



Prof. Danielle George

Interviewed by

Jane Bird

1st July 2021

Via Zoom

Copyright

Archives of IT

(Registered Charity 1164198)

Welcome to the Archives of Information Technology where we capture the past and inspire the future. It is Thursday, the 1st of July 2021, and we're talking on Zoom as has become customary during the Corona Virus Pandemic. I'm Jane Bird and I've been reporting on the IT industry for newspapers such as the Sunday Times and the Financial Times since the early 1980s. Our contributor today is Professor Danielle George, the current President of the Institute of Engineering and Technology. She is also Professor of Radio Frequency Engineering, and Associate Vice-President at the University of Manchester.

Professor George is not a mainstream IT person, but she is an outstanding role model for women in science and technology. She is an electronic engineer on the edge of telecoms, but really, radio, astronomy, and low-noise RF amplifiers. She is passionate about raising public awareness of the positive impact of engineering and science in all aspects of our lives and is a strong role model for women in STEM subjects.

[00:01:07]

Professor George, welcome.

[00:01:09]

Ah, thank you—thank you very much, Jane.

[00:01:11]

You're welcome, I'm very much looking forward to hearing more about your professional achievements and experiences. As a young female, you came to be such an eminent figure in the world of engineering and technology. So, if we can start, erm, you were born in Newcastle, er, in January 1976, and you were the middle child of 3 daughters, I think?

[00:01:34]

Yes, that's right.

[00:01:36]

So, and your father was a mechanic, and your mother a special needs teacher. So, what was it like, your...your fam... early family life?

[00:01:45]

Oh, it was great, yeah, full...full of... full of laughter and...and curiosity really. Erm, I was... I was always the...the child who was sort of asking why all the time. And my... both my sisters sort of did, but...but I sort of asked it a bit more, um, and...and it all...you know, my...my parents and...and my two sisters were always so brilliant with me, you know, sort of...thi...I don't know why, l...let's find out together, you know, and that...that was the...the fun and the curiosity part was...was very much a part of...of my childhood.

I remember once, um, I got into astronomy at quite a young age, about 8 years old, my parents bought me a...a telescope, um, just a...you know, a really optical telescope for Christmas and, um, I remember we used to—I used to love looking at, um, at the lunar eclipses, you know, the sort of moon eclipses and, um, I remember my, er, my family, including my two sisters as well, would wake up, you know and it would like 1 o'clock in the morning and we'd all go outside together and look at the eclipse and, um, and, it was just such a, um, such a supportive environment that we were all in, which was brilliant.

[00:03:00]

Yeah, yeah, and what about, erm, w...were they highly educated your parents, or not particularly?

[00:03:07]

No, not...not...not very much at all. My dad, erm, my dad...my mam more than my dad. So, my dad was a...a car mechanic, um, so, he had his...his own garage. So, it was very much hands-on, so, I guess maybe that's where my hands-on bit comes from. Erm, my...my mam went to Grammar school, er, and then, um, didn't work for...for years. Well, I say she didn't work, she sort of didn't get paid when she had 3 children, so, she was very, very hard working. Erm, but erm, but absolutely, you know, put her career aside to...to raise three children. She did an awful lot of

voluntary work in our schools where...where we were. And then, er, went back to, um, as we grew up, went...went back to her career in, um, in special needs. So, she was a...a special needs teacher.

[00:03:56]

Yeah, yeah, and what about your schooling, so, you went to the local comprehensive school, to...to the local schools and onto the local comprehensive. So, you didn't have the trauma of taking the 11 plus, I g...I guess?

[00:04:07]

No, I didn't, no, no. We—I went, um, I went to a first school and then a middle school, um, and then there was a...a high school, but that was a lot further out and by that time, I had made a lot of friends, sort of locally where we lived and erm, and I wanted to go to the...the local school, which was a comprehensive school. So, I went there, um, at...at 11. And er, and it was...it was huge, it was such a massive school, you know, I wasn't...I wasn't used to it, I had gone to a very small first school and a pretty small middle school, and then I went to this massive comprehensive school. Um, but I...I wouldn't change it for anything now.

[00:04:49]

You...you had a happy time, did you have, um, supportive teachers. I mean, y...you...you did A-Levels in maths, physics, and chemistry, so, it must have been, h...h...had at least, er, academically, been quite...quite strong?

[00:05:00]

Yes, it was, yeah, yeah, I mean, we had great teachers. I think, um, we—so...so quite a lot of my friends, they...they didn't sort of take the same subjects as me but they...they wanted to excel in...in the subjects that...that they had chosen. And...and we had really supportive teachers who...who didn't...didn't just sort of focus on the...the students that maybe needed more help, they...they also focused on that sort of higher end of student and really pushed us to...to do more than, erm, than maybe some...some of our other sort of peers did. So, they were very, very supportive.

[00:05:39]

Because in a comprehensive school that can be a problem can't it, as you say, it's not a high school, so, often the emphasis can be on those with, er, er, more in the middle of... middle of the road. So, you...you were able to fulfil your academic potential you felt then, did you?

[00:05:53]

Yes, I did, yeah, yeah. I think it really helped 'cause I had a...a maths teacher who, um, who had gone to...to university to study astrophysics and, um, and he knew that I was very much into astronomy, you know, as a...as a sort of a hobby and I...I liked...liked maths and I liked physics. And I remember one day, he...he showed me his books, his sort of textbooks from university and, um, and I was just filled with awe about, you know, what he was doing—a...with these...a... amazing equations and...and that really inspired me to...to sort of think, oh, a...astrophysics, yeah, that's the thing for me at university.

[00:06:32]

So, you went on... that...that's what you went on to study at university, astrophysics, and radio...and radio astronomy. W...which university did you go to?

[00:06:40]

Liverpool as an undergrad and then I came to Manchester to Jodrell...Jodrell Bank Observatory, which was part of, er, the Victoria University of Manchester, um, for my... for my master's, er, in radioastronomy, and then never really left.

