Prof. Tom Crick MBE

Interviewed by

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Via Zoom

Welcome to the archives of information technology. It's the 12th of April 2021 and we are recording this interview on Zoom. I am Elisabetta Mori an interviewer with Archives of IT. Today I will be talking to Professor Tom Crick. Thomas Crick is a professor of digital education and policy at Swansea University. His academic interests sit at the interface between research and policy. Some education and skills curriculum reform, data science, intelligent systems, smart infrastructure, cyber security, software sustainability, digital transformations, public service innovations, and skills infrastructure for the digital economy.

He is the Editor in Chief of the Computer Journal published by Oxford University Press. He is also an Editor of the Wales Journal of Education. He was appointed MBE in the 2017 Queen's birthday honours. In 2020 he was made a fellow of Learned Society of Wales. He is also a chartered fellow of the BCS and the IET, and a distinguished speaker and senior member of the ACM. He's a non-executive Director or Dwr Cymru, Welsh Water. Between 2017 and 2020 he was Vice President of the British Computer Society. Welcome Tom. So, let's start with the – where were you born?

[00:01:40]
So, I was born in Oxford in England in 1981, it feels like a long time ago now. So, I was born in the John Radcliffe Hospital and I grew up – both my parents and my brother were born in Oxford and we lived there until I went to university at the age of 18.

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Can you describe your parents?

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Yeah, so I suppose coming from – I was the first in my family to go to university. They both had, erm, a range of different kind of roles, as I remember, over my childhood, erm, and I think my mother worked in adult education which I think was kind of useful and challenges because she also was based at my – her office was at my secondary school, so it was probably quite frustrating to see my mum actually at the school sometimes or, you know, to kind of be in and around the school. My dad worked in, erm, it was sort of technical scientific kind of furniture, sort of technical seating company and was a production manager there so he kind of worked his way up through the organisation.

So, I suppose I had quite a sort of a diverse background, a bit of education from my mum's side, and then I suppose, erm, there was a kind of technical manufacturing side from my dad's side.

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What was your family life like?

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It's really interesting kind of reflecting back on that, particularly as I've got a family now. I think it's, you know, it's a very happy and loving atmosphere. You know we had a perfectly kind of, erm, comfortable upbringing in that sense. It's interesting if

you reflect on any kind of privilege but we – both my mum and dad kind of allowed me to explore my own interests, I was perhaps a bit of a strange combination of someone who is quite geeky and deeply interested in science and technology, but also I was quite sporty as well. So, I played tennis and football to a high standard when I was a teenager.

And I continued to play sports all of my life but there was a real focus on – I was unearthing some old pictures from way, way back, I was very interested – I think I was deeply interested in physics and astronomy when I was quite young, and I think that's all morphed into, you know, across the physical sciences and certainly mathematics, and then I – that sort of developed into this very kind of, you know, implicitly a big focus on computing and then it became much more explicit as I kind of finished my compulsory kind of formative education and I went through to into university.

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What was your relationship like with your teachers and tutors?

[00:04:31]
Yes, very, I mean very good in some respects. It's interesting when you think back to the impact that a couple of teachers can have in your life. I actually went back to my secondary school, so it was Wheatley Park School in Oxford, and it used to be a girl's grammar school, and actually it was the same school that Teresa May went to when it was a girl's grammar school, erm, so it was a very, very – it's a very nice campus. Oxford being a sort of Civil War stronghold, it was, you know, it had a moat, and it had some very old buildings in and around the school.

But it was a state maintained secondary school and it had a real kind of diverse catchment and like a broad sort of demographic who came to the school, erm, but I – it had a massive impact on my interest in certain subjects, so there's, you know, I went back to give a prize giving speech a couple of years ago which was so surreal going back to – (1) just going back to the school anyway because I hadn't been there for such a long time.

And then even just the sheer fact of going into the hall there's bits that haven't changed. It was – the memories were very, very strange but a couple of teachers really stand out, erm, you know, who have clearly had a big impact on my career and my interest in certain subjects, so Steve Drywood, Mr Drywood who was my mathematics teacher. He sadly passed away a couple of years ago through having a fairly serious illness and he instilled my love and interest in mathematics.

He was – he certainly taught me for A level, but he also taught for GCSE, and it was just – distinctly I think he had an impact on lots of people at that school but – he was a fairly senior, I think he was the Deputy Head at one time, but he was well known, a very well-liked teacher and in particular mathematics, because not everyone gets on with the subject of mathematics, but he was always well regarded by everyone. And he sort of instilled a love of mathematics and problem solving for me, and just that kind of deeper understanding of mathematics.

So, it wasn't just about passing the exam, it was about to understand the kind of the structure and the nature of mathematics, and how that can be applied to solve interesting problems. And then also one of my – my form tutor for many, many years, Colin Clarke, Mr Clarke, who was also my physics teacher. So, actually I was very lucky that my, you know, that my form tutor was also my physics or was a physics teacher and I do remember lots of discussions around – I probably shocked him at some stage by asking questions about atomic and nuclear and particle physics as a fresh faced kind of, you know 12-13 year old.

But he was – I suppose just having that opportunity to talk about stuff and to ask questions, and to read random books that were probably way above my level and above my age – my ability to kind of – to understand the physics but that had a massive impact on – formative impact on my interest and my kind of passion for some of the subjects.

[00:07:27]
What was your first computer?

[00:07:31]
It's really interesting, so (1) from a gaming perspective I was very into – I think it was much more the kind of console era, so very much a Nintendo person, so I had a NES and a SNES, so the Nintendo Entertainment System and the Super Nintendo Entertainment System, so I'm still obsessed by Mario and Super Mario, and that's kind of – they're my formative sort of computer games and even my eldest son is kind of obsessed by the latest iterations of Super Mario.

I can remember getting – when we got those – I had a Game Boy very early on and the idea of just having the ability to kind of play games probably obsessively for – you know, the best Christmas for my parents because probably we were either hidden away in the room playing the console and we weren't having any problems if the batteries ran out on the Game Boy, but I suppose from a computing perspective, erm, it was probably – we actually really didn't have a home PC until much older.

But I remember playing or having access with, erm, you know, proper computing at primary school, towards the end of primary school and being very lucky to – I suppose, you know, through the class UK government initiatives, massive investment in the sort of computer and literacy projects, so BBC Micro and an RM Nimbus, so I remember there was a couple of us who used to try and get to primary school early so we could get on the computers and ostensibly play some games but kind of do a bit of programming and kind of mess around, and have access to the machines for kind of 20-30 minutes before school started.

So, I probably didn't have a – I don't think we necessarily a PC at home until kind of teenage years for sure, but it was, you know, I think it was around that kind of time when they either became much more affordable and you could get – I think it was early Pentium, so it might have been like a – Pentium 90Mhz processor, so it was kind of cutting edge of the time, and that was our first proper home PC which was the family PC, but then basically was in my bedroom.

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And so, when you had to decide which faculty you wanted to go after high school what did you choose?

[00:09:54]
This was – it was quite difficult at the time because I think there were massive changes to – I suppose to ICT or IT or computing education in England at the time anyway, or in the UK, and I suppose I did my GCSEs in 1997 and my A levels in 1999, so actually ICT as a subject wasn't really – didn't really kind of exist in that sense until, you know, 97, I suppose it was the Labour government at the time who came I and made these massive changes to kind of IT education in schools, and obviously invested a lot of money on kit, and training and changed the curriculum.

So, I didn't take any – I actually have no school level qualifications in IT or computing, so I didn't – I wasn't able to take it at GCSE and I don't even remember if it was offered at the school, and I did physics, chemistry, and maths for my A levels, so I didn't – I don't remember if IT was offered as an A level, but I don't think it was because I probably would have taken it. So, I remember being quite traditional and going for the physics, chemistry, and maths, the Holy Trinity I suppose.

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And then you went to the University of Bath, in 2000?

