet are smaller and there's an even skinnier last for ladies' feet. But I've often said to Adidas, 'You need to get a wider last.' That's the two answers."

Audience member: "Going back to the thing about the studs, would you think that studs are better than blades or mouldies or just wear mouldies sometimes or what would think?"

Johnston: "You're a soccer player, right? What would you think is the best?"

Audience member: "I don't know that's why I'm asking you. You're the expert."

Johnston: "You're not getting off that easily. Honestly what do you think is the best?"

Audience member: "I think it depends on what boot you wear."

Johnston: "Yes. Well, are you talking about the winter time or the summer, because there's a big difference."

Audience member: "Would you say to wear mouldies in the summer and blades in the winter or what?"

Johnston: "That's what most people do. But what do you do?"

Audience member: "I would do that usually."

Johnston: "You do that usually. Well, that's what I mean. So in the wet, you've got to have a stud or a blade but you can't have a mouldy, because a mouldy is basically for summer. Then beyond that, the blades are the traction sole that I actually invented, but these days what's happening is that they're too deep and they're causing more problems than they solve and it's gone away from the original concept."

"And I feel more and more that FIFA should actually go back to the old rounded studs and make them to a certain length, and beyond that you can't go. Because I think, we can talk about Beckham and Rooney's broken metatarsals, but we've also got kids up and down the country, change of season, are actually having injuries all the time on their ligaments and their cartilages because the studs are wrong. So I think the whole thing needs a real look at. I think the old steel stud that you used to get is probably the best way, you know the studs I'm talking about, even better than the blades or the traction, which I actually invented, and I'll say that most honestly."

Gilroy: "The story about the steel studs is actually really interesting. It was Adi Dassler, who formed Adidas in Germany, who invented them for the 1954 World Cup final when West Germany beat Ferenc Puskás's Hungary. And people credit that with being the difference between the two. It lashed rain in Berne the day of the final and they came back from two-nil down, no they were two-nil up and they actually sustained their effort in the last ten minutes when the Hungarians were completely exhausted."

"And the thing about that was Adidas built those shoes specifically for the German team. I was kind of interested in that. If you had given your Predator exclusively to Man United say, or Arsenal, or Real Madrid, or Germany, or England, or Australia it could have been the difference between one country winning the World Cup or one team being dominant, but you kind of decided that it was OK to share it with everybody."

Johnston: "Well actually it was suggested that Bayern Munich get them before anyone else. And that story about Adi Dassler is quite famous, to be honest, and it did make the difference. He did invent the screw-in studs and when it poured rain the German team had them and the other team didn't, they had moulded studs, exactly what you said, the right studs for the right conditions and they won the game. And the Adidas company was formed on the back of that. It was quite clever."

"I always remember the first time we had, I had spent years and a lot of money developing the Predator, and then Adidas, two or three years with them, a lot of money, a lot of hype. And we're all sitting in the canteen one night working back late and the news comes in: the first Predator goal has ever been scored. And we all start jumping up, 'Yay, the first Predator goal. Fantastic.' Then the news came through about ten minutes later and they actually said it was a header. Back to the drawing board. We were so excited, you know. Anyway..."

Gilroy: "Can I ask you now, with all this information and knowledge and love of football and obsession with the sport itself, what do you actually do with the information? Do you ever actually switch off from thinking, 'I can improve the football boot,' or 'I can improve the football' or..."

Johnston: "No. I know it sounds sad, but the answer is no. Women love shopping and love buying shoes, I love thinking about footballs and football boots. And I love taking photographs. I love coaching kids football because the lessons I learnt are so relevant. So I've tried to design and invent a whole bunch of stuff that matches the story but actually puts it in a really clever way, you know; here's the story. That's fine, we've heard the story, but here's how you get better on a daily basis. I did something really, really, I thought, clever and I divided the penalty box, which is eighteen yards by forty-four yards, a six yard box and a twelve yard... I turned it into a mathematical grid and then I looked at kids in an hour doing ten drills and, you know, one of these acronyms I developed, was distance-accuracy-time analysis for ten drills. Any kids know what that spells? Distance-accuracy-time analysis?"

Audience member: "DATA."

Johnston: "DATA, good man, good man. So that's what you actually do as you dribble. And again my friend over here said, I would do the Georgie Best, OK, eighteen yards long, nine poles, remember what I told you about garbage cans? Well, you use poles or cones and then you go left foot, right foot and you measure your... Distance is standardised. Accuracy: every time you hit a pole, you get five seconds more on your time. The analysis is 'How many mistakes did I make?' and 'How quickly did I do it?' So by running eighteen yards and swerving nine bollards, you've actually created your DATA for that particular skill, which is dribbling. Then you do it left foot, right foot.

"Now the interesting thing is that, then you get Wayne Rooney's DATA for exactly the same thing, or Beckham's or whoever, Ronaldo, Christian Ronaldo, and that was my big brainchild. When you're passing, shooting, dribbling, that's what I did at Middlesbrough. So believe it or not, I spent, I'd say much more than two million dollars on that project, which is called Super Skills. And for whatever reason, the FA, the Premier League, chose to not go ahead with it. And that actually was a DATA driver, because then a kid from the cradle to the grave, much like a golf handicap, you're playing against the course, and next weekend you want to beat yourself which is the thing I did years ago in Middlesbrough.