[00:06:56]

No, no, so you...you... you went to the right place obviously, that...that was sort of ideal for your...your interests in the UK?

[00:07:04]

Yes, yeah, yeah, no, I was really...really happy with it, erm, and there wasn't that many places, as an undergrad who were doing astrophysics at the time, erm. I remember I had an...an unconditional offer from Edinburgh and...and from Liverpool, and I... I chose Liverpool. Erm, I think my parents would have wanted me

to...to choose Edinburgh—I don't know whether it was the sort of the prestige of the university or it was closer to Newcastle, um, but, um, but I...I chose Liverpool and...and never regretted it 'cause it...it's taken me on the path that I...that I am on now, so—

[00:07:39]

Yeah, yes. So, then, erm, you obviously decide...you...decided you were going to do a post-graduate, er, er, you did a PhD. So, had...had you right from, sort of being at university, did you immediately start to think this is where I...this is where I want to stay now?

[00:07:55]

No, I didn't, I sort of f...fell into it almost, um, because I hadn't really got a...a career plan other than, I loved doing what I was doing, I...I loved, erm, physics, I loved the practical side of physics, erm, the mechanics, erm, and...and maths. So, I knew something—it was going to be something about that, but I wasn't quite sure what. And...and at first, I went down the sort of traditional astrophysics route of more about the sort of the computing side in terms of reducing the data, so, it was very much sort of a...a data-driven, erm, environment when I was doing my... my MSc, my master's in radioastronomy. And then, I was like, oh, this isn't for me, I... I can't just sit at a computer and just do it; I need to be doing something with my hands as well. And, um, and so we...I started working with the engineers, erm, at...at the university out at Jodrell Bank Observatory, and um, and then we had to get sort of a special dispensation for me to do my project, my sort of dissertation project with the engineers rather than with the academics. And erm, and so, I did that because I really wanted to be hands-on, and I carried on doing that hands-on. A job came up as a junior engineer, just as I was finishing my master's and I thought, yeah, I'm going to do that 'cause I...I want to do more of the...the sort of hands-on.

So, I didn't go into academia straight away. It wasn't until I was sort of, um, I had become a senior engineer at...at Jodrell Bank Observatory and...and a lot of research work. I was working on a...a...an unmanned, er satellite—a spacecraft, um, project. And erm, and someone in the university was like, “Oh, hey, you...you know that's engineering, don't you, and...and it would be great to write that up as—for a PhD, in,

um, electronic engineering.” I was like, “Oh, no, I didn’t—I...I hadn’t really thought about you know, sort of a PhD and...and writing all this up, I just love doing my...my res...research, I love doing my work.” So, that’s what I did, I wrote it up as I was working.

[00:09:54]

Oh, wow.

[00:09:55]

Erm.

[00:09:55]

So, you... so, that was from 2003 to 2006, was it roughly, that you were doing those?

[00:10:01]

Yeah, yeah, yeah, and then in 2006, as I handed in my PhD, erm, and had my Viva, I had my job interview for a lectureship position, er, because it had just so happened that the department that I’m now, Electrical and Electronic Engineering were looking for a...erm, a lecturer. So, and someone said, “Why don’t you try?” I was like, “Yeah, okay, that sounds good” because I was looking for another role by then as well, you know, a new challenge. And er, I was very lucky, I...I got the job and then started down the academic track, never have taught before, so, it was...it was very interesting to sort of be sort of thrown into the teaching side, which I absolutely love, it gives you a different buzz, you know, y...y...you get an amazing buzz from...from your research and a completely different amazing buzz from...from teaching, especially first years, teaching first-year undergrads is brilliant.

[00:10:58]

Hmm. So, um, you...you never looked back, you’ve never thought, well, I want to go back into the normal working world, erm--?

[00:11:06]

No.

[00:11:06]

Or become an entrepreneur, or erm, er, anything like that?

[00:11:11]

No, no, I'm, er—I...I think what...what I love about my job is it's...it just keeps changing all the time, even though I'm sort of still with the University of Manchester, my role changes, the challenges change, the research challenge changes, the...the teaching, the type of students you have, change, you know. So, it's all...it's always changing and there is always something new and challenging so, I don't feel like I've got the same job that I had in 2006.

[00:11:36]

Hmm. So, how would you—just looking back over the years since then, how...how would you describe the sort of, er, evolution of that role and...and what the perhaps the obstacles and challenges have been along the way?

[00:11:48]

Hmm. So, I went from sort of—once I was on the academic track if you like, then...then I went from lecturer, senior lecturer, Reader, Prof, and, um, and there were...there were challenges in terms of I was...I was very young, um, er, a lot younger than most of my peers and I...I was female, there wasn't very many females, um, in, in our department, certainly not in my area, as well. So...so, I was—a...and I always wanted to sort of be, right I...I want the next challenge now, right, I've done that and...and that's really good. Now...now can I have a new challenge. And, um, I was very, very lucky that I had some excellent peers and an excellent, um, head of school at the time, er, and...and he didn't...he didn't see age as a barrier, you know it wasn't sort of a time-served, well, you haven't been here that long so you can't really take on a...a...another role, you can't, you know, take on a...a senior leadership-type role within...within the school. And so...so, I did, I took on, you know different roles, and then I got promoted and, um, and a lot of it was you know, self-driven, I was...I was always sort of very—I wanted that sort of next new challenge, but a big part of it was also, I did have support from my peers and from my head of school,

who didn't see age or... or perhaps gender, which some people did, I think at the time, um, as a barrier, which was good.

[00:13:21]

So, you haven't really come across that, erm, er, sort of sexist, um, barrier, er in terms of your career developing would you say, or, you have a bit?