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Yeah, and I don't really – I can't really remember why I necessarily applied to Bath or why – because I originally – I remember I had a couple of offers. I went to look at natural sciences at Cambridge, erm, Peter, sorry at St Catherine's College because my uncle went there. I wanted – I went to speak to Imperial to do physics, and at Bath I looked at both physics and electric engineering, and I don't really remember why I necessarily opted for Bath or – because I first started on an under graduate degree in electrical engineering, and that started in 2000, and I think I rapidly realised after at least the first semester that all the stuff that I was really interested in was either going to happen at the back end of the course, or it was – actually it was – I should probably do a computer science degree.

So, I actually stopped halfway through my kind of first year and then I restarted in 2001 doing computer science, in the brand new computer science department, at Bath, I had just come out of the School of Mathematical Sciences.

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What are your memories of those years?

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So, I don't remember why I made those decisions. It's kind of interesting thinking – I can't really remember why I opted for electrical engineering, but I still hold a very clear kind of engineering philosophy and approach, I'm a chartered engineer, erm, I interact with a lot of kind of engineering professions and aspects through kind of my various roles, particularly from a policy perspective. Erm, it was – I remember when I started my computer science degree I had realised this is what I like doing. This is what I'm interested in and motivated by.

And that had kind of been built on the back of having a gap year, actually working at RM, so you know, Research Machines, which actually kind of – linking back to the machines I was rushing to get to a primary school for, because obviously they were a major part of I suppose the UK kind of computing history, so I did a gap year there. I was a junior analyst programmer, and I did, you know, kind of a lot of software development in Visual Basic, and we were working on a range of enterprise software, and doing kind of data migrations, and kind of working in their sort of educational kind of technology areas.

Erm, and I think that really reinforced that I probably at that stage wanted to do something in the kind of software IT world, erm, or certainly programming and that gave me a very strong foundation when I went to university, and you know, different languages, different technologies, different kind of platforms etc. but I think at that stage I knew I was going to do something in technology.

[00:13:54]
And what about your PhD?

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Yes, so I suppose after going through my undergraduate degree it was, erm, I was obviously very happy with – I kind of really enjoyed doing my undergraduate dissertation project with, erm, Professor John Fitch at Bath, and that was around kind of looking in the kind of compiler optimisation which was – I think at the time had sort of fallen into a bit of a strange area of not being a very interesting or sexy area, and, you know, I think there's been a massive resurgence in – so I suppose that kind of area around software efficiency and performance, and optimisation more generally.

But I think at the time it was – it had seemed to have been quite a quiet area. I think it was pre multi-core, pre, you know, thinking around like – it was largely seen as a fairly, not done field but it was hard to get funding in that area, but I was massively interested having done my undergraduate dissertation kind of looking at stuff with GCC, the kind of major open source, erm, compiler, erm, and it just kind of came off – and through my undergrad I was also sponsored as an undergraduate student by Arm in Cambridge, so I spent a couple of summers there as a summer research intern.

I worked in the compiler group and I worked in research and development and I think again, sort of a formative person, so it was a guy called Samin Ishtiaq.

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That was between 2003 and 2004, right?

[00:15:20]
Yeah, exactly. So, two summer placements as part of my undergraduate degree spending six weeks or so in Cambridge, which was again a sort of fantastic experience and working with other students but also just having the benefit of working for a leading sort of technology company, and one of the senior engineers there who was kind of my mentor, a guy called Samin Ishtiaq, erm, kind of mentioned the idea, I think like you should consider doing a Masters or a PhD, and he had done one because he'd done a computer science PhD at QMUL and in kind of quite formal, erm, sort of theoretical computer science.

And erm, I stayed in touch with Samin all the way through my career. You know, he moved from Arm to Microsoft Research in Cambridge, and now he works for Samsung AI. I suppose he sort of sparked my interest in thinking about actually maybe I should do a Masters or maybe I should do a PhD, and I think serendipitously when I was doing my undergraduate project with my supervisor, John Fitch at Bath, erm, the idea of actually maybe you could do some further work in this area and, erm, that kind of culminated in a project – you know, an EPSRC funded studentship at Bath and I did my PhD with John and Marina Devoss who was another kind of – at the time she was a fairly new member of staff.

And she's still there now, so it's, erm, yeah, it was – I'm not sure how planned it was but it certainly – I like the idea of doing research. I like the idea of, erm, you know, it kind of opened my eyes to doing stuff, you know, being independent and doing it, sort of a led project by yourself and also what that could entail afterwards. So, actually what could it do – I don't think I wanted necessarily to be an academic at the time, but I liked the idea of actually this would be a strong foundation for kind of working in the wider tech sector.

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You got your PhD in 2009, right, and then what led you to move to Cardiff, what happened?

[00:17:19]
I think as with all PhD students I think at some stage you fall into the – you probably have good days and bad days, and good years and bad years, you know, I wouldn't say I had – I think I had – I thoroughly enjoyed my kind of PhD time. I enjoyed kind of being at Bath for such a long period of time, because essentially I was there from 2000 until 2009, and actually I suppose my PhD was slightly more complicated because I essentially did – I was also a post-doctoral researcher before I finished my PhD because I worked on the European funded project as well.

So, that's why I felt like it took a little bit longer than I probably wanted to, erm, but I thoroughly enjoyed working with colleagues at Bath. I stay in touch with – there's a guy who taught as an undergrad, James Davenport, who I do lots of stuff with through the BSc, the professional body. I've written papers, lots of papers with him. And it was, you know, it had a huge impact on my – the kind of thinking about being an academic and the kind of mindset of being an academic, and erm, halfway through my PhD I probably didn't want to stay in academia, and I looked at perhaps moving into working in finance and professional services.

Or, you know, going to work for, kind of, technology consulting, and going to work in the city and having a few interviews, and thinking about where a technical PhD could kind of take you, but then towards the end, I think when you realise you're kind of close to finishing and actually you do like it, and there's huge benefits, erm, and you know, the ability to be quite in control of what you do, I think I realised that actually I can't – it's not possible to stay at Bath so I'm going to have to think about where I could go and, you know, I needed to look for a job.

So, I probably – at the time I wanted to stay in the South West of England or kind of, you know, South Wales was an option and I looked at kind of jobs across the various institutions, across that area and I got my first job and started in August 2009 at Cardiff Metropolitan University, which at the time was called UWIC, of the University of Wales Institute, Cardiff. It was part of the University of Wales, and that was my first – that was the scary move from being a, you know, a PhD student into being a member of faculty, and being a lecturer in computer science.

[00:19:29]
When and where did you learn Welsh?

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So, I'm – I feel like I'm certainly still learning, I don't think I have the hubris or the audacity to say I can speak Welsh, but I've been learning – I mean it's interesting, I've lived in Wales since 2008-2009, and I think it's interesting – you know, I'm English in that sense, well I was born in England and it's interesting kind of being aware of the sort of unique cultural inheritance of context and language and heritage of the kind of living and working in Wales for a long time.

And, you know – (1) I really like it in that sense, there is a distinct and unique kind of sort of cultural history and a lot of that is – there is huge basis around the Welsh language and I suppose also it's – it felt like an intellectual thing perhaps, you know, you live in a country where there's – the Welsh language has kind of expanded over recently years and there's huge Welsh medium education, it's had a massive resurgence but not, you know, it's geographically distributed and obviously not – I think around 29% of the population can speak Welsh.

But there is very, very clear aspirations from the Welsh Government, to be a bilingual nation, the ability to kind of converse in multiple languages, and (1) it felt like an intellectual thing, why wouldn't I learn Welsh, it's something that – it's different from what I do, it's nothing to do with computer science, it's nothing to do with kind of technology, whatever, and it felt like perhaps something that would be kind of – if you're going to live and work in a country why wouldn't you learn the language to better understand the culture and it would be valuable.