"You know, the interesting thing, that's why I'm a bit jaded. And yes, I've had some pretty successful products. I actually want to say on the record that I've had some products, projects, that have failed. And that one's failed and I don't know why. I'm not going to give in, I'm just letting it go quiet for a while. So to answer the question Ger, I wake up in the middle of the night; I have great ideas for football shoes and have to stop myself from going over to Germany and saying 'Look, here's this idea mate.'"

Gilroy: "But I think that's also really good advice, not to be afraid of making mistakes, not to be afraid of failing at any point, because you get back up, dust yourself down and go again."

Johnston: "Yes. Sometimes it hurts though. Sometimes it costs a lot of money."

Audience member: "Would you think that having the new studs is better than having no studs?"

Johnston: "Than having no studs? Definitely. Especially if you want to stand up on a wet pitch."

Audience member: "During the World Cup Jens Lehmann was complaining about his boots and he said he was going to maybe sue Adidas because of them, because Germany made him wear them instead of his normal Nike boots. Why was that?"

Johnston: "Because football is full of politics, and vested interests, and people being too greedy, and there's far too much money in the game. And it's one of the reasons I've sort of chosen not to be in it for a while. As I say, you know, it's strange when you can't wear your own football boots. I mean, what's the world coming to? Somebody says, 'You have to wear these boots.' It's sad. So did he wear them?"

Audience member: "He said he got injured and he missed the first few games of the season because of it."

Johnston: "Is that right? I didn't read that but it's typical."

Gilroy: "And now he's lost his place. And he's not getting it back any time soon."

Audience member: "How much does it actually cost to patent an invention?"

Johnston: "How much? You know, it costs a lot of money. It costs a lot of money and the lawyers are very clever because they say, 'Well, just do this bit' and when you've done that bit they say, 'Well, just do that bit' and 'If you just do this bit well blah, blah, blah.' So it starts off very small but before you know it you're up around one hundred thousand pounds or something. So you have to be very careful when you patent something. And the good thing about being online is that you can check what everyone else has patented that's done similar things. So before you do a patent, you do all of your homework and your research and you make sure you've got something brand new that nobody's ever done before. Otherwise it could be very expensive."

Gilroy: "I think we have time for one more final question. No pressure, this is the final question of the evening, make sure it's a good one."

Audience member: "What team did you originally support?"

Johnston: "What teams?"

Audience member: "No, what team did you originally support?"

Johnston: "Good question. Good question. I'm just about to alienate most of the audience here. Thanks for that mate. I was getting on well as well. Because I have to be honest. And apart from Brazil, the team when I was really young, we're talking about twelve, thirteen, fourteen, who was actually the best team in England, was actually Leeds United. I know, I know, I didn't ask the question. But I loved Johnny Giles and Billy Bremner, and Sniffer Clarke, and Peter Lorimer because he kicked the ball at seventy miles per hour, you know, he was my favourite because that was like, scientific. Seventy miles an hour. And Jack Charlton, funny enough, was a centre half. And they were my favourite team.

"A funny postscript to all that stuff I was saying before when Brian Clough and Bob Paisley called in the same week, so did Leeds United. So in fact, twelve Premier League clubs phoned or spoke to Middlesbrough and said, 'We want to buy the kangaroo.' And I've got that headline, there was a headline in the paper. Actually the headline was 'Take Your Pick: Twelve Clubs Want to Sign the Aussie.' So you've got one of my secrets from me there. I don't admit that very often. Especially in public.

"But can I just say again, I told you I lived here [in Ireland] for four and a half years. I had four and a half of the most creative years of my life and I loved it here. I loved the Irish way of life. I call you the 'European Aussies'. There's a definite connect there, going back to Ned Kelly and what have you. And again thanks to Discover Science & Engineering and Forfás and everybody for actually bringing me here. We had to fly from the States to be here. And like I said, probably now I know why I don't do any public speaking because it all comes back in a rush and it's difficult to do and I won't be doing it again in a hurry let me tell you. But I'm glad it was here in Dublin. By the way there's two people in the audience that worked with me here when I lived here, Gerry McGovern and Niall O'Sullivan, can you just tell me where you are guys? Just so I know. Two brilliant guys, with brilliant minds, who helped me with the football boot products and the butler, the minibar system. So thanks for turning up guys, I'd love to take you for a beer now if you're up for it. And I just wanted to say thanks to you as well Ger."

Gilroy: "I think we should probably show our appreciation. Guys that's great. Thanks very much. I hope you enjoy the rest of Science Week."

Johnston: "There's one last thing. There's a prize. This football. Even though it's not mine, I'm going to give it away. Sorry, this icosahedron, for the person that asked the best question. And the best question, she must have been listening because it was 'What's your favourite skill drill?' And that was that lovely lady over there."