[00:13:31]

Yeah, I have a bit, yeah, um, certainly, in...in academia, sort of within the university, I have a bit. When I was, um, doing some of my research with...with industry, I, um, I was sort of the...the senior project engineer from...from the university side when we were working with that—quite a...a big company in the UK. And...and every time we would have a meeting with them, they would always look at...at my colleague. So, I...I would ask a question, or say, this is what we're going to do and then they would look at my colleague, who was older and male, and they'd sort of say, "Oh, is that...is that what we're going to do, you know are you happy with that?" And thankfully, my colleague was all...would always say, "Well, Dan, what do you think 'cause you're leading this project?" and so, he would always sort of bring it back to me. And at first, I got really vexed about this, you know I was really, really angry about it and I thought right, okay, I can...I can either get really angry about it, this is not going to be the first time or the last time that it happens in...in my career. So, I can just get really bitter about it at...at a fairly young age, and then it's going to affect me, or I can do something a bit more positive about it. And so, I thought, right I'm...I'm just going to challenge the...the guy who said it or...or...or kept saying it all the time. And...and so, I said, "Look, do you realise that you're doing this?" and so, I walked through the scenarios of what he was saying. And he was like "Oh, my goodness, I...I'm so sorry I didn't realise that that's what I doing."

[00:15:02]

Yeah.

[00:15:02]

You know, and it was really nice because we then talked about it and he said, “Look, I...I work in this industry, it’s still very much male-dominated, white male, generally middle-aged dominated environment and I’m just not used to a young female engineer leading a project and I’m...I’m really, really sorry that...that... you know, I was like that to you. And I...and I felt really good about it then because I was like, okay, so, we’ve got over that. Um, and...and it was a positive thing and something that I kept with me as... you know, in my head, when it happened again and to be fair, it hasn’t happened very much at all. So...so, it was a good positive rather than thinking, oh, my goodness, I’m just going to be bitter about this for the rest of my life.

[00:15:47]

Yeah, and you weren’t asked to make the tea at least by the sound of it?

[00:15:52]

No, [laughs] thankfully, yeah. Although, there...there was always lots of jokes because my, um, my, er, my maiden name is Kettle so...so, I did have lots of tea comments-- but it was more about my maiden name than [laughs] than anything else.

[00:16:06]

Yes, that...that could be a problem. So, um, so, anything else you’d like to highlight, um, over...over your career in...in academia so far? I mean, obviously, as you are still so young, er, it’s not a—er, a lot of people on our database are, you know, octogenarians and so they’ve got a few more years under their belt.

[00:16:23]

[Laughs] Yes, I mean, I’m...like say, I’ve got you know, another... probably another 20 years, um, at least of my career so, um. But I haven’t really got a...a plan in terms of what...what I want to achieve going forward. Erm, I’m...I’m super happy with what I’ve achieved so far.

[00:16:43]

Mm-hmm.

[00:16:45]

And...and not quite having that plan has...has sort of worked for me so far, but just having that, I...I really want a new challenge and I really want to enjoy something when I'm doing it and if I don't, I need to change that somehow, to either make it more enjoyable or to change what I'm doing to find something that is enjoyable. So, hopefully, I'll keep on doing that.

[00:17:05]

You, you've stayed in the UK—I mean, not tempted to go, er, overseas to the US perhaps?

[00:17:12]

Yeah, so, I...I've worked quite a lot—so, astronomy—radio astronomy, which is my area of research is—is a very, erm, international sector, you know we...we work very collaboratively around the world, which is brilliant. And it's, um, allowed me to...to travel quite a lot in my...in my research and spend sort of prolonged periods of time in... in the US and in Australia especially. But I've sort of travelled a lot in China and...and other places as well. And, um, and I remember getting a...a job, um, sort of in...invitation to... to maybe have a job—not quite an interview or anything, in the US and in Australia and, um, I remember thinking, oh, could I...could I live in another country, would I want to do that in another country? And Australia was very appealing in many ways—the...the...the work was super-interesting, it was with the...Australia, um, National Telescope Facilities, um and that was really interesting, but...but I don't regret it. I...I did make the decision not to sort of go for the job or—and I don't regret it now, but it...that would have been the place. And I remember saying to my...to my mam, um, after I had sort of thought about it and thought, right, I'm not...I'm not gonna go for the job. And um, and like I say, my mam, when I was saying it to her, like, oh, this...this job in the...in Australia that I'm thinking about. And I could see her sort of welling up and thinking, oh, no, don't move to Australia, that's too far away. So...so, once I'd said, you know, I'm...I'm not...I'm not going to go for it, she was like, "Oh, thank goodness for that" you know, "It's so far away and we'd miss you—" da, da, da. So, er, she thinks Manchester is far enough to go from Newcastle [laughs].

[00:18:55]

Right, so, you see your future probably—I mean, there is Europe as well, I suppose, there's quite a lot of, er, of...of work, er, in astronomy in Europe too, isn't there? Would you--?

[00:19:04]

Yeah, there is, yes, yeah, yeah. And I think now—well, maybe not now, but pre...pre-pandemic, being able to...to travel to...to Europe, even in a day and back, or...or certainly, you just spend a couple of days, and...and come back, you can actually achieve quite a lot there. Er, we have a...a 6-year-old daughter, so, um, and she's been sort of schooled here, so, I wouldn't want to sort of disrupt that. But...but I don't...I don't really have any huge desire to...to work in...in another country. I love travelling, I love travelling for work and I love travelling, you know for...for pleasure, for holidays. But, um, but I'm very happy working in the UK—for now, at least.

[00:19:43]

Yeah. And have you—so, your—you...you now have quite a...a big teaching role presumably, um, are you teaching lots of—and a...a...are there lots of girls coming sort of, in your wake, has the... has the situation changed since you started?