It would connect you into different communities in different groups, and then I suppose, you know, particularly as I started to do more and more kind of say more kind of policy focused stuff, and particularly around education, I think it gives you a real insight into kind of politics and policy making, and erm, I think, you know, you don't have to speak Welsh to be Welsh, or to have a Welsh identity but I think it is something really valuable to better understand the history and culture.

So, I am doing three [speaking Welsh 00:21:39] I'm trying to learn to speak Welsh and I think long will it continue, but it's erm, if I'm having kids as well, you know, they have to do Welsh at school and that's kind of a key part of education, erm, it just feels like a missed opportunity not to embrace that as the ability to kind of learn and be able to speak in a second language. We have, erm, we have two children. Two boys, erm, Freddie who's six and he's in his first year at school and, erm, Bertie who is three and a half, he will be four in October, who's – yeah, so they both – it's interesting from a, you know, from an identity perspective.

So, you know, I would say I'm British in that sense but I have a very strong affinity to Wales, erm, and obviously both of my children have born in Wales, and it will be very interesting to see where they see their kind of identity and cultural, particularly as they're growing up in Wales, erm, even though they have two English parents, or two parents who were born in England, erm, and I think that's kind of interesting and exciting to see where they will see their own, erm, their own, er kind of history and heritage as well. So, but yeah, it definitely makes you reflect.

I suppose you ask me questions about kind of my upbringing, then you kind of – then when you have children it makes you think about how you want to do things the same, or do things differently, or expose them to different things, so yeah, it certainly makes you think about your kind of roles and responsibilities.

[00:23:10]
In 2011 you were a Science Media Fellow with BBC Wales; can you tell us more about this experience? What did it mean to you?

[00:23:22]
Yeah, so I suppose that's around the time that, erm, yeah, I never had any aspirations of kind of maybe doing any kind of media related stuff but I was involved in this – one of the professional learning society, so the British Science Association, it was formerly the British Association for the Advancement of Science, erm, and they have had this long running kind of science media fellowship, I think it's been running for nearly 30 years now, erm, and essentially, you know, I think 20 or 25 people every year, erm, do these funded, erm, science media fellowships with kind of high profile media organisations because it's to better – to change perspectives about the communication of science and kind of the understanding of science to society.

Erm, and you know, that's – (1) it's beneficial for the research through academics because it makes you better understand how the media works and how stories and how news is created and conducted, and then also from the other side you can embed some deep expertise within kind of these organisations and you can kind of exploit your professional networks, and to hopefully provide a bit of insight when there are kind of, you know, science and sort of technology related stories.

I was involved in the British Science Association anyway because I sat on there, I was a member of council and as trustee, and around the same sort of time I had – since 2011 to 2017, as a trustee and member of council, erm, I was very, very keen to do the media fellowship. So, no, I hadn't seen many computer scientists do it, so that was one of the reasons to say, I think that was an interesting kind of niche from a technology perspective and thinking about computing, thinking about digital, thinking about data.

And also, erm, doing something in Wales. So, the potential of doing stuff with BBC Wales and how we could kind of – you know, one develops relationships with BBC Wales but also kind of to build some kind of capability there about, erm, kind of the reporting of science.

[00:25:23]

So, as you mentioned you supported measured reviews of computing education both in England and in Wales, particularly for England you support the Royal Society's two major reviews of computing education in 2012, and 2017. Would you like to speak a little bit more about this?

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So, I think when I first moved to Wales and got my first job I think realised, erm, I started to become much more interested in that kind of public engagement and science communication work, so I wanted to talk about computer science. I wanted to explain, you know, empowering and interesting a subject, and I think there was a real big – that was around the time of the kind of stem agenda more generally. So, it felt like computer science was a very poor cousin to the more established physics, chemistry, biology, engineering, mathematics, and it felt very hard to get into some of these – to speak at events.

There was so much prominence and profile to increase stem engagement or to increase stem education in schools, and it felt really strange that computer science wasn't – didn't seem to be a mainstream part of that conversation. Obviously, the T and the stems seemed to be about technology, but computer science wasn't, you know, wasn't regarded as a core part of the wider stem agenda, so that was the rationale to kind of do – get some more visibility and prominence with some of the work in Wales, and particularly when I got my first job, I wanted to go and just speak to schools.

It was quite beneficial in a sense of my job was admissions and kind of undergraduate studies, so it was good from a recruitment perspective, but more generally I just wanted to talk about computer science. You know, I wanted people to understand about how interesting it could be, and how much of an impact it has on people's lives, and then I think that morphed into thinking about what's in the school curriculum, what qualifications do they do.

And around the same sort of time, erm, 2010/11/12, in England certainly there was a massive focus on actually was the ICT curriculum fit for purpose. Michael Gove was the Education Minister at the time. Eric Schmidt of Google made a very high profile speech at the Edinburgh International Film Festival, simply saying Britain is doing its young people a disservice by not teaching computer science as part of a core part of the curriculum, and that precipitated changes in England, and I suppose that was also an ability to kind of leverage that to kind of stimulate change in Wales too.

And I suppose when the work that Gove did as, you know, when he disapplied the IT programme in England and obviously the Eric Schmidt speech that stimulated a lot of policy change in England, and that stimulated the Royal Society's report that was published in 2012, you know, through the BCS, through professional bodies, I suppose got involved in helping out with the Royal Society's work there, and I suppose partly to try and connect them to what was going on in Wales and to make sure that this is reflective of the UK.

And not just an England only picture. It was very early on in my career but it was really nice to be kind of acknowledge in that 2012 report by the Royal Society, and I think that was the stepping stone then for driving those reforms, you know, allowing

to drive those reforms in Wales because stuff had started to happen in England, and it was easy to kind of point to curriculum reform and qualifications reform, and a wider focus on why computer science education was of benefit, not just economically, but also socially and culturally. It was beneficial for having a digitally confident and capable citizen not just for we need all these high value kind of you know, knowledge economy, digital economy jobs, because it was about saying we teach people physics, we teach people mathematics to understand the world in which they live.

Why don't we allow people to better understand the digital world and not just to be passed to consumers, but hopefully to be savvy consumers and also to be maybe creators and manipulators of that digital world.

[00:29:30]
What do you think are your major contributions in the reviews, your personal ones?

[00:29:44]
Yeah, so it's kind of interesting reflecting back on it, as always with these things so many people have been heavily involved over the years and, you know, particularly I've acknowledged the amazing work from Professor Faron Moller at Swansea University, and the Techno Camps Project who have been doing stuff, who's been doing the activities at Swansea but across all of Wales for well over 10 years. But I suppose it was, you know, there was some serendipity for having been in the right place at the right time.

I was very passionate and motivated, I was probably a bit young and naïve in thinking, you know, a bit bold in the sense of maybe I was asking questions that some other people might not have been prepared to ask and it was – because I wasn't aware of the consequences or, you know, it was easy to push at the right time because of the Minister in Wales, or because it was easy to point to curriculum reform in England, erm, but I suppose that was – that culminated in me co-chairing a review, the independent review of the ICT curriculum in Wales in 2013 with a couple of colleagues, Janet Haywood and Stuart Arthur.

Which kind of pulled together me as an academic, Janet as a very prominent primary school Head Teacher, and Stuart kind of reflecting the IT industry, and then I suppose that – everything kind of exploded from there because I think that sort of set the aspiration for what we wanted to achieve in Wales for reforming the ICT curriculum, and what a new sort of computing curriculum could look like, and then that lead into the major independent review of curriculum and assessment in Wales, which was chaired by or led by Professor Graham Donaldson.

And our ICT review recommendations were a very strong part of that. Massive changes to ICT. Big changes to science education, and then obviously a big thing was to have this cross curricular digital competence to be recognised as a key cross curricular skill alongside literature and numeracy. So, after that review was published in 2015 I was asked to chair the development of the digital competence framework which was a – is unique in the UK and I think it certain is distinct internationally, but this is a bilingual cross curricular digital competence framework for the ages of three to 16 which, you know, separates out some of the concerns and challenges around ICT.