[00:19:57]

Yeah, erm, I don't teach at the moment, just purely because I have quite a major senior leadership role in the university as the associate vice-president and being President of the Institute of Engineering and Technology for this year, was... I...is quite time-consuming as well. So...so, I'm not teaching at the moment, um, when I do teach, I teach first-year electronic circuit design, um, and I've also taught at the master's level, so, sort of either end, um, of first years and fourth years or...or master's level. Um, so—but I do...I do miss it, um, like I say, the...the challenge that you get from...from teaching is...is brilliant, it's such a wonderful experience. And I always say—you...you know, I always get in a sort of a fire in my belly when I'm teaching. So, just before I start teaching, er, you know, just before that lecture starts, I'm thinking right, this is what I want to get across today, er, but, you know, a...a...a question could come from left-field and you want to take that and not shut it down, you want to run with whatever questions they've got. And...and so, I always have a

fire in my belly and...and I've always said if I don't have that fire in my belly, I'd...I'd probably ask to stop teaching because I think it is really important to...to have that and to have that passion and that energy, for...for your subject when your teaching students.

[00:21:20]

Yeah, yeah, yeah—so, um, er, so, yes, you said, looking ahead, um, do you want to talk a bit about maybe what your l...l...life is like in terms of your responsibilities there now. Erm, is it...is it quite difficult, or, um, do you...do you feel on top of it?

[00:21:40]

Erm, I'm not quite sure if I feel on top of it, it's so much work, but...but, you know, that's the same for everyone, I guess. Erm, so, the majority of my work is as associate vice-president for...for blended and flexible learning. And you can imagine the amount of more blended and flexible learning has...has appeared in the past—you know, over the past year, 14 months. So, there is a lot of the sort of digital technology side that sits in my remit now and making sure that...that we have the digital technology to be able to teach, to be able to learn, um, to...to be able to sort of make sure that, no matter where a student is, or indeed a staff member is in the world, they can access, you know, synchronous activities as well as asynchronous activities, um. And making sure we've got platforms and people have the digital skills, so, their digitally literate as well, so, all of that sits in...in my remit.

[00:22:38]

Yeah.

[00:22:40]

Busy, but good.

[00:22:41]

Yeah, yeah. So, um, er, you...you're solving...er, or you... your research is involving, er, solving the... the ...one of the 14 problems isn't it, of, er, er,-- so, can you explain a little bit more what that is?

[00:22:57]

Yes, so, there are 14 world engineering grand challenges, um, and they are things like, um, reverse engineering the brain, um, engineering better medicines, and then, the one that I work hard on, which is engineering the tools of scientific discovery. So...so, there are, er, astronomers, astrophysicists around the world, who want to study the universe more, they want to understand our universe, so, it tells us a lot about, sort of, fundamental physics of the universe of our earth as well. And...and I help to design the instrumentation that allows them to do that, so, engineering those tools for those big scientific discoveries as well. So...so, I work on space-based and ground-based instrumentation. I develop what is called the low-noise amplifiers, so, if you image the... the signal that we're trying to attract, could be very, very far away in the universe, you know, and it's a tiny cosmic signal, a very weak signal. And so, what you want to do when you, um, when you receive that signal, is you want to amplify it, so, you want to m...m...make that signal bigger, um, but not anything else, you don't want to amplify any noise along the way, just the...just the signal.

And this is pretty hard to do, it's not like you can get sort of off-the-shelf ampli— amplifiers to...to do it. so, I erm, I and my team design amplifiers which are called monolithic microwave integrated circuits and they are, er, they are sort of between 1 and 2 millimetres square, as a...as an amplifier, so, they're tiny little things on different semi-conductor, er, erm, materials and, um, and we package them and then we cool them to about to, er, about 20 Kelvin, which is minus 253 degrees Celsius in a sort of a cryostat and then we put that on a telescope and that allows that tiny cosmic signal to be captured and then amplified as well, so, that the astronomers can then reduce all of their data and make their maps of the universe.

[00:25:06]

Okay, and is that t...you refer to your team—is that all over the world or are they all in Manchester or... who el...who else is in it?

[00:25:14]

They...they're from many areas of the world but they are in Manchester, um, or most of them are in Manchester at the moment. Erm, but we—so, this is the sort of research, sort of post-doctoral, so, they've already done their PhD and they're doing

their-- sort of research associates, and then PhD students as well. So, we have them from, er, South America, from China, Taiwan, the UK, um, we've had them from the US, Spain, Italy, er, Australia—you know, just—it's a very, very international team, which is great.

[00:25:51]

And is it an area where you feel the UK is a global leader or...or are we playing catch-up all the time? I mean, generally speaking, space is not some...something that's been seen as an area of big investment in the UK compared to some other countries?

[00:26:06]

Yeah, absolutely, yeah, which I think is...that's probably true for...for m...many countries now, which is why we work together a lot as well, so, they're big international collaborative, er, projects. Erm, in terms of the instrumentation, I would say we are...we are quite, um, advanced and work with the best people in the world with that as well. I think having places like Jodrell Bank observatory and the...the history that that has in terms of the pioneering aspect of...of Jodrell Bank has really helped, erm, and...and sort of opened different doors to different, er, different other observatories around the world that I now work with as well.

[00:26:54]

So, would you describe what you've done there so far as your proudest achievement or, erm, something else—what...what are you most...most proud of when you reflect?

[00:27:05]

Yeah, I don't know, I...it's—from a research point of view, working on a...an unmanned spacecraft that went to...um, to some...somewhere called Lagrange Point 2, er, which is, um, twice the distance we are from—the earth is from the sun, so, quite far away—um, to study the remnants of the Big Bang, something called the Cosmic Microwave Background, er, that was probably—I don't know because there are so many. That...that was sort of special, I guess, because it was one of the very first things that I worked on, and it was a huge, huge project between different space agencies around the world, that was really good, erm—

[00:27:49]

And when did you do that?