But that means we have now computer science in the curriculum and also you have this cross cutting thing around digital competence which acknowledges that it has as much prominence as literature and numeracy, and it is thought in a whole kind of cross school approach, and then that was made available to schools in September 2016, and then we got into the major curriculum for Wales, implementation, and I chaired the development of this new science and technology area in the new curriculum for Wales from 2017 to 2020.

So, that brought together physics, chemistry, biology, computer science, design, and technology, and, you know, well established subjects as well as, you know, perhaps newer subjects and bringing this into this cohesive area of learning and experience, one of the largest in the new curriculum of Wales, which was published in January 2020, and will now start to, you know, we'll start to phase in and be implemented from September 2022.

So, you know, the culmination of stuff from say 2010/2011 which has essentially culminated into a new curriculum for the whole of Wales that was published in January 2020 it's shows that this is a long running thing. It was quite frustrating after we did the ICT review in 2013 because we expected probably quicker reform and actually, you know, these things do take a while and you have to play a longer game to realise that. I've worked with at least three Education Ministers in Wales and we've seen massive changes.

Economic changes, we've seen lots of things have changed over the past 10 years but actually, you know, I think we are in a position where we have a new curriculum that's been designed in Wales, it's been co-constructed with teachers, it's fit for purpose for a new modern curriculum in Wales and we have the kind of prominence and profile for computer science, and we want to be able to develop digitally confident and capable future citizens, so there is – it feels like we're in a very exciting time.

Moving from having changed the curriculum but now we need to implement and make sure it's delivered effectively going forwards.

[00:34:07]
What do you think it's place is for the history of computing, science, and technology in the stem curriculum?

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I think it's really important. Obviously, you know, I think we can talk about kind of history and how it is, there's obviously a big focus on things like Curriculum Cwm-Rhyd, Welsh history and culture anyway to make sure that is a key aspect of the curriculum but obviously, you know, the UK and certainly Wales is – kind of technology heritage is very, very strong and clear and it's, erm, it adds really valuable context for people to understand, you know, technology – it's not just driven by US technology companies.

I think, you know, the UK had a very, very rich computing heritage and it kind of goes all the way back to say, you know, Alan Turing, Bletchley Park and the countries

in the war, the development of the first programmable computers in the late 40s and 50s in Manchester, and then you see the development of the UK's kind of computing industry and the impact it has had on commerce and society, and the economy and I think we can – you can do a disservice by not articulating that and only focusing on, you know, your IBMs or your Microsoft, or your Apple, and now your Facebook and you Google.

And you can neglect how that was only made possible because of what was done in the kind of 1950s, 60s and 70s, and obviously, you know, that shifted the kind of centre of gravity. It shifted from the UK, you know, in the early days to certainly to the US for a variety of reasons but actually I think it's really important to recognise and acknowledge the very, very important contribution from the UK both from organisations and government, but also from people.

There are some very important people in kind of – in the early days of computing who are – who are British and that's an important part to bring into the curriculum.

[00:36:03]
OK. Let's go back to your life experiences, let's go back to 2013 and in 2013 you became the Nesta Data Science Fellow until 2015, would you like to talk a little bit about this experience?

[00:36:22]
Yeah, so I think having had a very I suppose done a very theoretical – kind of a mathematical foundation, you know, very technical kind of PhD, erm, I think I realised when I got my job at Cardiff Met and I think I – you become an independent researcher. You develop yourself as an early career researcher. You kind of explore new areas of research and interest, and probably moving away from what I did as my kind of PhD and post doc.

I think I realised as part of this wider work with digital skills and curriculum reform I really liked doing stuff, the research policy interface and I think realised that there was kind of valuable contributions for being able to articulate some of those interests in kind of technical and technological challenges, and also thinking about what it looks like from a politics and policy making perspective. So, you know, clearly it has a huge focus on digital infrastructure.

Digital economy, digital skills and, you know, kind of technology science innovation policy. Where does it all fit together and, you know, through work with Nesta and related organisations there was the potential for actually, you know, how does that work from a digital and data driven policy making perspective, so the work with Nesta at the time and a colleague there who's one of the Exec Directors, Stephen Westlake, he's now the Chief Executive of the Royal Statistical Society, but he was a special advisor to a couple of universities over periods.

Building a relationship with him and colleagues, and thinking about actually the benefit of having an academic who could come in and work with Nesta's kind of policy and research team to think about how you could more meaningfully embed a data kind of science capability within government and within policy making, and this I think – this is a culmination of a lot of work from Nesta but I think we've seen the

benefits of this; one in the development of things like the sort of DDAT, the digital data and technology function within government anyway with the civil service.

But also the acknowledgement that actually having the right kind of data and evidence, and digital capability through all aspects of kind of government policy making is huge beneficial, so you know, I think it – some of that work was successful and, you know, Nesta's work in this space has been really, really successful, but I think also it reaffirmed to me that there's – this is valuable – there's valuable work to be done as an academic and also there's very interesting and intellectually interesting work to be done as an academic sitting at that research policy interface.

So, doing your own kind of domain research but also providing that expertise to advise governments, to advise other organisations, and provide the ability to kind of communicate to different audiences and domains, and not be perhaps a traditional academic who isn't able to speak to policy makers or civil servants, or to communicate complex ideas to Ministers and Chief Executives, and whatever, and I think that was really beneficial for me because it developed – it refined and developed a skill set that I thought was useful and valuable, and I think has really kind of – has been a key part to my career and success over recent years to be able to communicate between those different communities and bridge, and think about inter-disciplinarity and also has allowed me to do a diverse range of roles alongside my academic role as well.

[00:39:44]
And the following year, in 2014, you were elected a Fellow of Software Sustainability Institute, what are your views on software sustainability and what did you do?

[00:39:58]
So, this is a big BCS funded project that, you know, there's a very strong – so the Software Sustainability Institute is a – I think it's a fantastic organisation that does a lot of work in this space, you know, all the way from kind of open science and open research, but I suppose to really reaffirm how important software is not only to the academic and science and research community, but essentially, you know, more broadly to kind of society and the economy. So, the world is, you know, the world is glued together by software and that software is eating the world.

And actually if we don't understand about, you know, it's not just about the maintaining of this, of our software infrastructure and our digital infrastructure but actually acknowledging that this is a valuable contribution to science and research more generally, so it isn't just about the people who are writing the papers or who are doing the research, there's this whole kind of infrastructure behind the scenes that allows science and engineering, and research more generally to work and to function effectively, and I think the Software Sustainability piece is a very – I think over the period – so becoming an SSI fellow in 2014 that feels like such a long time ago now because now you don't have to make the same sort of arguments around well of course you have to share your data.

Of course you should share your code and you publish a paper you share the open data, you share the git hub repository where the code is, I think that whole kind of aspect of, you know, reproducibility and replication of scientific results is a key kind

of foundation – a scholarly communication dissemination but also that's just how good research is conducted and I think that certainly wasn't the case in 2012/13/14 and I think with – there's been a big kind of behaviour culture and mindset shift. It's not perfect, there's still lots of reasons why people don't do it, or don't want to do it.

Or they don't want to upset the status quo. There's still huge privilege about publishing in certain high profile journals and actually you don't want to share data sets because you want to exploit all the outcomes before other people potentially can, but I think that has really changed the perspective around the prominence and the importance of software for research, and also, you know, around research software engineering being a valuable and valued profession.

It's had so much – it underpins kind of research across the world and, you know, you have to acknowledge that, you know, that's why we can do the type of science and research we can now because of all this software infrastructure and this wider digital research infrastructure. We're not there yet. I think there's still lots of work to be done and I think, you know, research councils and funding bodies realise that this stuff is really important.

But I think that I enjoyed being an SSI fellow because there was this advocacy piece too that was about like prominence and profile, it was about skills, it was about trying to kind of effect change within sort of a research community, also it's about the prominence of being able to speak about these issues and to try and be part of this wide open research group as well.