[00:27:51]

Er, that was around—oh, when was it? Early 2000s, er, when I was working at Jodrell Bank, er, so, pre...pre-PhD, um, and it was—yeah, it was a really great time but, I suppose, it...sort of your next challenge is always the...the interesting one, and, er, I'm working on two...two projects at the moment, one...one called ALMA, which is the Atacama Large Millimetre Array, er, which is a...a series of 66 dishes, so, 66 like, radio telescopes and they're working at super-high frequencies for radio astronomy, so, we're into the hundreds of gigahertz, um, so, we're sort of, trying to push—my...my team are trying to push semiconductor technology in the—up to terahertz levels and still get that low-noise, er, that...that astronomers need.

So...so—and that's just amazing different challenges. There is another one called the Square Kilometre Array, which is, um, which will be the...the largest facility—um, radio facility ever built. And it's in a remote area in South Africa and in Western Australia. And the idea is there are sort of, hundreds of thousands of these dishes or, you know, the old-fashioned sort of aerials, that you might have seen on...on top of roofs, on houses. And, um, and they're all connected across Western Australia and South Africa. And when they're all connected, they make a square kilometre's worth of collecting area. So, it's almost like having one giant dish that was a square kilometre's worth of collecting area, but instead, they're sort of spread out all over the place. And it's going to be 50 times more sensitive than any other radio instrument ever built. Erm, we're still building it, we're building 10% of it at the moment, um, but it's still—it's already sort of opening new windows to...to the universe, um, and you know, making new discoveries. Er, and that's at the lower end of the frequency scale, so, that's more sort of 70 megahertz up to about 20 gigahertz. So, um, so, I have some great challenges on that, b...because of the scale of it, you know, all of the engineers and the scientists working on this, the amount of data that the data scientists and the data engineers are...are having to deal with are...is amazing. You know, when...when the whole thing's built, it's estimated that some, um, of the, er, some of

the collecting areas, some of the dipoles or the dishes, would...would collect more than 10 times the global internet traffic, every single day, so, it's—yeah—it's huge.

[00:30:33]

Yeah, so, yeah—so...so when people say, er, er, er, I s...suppose they sometimes do why...why sort of spend so much foc...time focusing, um, money and tech...technical expertise and so on looking out into space, rather than...than solving so many of the real problems we have, you know, in the immediate—you know, our immediate vicinity in the world—what...what would be your answer to that?

[00:30:54]

Yeah, I get asked it loads actually, you know, when I...when I do public talks. So, you know, just chat to people, they're like, why...why bother? Erm, and I remember being asked it once in a...in quite a big public talk and, um, and at first, I was sort of...I was quite defensive about it, you know, like, well, um, well, we...we—you know, er, there's loads of technology transfer and things that are developed in, for...for radio astronomy or to...to look at the universe then get used for other things and vice-versa, you know, there's, um, er, x-rays and telescopes from...from naval and there's Velcro, and there's this, you know, and started...I started rambling all about it. And then, and I was a bit like—no, actually, one of the reasons is because what makes us humans, is our curiosity, and we should be curious about the world around us. And...and that should include solving the many challenges that we have here on earth. But also, looking further than those horizons and seeing what else is...is out there and being curious about that.

[00:32:09]

Mmm, absolutely. So, you...you're happy about the idea of being a role model, are you and going out and evangelising for the subject?

[00:32:16]

[Laughs] Yeah, it's, um, it's a...it's a funny—I mean there's...there's loads of amazing role models out there and it...it's lovely to see more and more female role models, which I think is r...really important, for boys and girls, it's not just role models for girls, you know, we need to have role models—female role models for

boys as well. Um, I think...I think what it...what it's done for me sometimes is I'm...I'm very, very critical of myself anyway in terms of what I've done and making sure it's the best I can do. When you then put yourself out there as...as someone who...who doesn't mind talking about the challenges they've faced or, you know, what...what you do as an engineer, or, and there are some people who just say, well, I don't like that—I don't like what you do, or, well, that's not interesting, you know, and...and are very critical about it. And, um, and at first, I...I found that very difficult to deal with, um, when people were sometimes just not very nice, for...for whatever reason. You know, you see sort of these Twitter trolls or someone like that and you can be trolled by Twitter by people.

[00:33:26]

Have you had that problem?

[00:33:29]

Yeah, yeah. Not very often thankfully, but...but yes, um, and you...you just have to eventually, just take it as, okay, well, that's one person and there is—like all these people over here, you know you're hopefully making a difference to them and they're...you know, they're getting back to you and want you to...to help them with their career or, you know, mentor them or coach them or whatever—why do you—why does that one stick in your head, why doesn't the hundreds over here stick in your head? So...so, that is sort of a...a continual battle for me, just to make sure that troll ones, which are definitely a minority, aren't the ones that stick in my head and make the nice ones stick in my head if I can. I haven't quite mastered that yet though.

[00:34:13]

So, and...and what about money, I mean, have you, er, er, with so much technical skill, er, you could have chosen to—well, I mentioned venture capital and starting a business and so on earlier on. I mean, has...has money...h...has...has doing this made you rich or do you think it could make you rich, or is that absolutely not of any interest?

[00:34:33]

Erm, it's...it's not been a driver at all, erm, I've never thought about getting rich from...from what I do. I...I love what I do and...and I think...think I'm paid very well to do it, so, that's not—never been sort of, an issue. Erm, so...so, yeah, money has never been a driver for me. I think it will be interesting, and maybe this...this might be something I'll go into, you know, in... in the future, is that sort of entrepreneur side and...and maybe helping tech start-ups or, you know, something like that, I think would be interesting. But...but certainly, money has never been a driver, but that might be because I've been very fortunate that my salary is good enough for...for my lifestyle.

[00:35:16]

And do you think the UK has what...what it needs in terms of infrastructure or the skills, or...or erm, you know, the...the expertise to...to...to become an entrepreneur in this area or...or is it likely to be left to big countries with deeper pockets and bigger budgets?