[00:43:02]
In 2017 you were appointed MBE in the Queen's birthday honours for services to computer science and the promotion of computer science education, what do you remember of that day and what is your favourite memory?

[00:43:15]
Well, it was – I must admit it was, it was a genuine surprise, I imagine everyone says that but, erm, I remember when I got a letter sent through to my then work at Cardiff Met and I thought I'd been invited to a party because I think – I thought maybe I'm going to a garden party or something at Buckingham Palace because, you know, having been involved in lots of policy stuff I thought maybe I'm going to a – I've been invited to an event or something, and it was a fairly sort of non-descript sort of serious looking envelope that popped up at work.

And then essentially it said, you know, you've been nominated or recommended for this honour and would you be minded to accept it and I think I was really shocked and surprised at the time, and I suppose partly, you know, yes, I was delighted to be kind of acknowledged for some of that work around particularly computer science education, some of the wider sort of digital work in Wales, erm, and then I suppose it was then having to I suppose keep quiet for bit until you could tell other people.

Erm, but yeah, on the day it was fantastic. Eventually – it was – I picked up my honours in October 2017 at Buckingham Palace and Prince William was doing the honours that day, I think the Queen was supposed to be doing it, but I think he had to step in at the last minute, and it was kind of a surreal day. It was a strange – it was

obviously quite – you know, going to Buckingham Palace for that kind of occasion was sort of surreal and very well organised and obviously lots of other people there.

And, you know, everyone in sort of similar circumstances, erm, and erm, you know, I think it was – it seemed like you were waiting, you know, kind of going through the order or service and then eventually your moment came when you were coming up and you had a, you know, probably what was a couple of minutes of small talk with Prince William, and it was just really strange. It was kind of very surreal to be there on the day, but it was fantastic for my family.

It was a lovely day in kind of recognition and, you know, I acknowledge that some people, you know, receiving those sort of public honours can be contentious for some, but it has been a delight to be recognised for some of that work and, you know, it doesn't stop me from continuing to work hard and I want to keep doing lots of stuff in this space, but it was a delight to receive that.

[00:45:39]
In the same year, in 2017, you also became Vice President of the British Computer Society, what can you tell us about this experience?

[00:45:47]
I've been involved in the BCS for a long time actually and again this comes back to the point I sort of made before, colleagues at Bath, so James Davenport, a Professor there who taught me as an undergrad in my final year, erm, you know, I do lots of stuff with, collaborate and write lots of papers with. He advised me – I think it was his fault that I joined the BCS as an undergraduate student, but I think when I re-joined when I was looking for jobs in sort of 2008 and 2009 and James at the time I think was a member of council, and he used to keep me up to date with what was happening at BCS council and I think that was just the motivation to get involved and find out a bit more stuff about it.

And to basically volunteer, so I think at that time I joined, I think I joined the Executive Committee of the young professionals group which at the time was one of the biggest sort of member groups within the BCS because of the amount of young professionals, and then I became an ex-officio member of council, that would have been 2010/11 and then I basically then – on council and trustee over that period, you know, council elected trustee and ex-officio member of council, and then I stood for election as Vice President of the academy in 2017 where I did a three year term as a Vice President which was fantastic.

You know, there's lots of friends and colleagues through the BCS, I thoroughly enjoy volunteering for the BCS and have probably sat on most if not all boards and committees over that period, erm, and again I think there's that thing around – it's not about being – I'm not a member of the BCS because I want to be professional, I think I am professional and thinking about professionalism, but I suppose there's also that responsibility about the BCS have a royal charter. They are the professional body for IT and computing and I think it's just hugely beneficial to be involved and to build, you know, to have the BCS as a strong, erm, vibrant diverse community that reflects, you know, computing, education and profession in the UK and it's been beneficial for me kind of professionally, but also I like to think it's been, erm, some of my volunteer

with the BCS has been beneficial for them and has made a contribution particularly as a trustee and obviously as a Vice President.

And some of that work has linked back to some of the computer science education stuff with CAS, computer at school, and around the same sort of time, you know, being able to speak on behalf of the BCS to represent the BCS at events and other kind of activities, erm, and you know, I like to think I'll always be – have some kind of involvement with the BCS at some time or other. I'm back to being an elected member of council, so I've probably never come off council since I joined in 2011 but it's, erm, I like, you know, when you see the role that professional bodies and then societies play, particularly in that kind of, you know, promoting education.

The benefits and impact on society, the kind of shaping and influencing of kind of policy, that feels like a huge opportunity to be able to be involved in that and then obviously to build professional networks, to connect people, to, you know, you meet collaborators, you make – generally you make friends and it's been hugely interesting over the last kind of 10 or so years.

[00:49:08]
Nice. Erm, let's go back to Wales, so you sit in several wards and you are an advisor, an Executive Director of several bodies, would you like to tell us a bit more about this?

[00:49:27]
So, it's been – I suppose linking back to the point around, erm, you know, the benefit of being an academic is you largely have the ability to choose the sort of things you want to do, erm, and obviously that is obviously around your kind of own research and sort of policy and practice interest, but actually alongside doing all of the curriculum reform work in Wales, erm, I think I have been very interested in that broader digital message for Wales.

Like what's the opportunity for Wales, both from a sort of digital economy kind of society culture piece but we think about it actually, what's that long term piece for delivering a digital Wales, what would Wales look like in the, you know, not just in the next kind of, you know, in this current government but what would it look like in 10-15-20 years' time, and that's probably been exacerbated by things like, you know, Brexit and Covid, but the idea that actually Wales has a very interesting pitch, so this, you know, Wales is a digital policy test bed.

It's huge kind of potential as a thriving kind of digital economy. There's bilingual. You've got the economy, there's the kind of infrastructure piece. There's the, you know, building on it's industrial heritage and what's the potential kind of going forward. It felt like actually where does that economic renewal piece sit and actually how can you help kind of support some of that work from a kind of policy making perspective.

So, you know, that's where, you know, naturally the digital skills stuff moved into the wider sort of digital economy, digital infrastructure piece as well, so I think I've done a lot of work with Welsh government around, you know, what's this look like around the digital pitch for Wales, and I think that started to kind of turn into having more

formal roles with a range of different organisations and bodies. So, over that period, particularly around education skills, but that sort of now has moved into providing kind of, you know, board level kind of non-executive level advice and kind of governance for a range of different kind of public sector bodies and private sector organisations.

So, I sit on Swansea Bay University Health Board, so that's one of the biggest health boards in Wales, it serves 400,000 people across Swansea and Neath Port Talbot, so I'm a sort of ministerial appointment to the board for informatics. I'm a non-executive Director of Welsh Water, so Dwr Cymru, as it is Welsh, which is the sixth largest water and waste company in England and Wales. It has a regulatory capital value of kind of £5.5bn, so these are large scale organisations that provide kind of essential public services, so you know, water and health and social care to kind of to citizens.

And then also I'm Commissioner of the National Infrastructure Commission for Wales, erm, and this is around that kind of long term view around well what – how can we advise Welsh government for those long term kind of five to 30 year investments on kind of economic and environmental infrastructure investments in Wales, so it all kind of fits together. There's this kind of thing around digital is this kind of cross cutting message.

And where's the potential, what's the benefit, what does this mean for Wales perhaps as a sort of digital test bed, trying out new things and being innovative and the ability to do stuff on a national scale quite quickly which is harder in England and other countries, erm, and also, just – I suppose it's interesting having that – being able to provide that board level kind of advice and responsibility, and kind of governance and assurance for these major bodies.

Perhaps not all academics have the opportunity to do that and I suppose I'm very lucky that perhaps I'm doing it slightly younger than other people do too, erm, but it feels like it massively augments my other roles and responsibilities, and it all fits together across that kind of research policy and practice kind of interface, and I think it has benefits both for my kind of academic research, it's widened my network, I've had papers, I've had projects, I've had funding off the back of these networks and kind of collaborations that you build up to all these diverse kind of communities and I think, you know, it has benefits of bringing in a different perspective on a board level perspective and an advisory perspective for some of these bodies and organisations too.