[00:35:34]

I think we're doing more and more innovation and having that sort of entrepreneurial spirit about it. I think, erm, in—so, what, I think we need to...to get a bit better than we do now, as a country is we have, these amazing sort of research facilities, um, many of them in universities. Erm, and...and the research that is coming out of them is just incredible, you know, ground-breaking in...in so many different areas. And then we have industry and their needs in industry over here. And...and we're not brilliant, we're getting a lot better, but we're not brilliant at sort of putting those two things together and...and sort of taking...taking some ideas that are at the low technology readiness levels, and...and pulling them up to...to a high readiness level, that...that will be ready for...for a product in the market, so to speak. So, I think we're doing a lot more of that, but...but we... I think we need to go a long way to...to...to be sort of competing with the US in that sort of entrepreneurial area.

[00:36:40]

Yeah, wh...wh...what, er, erm, can you sort of think or comment a little bit about the way that society is changing or has changed or may change in the future as...as a result of the sort of work you're involved in?

[00:36:54]

Er, well, work generally—I mean, not maybe specific to mine, but...but engineering and...and technology more generally. I mean, I think it's, we all fall into this trap I think, it's so easy for us to...to take for granted the...the great feats of engineering and technology that we all rely on every single day. And I think it's...it's ironic that...that engineering is everywhere, isn't it? But it...but it's invisible because it...it really is woven into the very fabric of...of everyday life. So...so, I think, you know, we need to...to make sure that we're celebrating the role of...of science and engineering and...and what that role is in society, and I think sort of showcasing things is really good. So, role models, showcasing people, showcasing the inventions is really important, um.

I think there has been some amazing achievements or...or contributions, er, i...i...in this country—obviously, globally, but in this country as well, you know, um, electricity, you know, AC power, the fridge, you know, things like that, of course, there are sort of s...space exploration and, you know, huge, huge, big sort of developments. The development of the internet, for example, you know, all of those things, but even just, the common everyday things that we all massively take for granted. Er, you know, if you take fridge and...and electricity, imagine the past year without those two things, you know, you've got electricity, which we're...we're all massively relying on, the sort of AC power generation, that allows us to be—all to be able to work from home. And the fridge has played such an important role in the pandemic and the rollout of the vac...vaccines as well.

Erm, I think, for...for me, one of the greatest inventions—and this is sort of sticking to my radio astronomy is the radio. Erm, I think it's...it's such a special and important invention and it...it was such a springboard for...for so much of our wireless communication as well, which is...you know, imagine the world without wireless communication now. I think it's—radio has actually transformed society a number of times and it, you know, gave birth to this massive field of electronics as

well. And...and I think it's um, it's thanks to its...sort of—it's got this amazing chameleon-like ability to...to adapt to...to market changes and...and to the cutting-edge technology developments and it...it makes it still so relevant globally today. So...so, that's...that's the one that I think is...is a huge achievement and a contribution in terms of industry and society and a one that is much closer to...to my heart from a...a radio astronomy point of view.

[00:39:30]

Yeah. And...and looking into your crystal ball, for the next 10 years, for example, erm, what do you think are the... going to be the biggest breakthroughs in...in your area?

[00:39:41]

I mean, I think—just...just think about what we've got now, you know, in terms of, um, social media and tablets and smartwatches, and virtual reality, and, you know, wireless headphones, electric cars, you know. They...they are all innovations from...from the past few decades, and...and it would be really interesting to think what...what the next decade is. I mean, I think the world will change in really fascinating and very unexpected ways as well and I think we...we all need to be active participants in that, and...and to help shape the future for...for the good of humanity, for the good of our planet as well. Erm, and I think one of the most important things that...that any engineer or scientist can do, is to help the next generation play their part as well. And that, for me, that starts with empowering our children to imagine a much bigger and brighter future and...and helping them understand that they are the ones that are going to be shaping this future and bringing it to reality as well.

Erm, from...from my point of view personally, I think one of the most important technologies of the future is going to be Artificial Intelligence, er, you know, AI is already sort of radically changing our...our everyday lives as well. It impacts, erm, the...the future of pretty much every industry and every human being on the planet and...and it will continue to act as a...a technological innovator for the foreseeable future I think. So, so AI is...will—

[00:41:11]

Because you think it will be---I mean, AI has been around for sort of several decades, in...in fact. So, you think it will move into new directions which we haven't even thought of yet, do you?

[00:41:20]

I...I do, yes, I think it's, um—it has been around for a long time. I think it's only—fairly recently, the past decade or so that...that we see it more—it's more sort of socially acceptable because it's more in our everyday lives. So, everybody, whether they know it or not, has Artificial Intelligence around them. And probably relies on it quite a lot. You know, even if you've just got a thermostat at home, that's a...that's a bit of Artificial Intelligence. But to get more and more intelligent and to...to start looking at, um, at the sort of future of, sort of HI, sort of the Human Intelligence and the Artificial Intelligence and how...how they might be combined in the future as well, I think is fascinating.

[00:42:05]

Mmm.

[00:42:05]

Especially when you think about sort of, space travel, er, you know, as...as humans, we are not sort of, biologically set up to...to travel in space. So, you know, there is an awful lot of technology that has to go behind us to be able to travel in space. Could we get to a point where, you know, we are...we evolve and, you know and there...there's this morphing of humans and Artificial Intelligence, and it's that—that then does the space exploration and it is that—that colonises other planets if that is what we want to do or...or explores other planets around the universe, not just in our solar system. I think it's a fascinating area.

[00:42:47]

You mean, h...having AI implants in our brain, that sort of thing?

[00:42:51]

Or maybe even that... but maybe even going to...to the ultimate where it...it is the...the brain, or the, you know, the focus and...and the whole rest of this body doesn't exist, you know. Do we...do we evolve in that way, um, and...and it's the sort of mind side of the humans that is the thing that...that travels, not the—

[00:43:16]

That...that's seriously futuristic, isn't it?