[00:53:31]
And what brought you to Swansea University in 2018, you were at Cardiff and then you moved? What happened?

[00:53:44]
I think, erm, it's interesting you sort of never want to move role because you can be quite comfortable where you are. I'd been at Cardiff Met for just over eight years and I think it felt like it was the right time to leave, and I think it was – I was delighted I had been made a Professor in 2016. I was also Deputy Director of Innovation, so I had a sort of central university role alongside my kind of research role, and I think – it's kind of interesting when you're kind of reflecting on major achievements, I think I

was more happy achieving becoming a Professor than being appointed MBE because it felt like an acknowledgement of the work that I'd done and the kind of wider contributions from an academic perspective.

And I think after – I'd been a Professor for two years at Cardiff Met and I think it was, you know, it felt like it was time for a change, and I think it was, you know, I wanted to stay in Wales. I want, you know, a new opportunity and I suppose it was kind of having discussions with a couple of institutions at the time and, you know, having collaborated with colleagues, er, Professor Faron Moller and Professor John Tucker at Swansea, and I'd kind of known, you know, obviously the history and pedigree of the institution, it just felt like a very sort of serendipitous moment being able to work both in computer science but also in a school of education that had just been reformed.

And it brought together a couple of my interests and areas and that was – again, it was right place at the right time and sort of serendipitous in that sense, and this three and a half years have gone by very quickly. I love working at Swansea. It's a fantastic institution and it's also lots of collaborators across different areas and kind of disciplines. So, there's lots of good people working there and it allows you to kind of pull in expertise and work on a range of different projects that kind of fits with what I'm interested in as a cross cutting kind of digital research and policy stuff as well.

[00:55:42]
It sounds really nice. So, let's go, erm, let's go to contemporary, to Covid-19, you researched on that, as you know Covid-19 has impacted all aspects of society and especially education where you are particularly involved so I'm thinking about remote teaching at every level, online learning, teaching, and assessment. So, how do you think that the pandemic impacted education in the UK and what is your evaluation?

[00:56:25]
I mean it's had such a profound transformational impact and I'll caveat with both hugely negative and challenging things but also I think there was some really positive stuff to hopefully kind of come out of the Covid-19 pandemic. I suppose it links back to some of the wider work around curriculum qualifications reform in Wales, erm, I suppose having been heavily involved in that over the past kind of five to eight years naturally that links to, you know, the curriculum was published – the new curriculum was published in January 2020 and obviously kind of the pandemic hit in February and March.

So, naturally there was, you know, the delights of being able to kind of publish the new curriculum and then actually realising that there is going to be a massive impact on the education system across both compulsory and post compulsory settings, so – but particularly schools and obviously what does it look like for colleges and universities, and naturally the relationships and the projects I've been involved in for that work that allowed me to work with Welsh government to think about this kind of continuity of learning stuff, and about how we can ensure that practitioners are able to, to continue doing what they needed to do and what was possible to do in the early stages of the lockdown.

Erm, and also what does that look like, you know, over, all the way through kind of 2020, you know, into the kind of emergency remote teaching phase from kind of March 2020 to the summer, to then the much more planned stuff from September 2020 to kind of where we are now, and I think that's – it demonstrates the kind of shift of the range of different challenges that have been faced by educational practitioners over that period.

And I've done a number of – we've done some major work both funded by Welsh government but also in collaboration with colleagues at Swansea and the University of Bristol, as well as some colleagues internationally, around looking at the impact on practitioners. So, what does it mean for academics. What does it mean for universities. What does this mean for schools and actually both from a – you know, the impact of kind of emergency remote teaching and kind of online learning teaching assessment, but also mental health and wellbeing for practitioners.

I've got a funded project with Welsh Government with the four different institutions that I'm leading around the learner voice stuff, so actually what does it mean for Year 10, 11, 12 students for the future assessment, you know, kind of qualifications and their perspectives about the kind of impact of learning and teaching over that period. Another project with colleagues at kind other institutions around learning design, so actually, you know, it feels like the world has fundamentally changed. So, you know, this isn't going to go away now so actually what does it look like in the sense of how do we meaningful construct and design learning at all different levels and settings.

And how do we prepare practitioners to be able to kind of have the confidence and capability – in the same that we want them to be kind of curriculum makers, we want them to be learning designers. So, I think in that sense this is – I think the Rubicon has been crossed at some level, so the open university have been very good at doing kind of, you know, distance blended learning for many, many years but it feels like all institutions, all universities are going to be doing some form of kind of blended delivery.

There will always been some online stuff now. Actually, I think it's interesting what that looks like in schools because perhaps it's much more challenging because of the diversity of setting and the diversity of kind of composition, and capabilities to do this, but I think, you know, this is going to be a feature of education. And I think that's where the positive stuff comes going forwards around, you know, increased prominence of digital education.

Probably much more considered and critical uses of technology in education, so not just saying technology is the panacea for all problems, you know, understanding about what are the benefits and the efficacy, and the evidence base to use technology in education, their head tech and devices and tools, and software, whatever, but also to make it much more learner centred, and much more kind of practitioner focused. So, who benefits from this stuff.

We don't want it just being done to students. Students need to be meaningfully involved in the implementation of some of these tools and technologies, and it has to be much more learner centred and pupil centred, and we have to have much more explicit conversations around, you know, personal data and consent. So, I think in

that sense, you know, Covid has made things happen so quickly, the roll out of technology, the ability to do online learning and teaching, and we've seen some schools being able to cope with that much better than others.

So, there are benefits to doing stuff at pace, at scale, and I hope we can maintain some of those abilities, but also I think we do need to have some much more considered and critical approaches to what this means and the role of technology in education going forwards.

[01:01:01]
And in 2020, you were also elected a Fellow of the Learned Society in Wales, which is the national academy for science and arts.

[01:01:14]
It was a delight. I mean I think obviously the recognition of, you know, kind of these types of things again especially when it's by your peers is fantastic. Obviously having been involved in professional bodies like the BCS and the IAT for a long time, I think when you start to be recognised by national academies and the Learned Society of Wales, which has been going for just over 10 years now, this is the national academy for the arts and sciences in Wales, and kind of is for the benefit of the nation, and is kind of promoting learning and acknowledging excellence in that sense.

It was a genuine delight and I think, erm, again the recognition of being recognised by your peers for your contributions, you know, perhaps I'm only 40 and I feel like I've got lots that I want to achieve going forwards but again it's hugely beneficial professionally but also it is a delight to be – to have that recognition from your kind of diverse professional community. So, erm, you know, there's lots more that I want to do in Wales for Wales, and some of that can – will be facilitated by the Learned Society and by those kind of diverse professional networks that you build up through organisations like the Learned Society of Wales.

[01:02:27]
And recently, January 2021, you became Editor in Chief of the prestigious Computer Journal published by Oxford University Press.

[01:02:40]
So, it's interesting – I wear lots of hats I suppose but they all kind of – they all kind of coincide and support each other but it's interesting because from an academic perspective, and you think about the kind of, you know, I suppose marks of esteem and for many, many years it has been around kind of the ability to contribute to journals and to, you know, to be part of editorial teams, and it's a delight to be appointment the Editor in Chief from January 2021, and I took over from Steve Ferber who is also, he's an eminent computer scientist and engineer.

And I suppose that was a fantastic handover from an esteemed colleague, such as Steve, but also the Computer Journal is one of the oldest, erm, journals in computer science and, you know, it covers a very broad area of interest. There's not too many journals like that in computer science because they've become much more disciplinary or sub-disciplinary focused but again it has a lot of history and heritage, it's been going since 1953. A lot of famous papers have been published in the journal

over the years and again I think this links through – it's a BCS journal, but it's operated by Oxford University Press.

And again, I feel very passionate to have the ability for this to be viewed as a prestigious and impactful journal within the field. It's good for the BCS but it's good for the wider computer science research community, both in the UK and internationally. I've only been in post for a few months, but I've been working with my wider editorial team and we've got some – there are things we want to achieve both in the short term and the longer term, and I'm very, very keen to make sure that the prominence and the focus or the – not the prestigious but, you know, in the sense of I want the Computer Journal to have impact in the field.

And I want it to be viewed as a venue where you can discuss, you know, cutting edge research, but also perhaps you can discuss more contemporary kind of policy issues within computer science or the impact on society, so I think there's the potential for doing some stuff with the computer journal kind of going forwards, so I'm looking forward to seeing what we can do with that but, erm, yeah, it's amazing how, you know, having been Editor in Chief for the past three or four months, you know, there's lots of work to do but again I have a very strong editorial team.

Section editors and a wider editorial board, but again I'm looking forward to – over the kind of next four or five years to really build and strengthen the computer journal, and increase its prominence and profile.

[01:05:15]
And you are also a partner of Repair Cafe.

[01:05:21]
Yes, I mean this is part of a wider, not just the UK but a global movement around, erm, you know, kind of – as it says, as it's name implies, is about repairing things and I think it kind of really shows – I think we've seen, erm, it's very easy to discard work – electronics and kind of technology without really thinking about, you know, the impact it has on society and the environment. And there is…

[01:05:52]
We should say what a Repair Café is because not everyone knows about it.

[01:05:58]
It's interesting, because you know, it feels quite a descriptive name but I suppose, you know, the Repair Café movement has a mission to become a much more sustainable society and not to throw things away, and again I think the move is to have these kind of repair cafes which are grass roots kind of movements, you know, in every kind of town and city, as many as possible, which basically kind of nurtures a culture around fixing and repairing things, rather than, you know, if something is broken you just throw it away and buy a new thing.

So, there is that sustainability piece but actually there's the kind of knowledge and skill about being able to fix and repair technology, and to re-use and recycle stuff, for the sake of one tiny bit inside, erm, could work for a long, long time. Low cost repair and fix, and I think there is a culture and mindset that we need to move away from

just discarding stuff that is trivially broken and I think, you know, that then moves into this wider kind of make and movement, and kind of creator movement within computing and technology which is really beneficial.

Making people think about the type of technology that they use in their lives and think about actually when things break, some things are quite easy to fix, and understanding about basic electronics and technology is hugely beneficial to kind of understanding how the world works, so why not try and fix that toaster instead of just throwing it away and buying a new one. Yes, fine, a toaster might cost £20 but actually you could repair that just by learning how to solder and replace something.

Or to replace a little bit of wiring and there is a thriving kind of community, both in Wales, but across the UK and the world, so I'm not directly involved in the running of Repair Café Wales, it's been a growing movement over the past few years, but I'm very, very pleased to be a patron of it because it's something that kind of resonates with some of my kind of perspectives of the world and I think that kind of wider sort of technology and sustainable development is really, really important.

But also, I kind of like the fact that we're developing this kind of skills and knowledge, and understanding about how to fix and manipulate, and make and reuse the technology that is all around us, and I think that understanding and the kind of hands on approach to fixing stuff is hugely beneficial and is good for young people as it is for everyone else in society.

[01:08:24]
So, looking back what do you think were the key lessons you learned from your personal education that you can attribute to your latest success?

[01:08:38]
I think there's a thing around flexibility or agility perhaps. I probably had a fairly – in the sense of I've had a fairly traditional kind of scientific background. I did physics, chemistry, and maths, I did a science degree, but I suppose – I think – it's interesting when you think about that in the context of, you know, I also – as much as I view myself as an engineer I also view myself as a social scientist, somebody who does public policy.

So, having that ability, you know, the kind of inter-disciplinarity or the trans-disciplinarity and the ability to kind of – to discuss and communicate kind of complex ideas to a range of different audiences I think that's the thing that I have found really beneficial and the thing that I would advise people, you know, in terms of you can be viewed as this sort of stem versus arts and humanities, kind of super snob of the two cultures, and never the twain shall meet.

But actually, clearly that kind of false dichotomy and divide is so unhelpful and the idea when we talk about the stem agenda to the neglect of the arts and humanities, and the social sciences, all of these things inter-relate and that's how we create better policy. That's how we create better interventions. That's how we put a more fair and sustainable, and just society, and I think that's really key to reflect that breadth of expertise and to acknowledge that, yes, we do need technological innovations and developments.

We need people who are very, you know, at the cutting edge of research but we also need to understand how that impacts upon people and structures, and systems, and society, and we know that not all of those impacts are good, and there is bias, you know, how good at governance and transparency – we could write code and software in systems to do amazing things, but also we know that they can have disproportionate and unfair impacts on certain communities and demographics, so we need to understand that wider sort of responsible research innovation piece, and the responsible use and application of technologies, and the oversight and governance of their development and their application.

That feels – that is about inter-disciplinarity and that feels that computer scientists need to understand about this, this is just legal social ethical and professional issues, and that is why we, you know, the BCS promote these kind of things, but also you can't – it's not just about developing technology in a vacuum. It affects people, it affects society and I think that is – that's a kind of a key combination of kind – of competencies or dispositions or behaviours and cultures to – that we really need to kind of reflect and to, erm, to bring together kind of going forwards.

[01:11:10]
What were the key decisions, positive and negative, you made and what difference did they make?

[01:11:18]
I suppose I probably made a good decision to stay in academia and not go in – well maybe, maybe I could have gone and worked in the city, but that was probably around the financial crisis in 2008 and 2009 so that probably wouldn't have worked out too well. But I think – I don't know, I didn't necessarily have a plan, it's kind of interesting reflecting, you kind of retro fit a plan maybe when you look back, but I really enjoyed, erm, you know, when I got my first job at Cardiff Met and I had the ability to kind of, you know, to carve – sort of a niche, kind of different path from what I'd kind of previously done at Bath.

But again, I suppose part of that has been around building diverse networks and collaborations, and kind of working with lots of people in a variety of different context to have that flexibility and to do a range of different roles and activities, and so I suppose, you know, partly saying yes to lots of stuff has been a good thing, erm, I think I'm much more kind of considered. I need to be much more considered now about saying no to stuff because it can be very seductive to yes to everything, and actually you have to be pragmatic about what you can achieve and the amount of time you have to do stuff.

Erm, particularly now, you know, especially if you've done things before. You don't have to do them just because you are able to do them. I think you have to really consider about actually where's my time best spent or where can I have the most impact, erm, so that's the thing – I said yes to lots of stuff early on in my career and I think that's been hugely beneficial, but now the harder thing is to say no to things, even though you may want to do them, or you are perfectly capable of doing them, but you might not necessarily have the time to do all the things that you want to do.

So, that's the kind of advice I'd probably say to, you know, it's not an easy thing to do because you have to say yes to lots of stuff to – and you might have to go above and beyond, and you might have to work, you know, sometimes it can be very challenging to work evenings and weekends, particularly when you start to have a family or other roles and responsibilities you have, but that has been very beneficial for me, but now I think it's around, you know, where is my time best spent.

Where can I have the most impact, and actually what can I say no to because that's – and that's really hard, the kind of culture and mindset to say yes to everything, to start saying no to lots of things is really difficult.

[01:13:38]
What is the proudest achievement of your career?

[01:13:43]
Erm, it is hard, obviously, you know, the birth of my two boys in life is a huge – I'm extremely proud of that. I would say it probably goes back to the point I said before, like I was utterly delighted to be appointed MD in 2017 but I – and it's very professionally useful, it has a lot of value and kudos and credibility and a lot of different contexts, but I would probably say when I was first appointed Professor in 2016 because it felt like that was a culmination of the work that I'd done particularly because it was a, you know, it reflected my research as well as my wider policy work.