[00:43:20]

It is, oh yes, yeah, yeah, it is, yeah. But there are people working on it now, that...that's the fascinating thing I think about space and...and space exploration.

[00:43:28]

So, that people...people would literally cast aside this mortal coil as it were, our flesh and blood and, er, turn ourselves into computers so that we could go out there and conquer the universe?

[00:43:39]

Yeah, yeah, yeah.

[00:43:39]

That's quite a mind-blowing idea.

[00:43:42]

[Laughs] Yeah, but...but I think that's...that's what we need young people to be thinking about now, and saying, that—it's not possible now, but...but could it be possible in the future?

[00:43:52]

Mmm.

[00:43:53]

And...and do you want it in the future? You know, there is a whole...this—I think I in the past, we've kept sort of ethics and politics and technology, a...a bit separate and...and they're coming together a bit more now, which I think is a good thing. And just because we can do something from a...from a technology point of view, we do need to question is it the right thing, ethically, is it the right thing morally, is it the right thing politically, financially, etc? Erm, so, I think, you know, getting people to think about those—you know, the younger generation to think about all of those on the whole I think is a fascinating time for them.

[00:44:26]

Mmm. So, what would your advice to them be—young people who are thinking that they might want to have a career, er, in the world of engineering and technology?

[00:44:36]

I think it would be—tech--you know, technology has been improving our world and...and shaping our future for centuries, and...and I think we...we do forget that sometimes. But people have this idea that...that engineering is hard hats and, you know, it's a specific thing. It's the music you listen to, it's the phone in your hand, it's the clean water you drink. The other innovations that...you know, that are helping to...to restore our oceans. You know, engineering technology is at the heart of all of those things and...and they bring ideas to life, they turn dreams into reality, you know, they make solutions to...to big challenges possible. So, if you want a...a hugely rewarding career, there has never been a better time to join this profession, there is a huge demand for your skills.

[00:45:23]

And within that what would be the...the best preparation to, er, do physics, chemistry, and maths like you did or, erm, er, are there other ways in?

[00:45:33]

I think there are lots of ways in now, which is great. I think, you know, there...there was a time, certainly i...i...in sort of, my education where it was, you know, the 3 sciences and maths, or the 2 sciences and maths, whatever you wanted to do. I think it's...a...and to go to university, and that was the...the route. I think there are more

diverse routes now, which is great, people might want to study, you know, a language, with a science, or, um, or music, or, you know—all of these things can be engineering and technology. And I mean I...I know this is funny me saying this from...as an academic in a university, but I think it's great that there are other pathways that people can take to...to become an engineer, an, erm, a technologist, that onto, via university because I think it opens up the pool a lot more and...and that's what we need. We need people, we know there is an engineering shortage, an engineering skills shortage in the UK at the moment, um, and we know that there are not many women going into it. Er, it's better than it used to be but it's still 12%, so, it's not huge. So, um, so, sort of diversifying that, er, the output, hopefully, keeps more people in that pipeline and it's not as leaky because it's an extremely leaky pipeline at the moment.

[00:47:01]

Yeah, um, because people get seduced away by perhaps wanting to make lots of money doing banking or, er, astrophysicists quite commonly go into the city, I believe.

[00:47:13]

Yes, yeah.

[00:47:15]

That would be something you would presumably like to, er, well, correct the balance maybe.

[00:47:22]

Maybe correct the balance, I mean, then that's brilliant, you know, and I would...in a way, I would like to see more engineers in politics, 'cause I think it would be good to have scientists and engineers in...in sort of big roles in politics that actually understand engineering and science, I think that would be a very valuable thing for...for all of us. Erm, so, it's good, you know, I'm not saying that everybody should go straight into engineering technology if it's not their way. We do find a lot of people go into...into the city, into finance, um, quite a lot of it is because of the sort of financial remuneration side of it. But we find then that after a few years of...of

burning out there, they become, um, science teachers, or, you know, they then give back somehow in a different way.

[00:48:10]

That's good, that's good. So, what do you—yeah, so...so this 12% figure, um, of women entering...entering science and technology, that's...that's still not good enough, is it—why is that do you think?

[00:48:22]

Yeah, that's a great question. I wish...I wish somebody knew the answer, I wish I knew the answer, but I...I wish somebody did because, you know, we'd be able to change it. I think it...it's just—there isn't one thing, I think you know, we've...we've been in a... a society that for whatever reason hasn't...hasn't attracted or...or allowed technology and engineering to be attractive to...to girls, um, and some of that still is the image problem of the...the sort of boiler suits, hard hats, um, the sort of very heavy end—Which some people do and that is great because that is part of engineering, but some people don't too. Erm, and I think there's a...there's much more focus now, to get people to sort of think about the different areas of engineering and how...how diverse engineering is. Erm, and...and linking it with the...the global grand challenges, linking it with the sustainable development goals, I think is a really good thing.

There are so many of the sort of, um, generation Z, the Gen-Zs, who...who want to make a difference to...to their surroundings, whether that's climate change, sustainability, etc. And...and we, as engineers have to get that message out that, okay, if you want to do that, that's brilliant, here's all the jobs that you can do in the engineering, er, profession that will fulfil that for you—and get that out more. And...and that's...and if you want to be in fashion, and if you want to be in music, and if you—you know, all of the different sectors, if you want to do that and you're very practically-minded, and you know, you do love a bit of science as well as the textiles or the...or the music, whatever it is, here are a whole bunch of jobs that you can do in the engineering sector. So, it's just getting that message out a bit more as well.

[00:50:23]

And are you trying to do your bit to help there?