So, you know, I was delighted to be appointed Professor at the age of 36, and I think that reflects, I suppose that reflects the work that I've done around the curriculum reform in Wales, and that's something that I have not finished being involved in, and now it's kind of moving into the implementation phase, but I think the work – being this kind of high profile advocate for computer science education and sort of digital skills, stem education and being directly in the sort of leadership of its reforms over the past eight years in Wales, that feels like something that I could very tangibly point to, to say I led a lot of that.

I led that over the past kind of eight to 10 years and I'm looking forward to seeing how that is implemented going forwards and I want to help that and continue doing work both in the research policy and practice context, but there's still lots of work to be done, but I suppose it's nice to be recognised as the person who's led a lot of the sort of computer science and sort of digital skills, and stem work in Wales, especially when you start looking at that in a UK context as well as an international context.

[01:15:32]
And what would you do differently if you had your time again and why?

[01:15:38]
I suppose final caveats on work, that certainly isn't all me. I think I've collaborated and worked with lots of people in lots of different ways over the years, erm, but I think it's probably – sometimes not having a plan has been useful but also maybe having an implicit underlying plan which is adaptable and refinable has been really, really useful but there's lots of people I would – I've kind of acknowledged already and would love to kind of acknowledge going forwards, but they've both been

mentors and kind of collaborators and supporters, and people I work with, and maybe mentor and support kind of going forwards.

But it is having that kind of vibrant and diverse professional kind of community of friends and collaborators which has certainly underpinned my successes over the recent years. What would I do differently, was that the question?

[01:16:28]
Yes.

[01:16:29]
I don't know. Maybe nothing. I suppose it's kind of got to where we are now, maybe I could have been a bit more efficient and worked a bit more – maybe I could have worked harder but I think maybe I could have said no to a bit more stuff and been a bit more kind of focused and, you know, kind of – maybe have done things a bit quicker and a bit more efficiently and effectively, but ultimately nothing really. I think the point about playing the long game with some of the curriculum work and the kind of wider policy work, it could have been very seductive to have been furious when the ICT review wasn't immediately enacted or kind of changed stuff in Wales.

But actually, there was a – playing this long game I think has been beneficial and has had a much more considered approach to ICT and skills reform in Wales which I think will hold us in good stead going forwards. So, I think, you know, I don't know if there's anything that I would do differently. I think there's things that I would maybe – relationships and kind of people who I'd like to have worked more with or kind – you never know the consequences of small decisions but ultimately it's been – I'm kind of very happy with how things have kind of turned out and I suppose you can't – no regrets.

You can't regret things you've done because they've been a formative part of your kind of life and if they have been painful or they've not been – they've not come out how you wanted them to do they're still a formative part of kind of what makes you what you are now and how that kind of perhaps shapes and influences what you do in the future. So, you can enjoy the good bits because of the bad bits too, so you need the bad bits to provide context or motivation, or to understand, to reflect and maybe not to do the same things in the future.

[01:18:23]
What do you think are the biggest challenges and opportunities for stem education in the next 10 years?

[01:18:31]
It's tough. I think there's been such a huge kind of policy focus on stem education for the past 15 years that everyone knows it's important, everyone knows it has kind of economic and societal and culture value, and everyone knows that we kind of need scientists and engineers for a variety of reasons, but I think we – the evidence is really, really clear. So, there's a clear economic impact but also there's huge challenges around having a diverse stem profession, so we know not just gender diversity but also kind of ethnic and cultural diversity. So, we know there are some reports that came out this week led by the Royal Society and other professional bodies

saying the number of Black and ethnic minority Professors in science and engineering is terrible.

There are very few – like statistically there are zero in many domains because the numbers are so low. So, we know there is still a bit problem and yet we are still struggling to address some of those challenges. So, I think clearly some of the curriculum and qualifications reform work can make a difference. So, we do need to change cultures and behaviours in schools. We need to continue to change the way that the subject is taught, and there's prominence and profile in the visibility of kind of, you know, role models and mentors, all the way from primary school going into secondary school.

But again, this is going to still take a long time to affect change. I think there's still lots of work to be done in universities and in kind of academia more generally around – perhaps there are systematic kind of inequalities around how people are promoted or how people are recognised and acknowledged for their work going forwards, but I think that can be particularly challenging within the stem disciplines. Clearly, you know, we need a diverse kind of, you know, science, engineering, you know, mathematics, computer science community because it needs to reflect kind of the society that we live in.

So, you know, you don't want an all-White male faculty, that's absurd. So, that has an impact on the way that kind of learning and teaching happens. It has an impact on attracting people into those departments and those professions and clearly people will largely appointment people who look and sound like them. So, we do – there's still a lot of work to be done and the BCS are very aware of this and there have been lots of initiatives around kind of promoting diversity from an equality, diversity, and inclusion perspective within computing.

It links back to the work of the Royal Academy of Engineering, you know, being signatories to the wider [unclear 01:21:09] in this space but I think we probably need to be able to – the evidence is really clear, I think we need more action now going forwards.

[01:21:16]
What advice would you give to someone willing to pursue your career today?

[01:21:23]
That's a great question. I don't know necessarily follow what I did because, erm, it's been difficult and maybe it's – there's some serendipity there as well. I suppose perhaps that reflects the challenges of getting into academia now. So, you know, I saw an interesting tweet over the last couple of weeks around saying the people who are applying for kind of entry level kind of early career positions now, that would be getting senior positions 20-30 years ago.

So, there is a massive change in how kind of, you know, the recognition of the contributions of academics. So, it's decidedly – it's non-trivial to do a PhD and to then become – have a tenured or a kind of a permanent position in a UK institution and even harder to become a Professor. I think there was some work for the Royal Society a few years ago saying actually from – within science and engineering, then,

you know, from the attrition from PhD to permanent position is about 4% of people would get faculty positions and then 0.4% of people become Professors.

So, that's – and that doesn't mean that everyone who does a PhD has to become an – has to go into academia but again I suppose it shows that is not easy and the way that in which we're measured is still quite narrow, so it is about the number of papers you publish or the perceived quality of papers, there are a quite subjective quality of papers and where they're published, and also the amount of money you can bring in, but obviously I think my – I'd became a Professor by doing lots of kind of policy and kind of practice type stuff alongside my kind of research.

Papers and kind of funded grants, but actually I think we probably need to better reflect and acknowledge the diverse kind of activities and contributions that make up academia. So, it shouldn't just be about people can publish four star Ref papers. That doesn't reflect the diversity of kind of the roles and responsibilities and the potential impact that academics can have on society, and the world and I think we do need to better reflect that.

So, I think it's not easy. I think you do need to be quite rounded, so you need to have kind of solid research. You need to have papers. You need to have a track record of funding, but I think you also need to be able to do these things kind of science communication activities, to do public engagement, to get involved in policy stuff. To do media stuff. And to better communicate what your work – the impact your work can have to a range of diverse audiences. So, I think you have to think about that balance and what is comfortable for you, and what fits for you, but again I think if you are able to articulate that and to evidence that as part of this kind of broad and balanced kind of career then hopefully that will hold you in good stead going forwards.

But I wouldn't necessarily follow mine as a blueprint, partly because it will be a little while until there will be another curriculum reform piece in Wales, but I think, you know, maybe it shows that, erm, you know, you want to, you want to be involved in lots of different things and there is a kind of – there is a coherent consistent approach to some of these works and it fits together as a corpus of work, but I think the wider skills you develop of being able to speak to politicians and policy makers. To be able to speak to industry. To be able to speak to multiple publics.

To be able to speak to school children, and communicate all those complex ideas that is the – underpins all of your research, those skills are really, really valuable going forwards as well.

[01:24:58]
Thank you Tom. It's been a real pleasure talking to you today.

[01:25:05]
Thank you very much.

[01:25:05]
Thank you.

[01:25:12]
Shall I stop?

[01:25:12]
Yes.

[Audio ends: 01:25:15]