[00:50:27]

Yes, yeah, yeah, I...I'm very fortunate that I...I get to...to do quite a lot of public engagements, um, talks and...and I think probably the springboard for that was being asked to do the Royal Institution Christmas Lectures, erm, in 2014, that was an amazing springboard. I...I did some before that but...but not to the...the same level and after that, I got amazing chances to...to do some BBC documentaries, to...to do lots of public engagements—sort of activities, erm, from everything from sort of, the very big, you know, several thousand people, um, you know, talking to...to...several thousand people or even the sort of amazing pint of science ones that you do in...in a local pub, just talking to people about science and engineering in their local pub and...and everything in between, so...so, yeah, I feel I've been very lucky to be given that original sort of springboard. And...and that's something that massively changed my life. Erm, you know, I don't think there are many things that...that on a personal and a professional level can...can simultaneously sort of change your life and...and doing the Royal Institution Christmas lectures definitely did that for me.

[00:51:44]

Have people stopped you in the street, recognised you and, er, said--?

[00:51:48]

[Laughs] Yeah, that was funny as well, but yes, yeah, erm, but...but just being able to sort of think, um, I can...I can now use this as a...a really good way of getting the message out or helping to get that message out that...that science and engineering is...is just amazing. It's so much fun, when you're having fun, you are just steps away from solving the big engineering grand challenges that we all have.

[00:52:14]

Yeah, and, erm, so, that's what, er...th...th...that's...that's what you're going to be looking forward to doing over the...in...in the next sort of 10 or 15 years, is it?

[00:52:24]

Yes, yeah, yeah. I mean, I had a... and you know, I've got this year within the...erm, being President of the Institution of Engineering and Technology, you know, the on...only the second female, which hopefully, you know, that's gonna, hopefully, change a lot quicker in...in years to come. Erm, and...and having this...and it's our 150th anniversary as well, so, we had this amazing year, where we want to celebrate engineers of...of the past, the present, and the future. And...and celebrate what engineering and technology have done over the past 150 years and...and maybe look and see what is it that they're going to do in the next 150 years as well. So, again, a...a...a...an amazing platform just to be able to help spread that message in...in my presidency year as well.

[00:53:07]

Has that...has that been one of your goals, I mean, what have you been hoping to achieve during the year of your presidency?

[00:53:14]

Erm, the big thing I wanted to do was, um, was inspire the next generation about engineering technology in some of the ways that we've chatted about. And also, sort of come out of the...the engineering bubble a bit and show people, um, that...that engineering is everywhere. So, it is in fashion and music, and food, and you know, all of the other things. Erm, and...and have...have conversations about engineering and technology in unexpected places. I think, what...what we're sometimes very good at, is preaching to the converted, so, we...we talk to people who are already really interested in engineering and technology. And that, for sure is...is really important because you need to make sure you...you keep people's interest and, um, and help them with their career paths or with their questions, but also, get out of that bubble and...and talk to people who have never even thought about engineering and technology as a...as a possible career for them.

[00:54:12]

Mmmm.

[00:54:14]

And...and just expose people to all of the different, amazing, wonderful things that engineering and technology does, and say, you know, if...if that...if that interests you, there is probably a job for you somewhere in engineering and technology.

[00:54:27]

Yeah. And is there anything, er, when you finish that role, is there—what would you then like—is there anything looking...looking ahead that you would like to do and achieve?

[00:54:37]

Erm, I...I...again, I just used it to—like to use it as a springboard for...for something else, I'm not quite sure what yet, but erm, one of the things that...that we're...we're doing within the IET, um, is...is supporting, er, the Digital Poverty Alliance, so, we set up a...a Digital Poverty Alliance with, um, with a number of...of companies, and the Learning Foundation. And, um, and to set up and...and continue that, so, I...I'd really like to continue being involved in that and...and let's see where that...where that leads. If we can get more and more people involved and...and try and end digital poverty in the UK, I think that will be a huge achievement for...for the collaboration—for the alliance and I'd...and I'd like to play a part in that if I can.

[00:55:23]

So, erm, is there anything else you'd like to mention that we haven't covered?

[00:55:29]

Erm, no, I think that's pretty much covered. I mean, I guess from an...from an IT perspective, um, I was...I was, um, I don't know if this is going to go down very well with any of your listeners. But I was a Commodore 64 girl when I was young, so...so, that was, er, my first major route into...into, er, computing, er, was the Commodore 64. Er, and erm, and I do—I always have loved tinkering with, er, with computers, um, and...and that's from a hardware perspective, and sort of a...a software perspective as well. Erm, not a gamer, much more of a programmer th...than a gamer, um, but erm, but anything that involves tinkering, taking things

apart, putting them back together, working out how things work, then, er, I'll be interested in.

[00:56:16]

Do you think that young people today, because er, it's--you know, they've all got, I suppose smartphones, and PCs, it's not quite such a—much encouragement to them to sort of take...take the back off and understand how it works—as when you're learning to programme the basic Mac might perhaps have been.

[00:56:34]

Yes.

[00:56:34]

Erm, so, is that...is that a disadvantage to them or do you think they've just got loads more, er, opportunities?

[00:56:42]

Yeah, I think we went through this sort of dark ages time, erm, a few decades ago, where...where, you know, mobile were coming a bit more mainstream and everything seemed to be a bit...a bit of a black box, nobody sort of tinkered, there wasn't the sort of crystal radio set, so, things that...that maybe many of us had when we were younger. And erm, but I think we...we've really come out the other end of that now. I think things like Raspberry Pi's, Arduino's, they are...they are really massively making a difference to, erm, to...to young children's interest in computing and...and the skills that...that they need. So...so, it's really good that there are, you know, very affordable little boxes for...for people to...to tinker with like the Arduino's and the...and the Pis.

[00:57:28]

Well, okay, that's very interesting, let's leave it there, thank you very much, it's been great to talk to you, Professor George.

[00:57:35]

Lovely to talk to you, Jane, thank you so much