Professor Phil Blythe

Interviewed by

Jane Bird

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By Zoom

Welcome to the Archives of Information Technology where we capture the past and inspire the future. It's Tuesday 13th February 2024 and we're talking on Zoom, as has become customary since the Coronavirus pandemic. I'm Jane Bird and I've reported on technology and IT and telecoms for newspapers such as The Sunday Times *and the* Financial Times *since the early 1980s. Our contributor today is Phil Blythe, Professor of Intelligent Transport Systems at Newcastle University. Phil focuses on policy and technology in areas such as connected and autonomous vehicles, electromobility, decarbonising transport, age friendly and accessible transport and smart cities. He leads Newcastle University's Future Mobility Group and directs its Centre for Research Excellence in Mobility and Transport. Previously, Phil was Chief Scientific Adviser for the Department for Transport. During Covid-19 he was a member of SAGE and led the scientific team that advised the post-pandemic recovery of UK transport. In the past twenty-five years Phil has been awarded more than £40 million of research projects, from sources such as the research councils, government departments, the EU, industry and NGOs. He is principal investigator on the newly awarded national research hub that will work out how to upgrade and decarbonise the UK's national, regional and local transport infrastructures.*

Phil, welcome. I'm very much looking forward to hearing more about your life and experiences in the worlds of transport technology and innovation.

Oh, it's a pleasure to be here, Jane.

So, if we could start at the beginning. You were born in Durham in 1963 and you just had one younger sister, I think, is that right?

That's right, yeah. My parents were in the Fleet Air Arm and they'd been based down in Cornwall and they came back up to the north-east where my father was from in that winter of '63, and I was born ten weeks premature in Dryburn Hospital. So my dad's next posting was in Malta and my mum and I followed quite a while later because I was in hospital for quite a while, being so premature. So the fact I survived all that back in 1963 has always given me a sort of optimistic view of life.

Very cold winter, I think, wasn't it?

It was very cold, yeah. My mum, well, my dad sadly passed away in the early seventies, but my mum used to tell me about, you know, it was touch and go whether people actually survived on the roads at the time, it was a bad time, apparently.

So did you have a happy childhood then? You were in- so did you come back to Durham or…

Yeah, we were in Malta until I was about four, then we, my dad's last posting was at Royal Naval Air Station Condor, which is in Arbroath, which is now the Royal Marine base, but in those days it was still an air station. And we came to Durham when my dad retired from the Navy in 1969, possibly early 1970, and sadly my dad passed away at the age of forty-two at the end of '71 when I was eight, so my mum brought myself and my younger sister up by herself. So I'm eternally grateful for what she did and she sacrificed everything else, as a mum does, to look after her kids.

That must have been quite hard, I guess, do you think it gave you a certain hunger and drive?

Yeah, but I think that came a bit later, you know. It took a long time to reflect on that, because, you know, when you're eight, after a while just having your mum looking after you, it almost seemed like the norm. I think it was a lot later, you know, when, in my mid to late teens when you realised how much you missed not having that father figure around, although my mum did a brilliant job of both. But yeah, yeah, it was hard. But it was a happy childhood, we lived in a council house in Durham, at Framwellgate Moor, literally opposite the schools where I went to, so it meant my house was like the hub for a lot of people to come to before and after school, and yeah, we had the best of what we could have. So yeah, it was happy.

And what about academically? Were you academically quite bright from the early days?

I wouldn't say I was anywhere near the top of the class. You know, I worked hard but I wasn't in the top ten per cent or twenty per cent or whatever. And I think sometimes

also there was a lot of people from the private estate, so I think they felt more entitled and more, you know, able to move on. So, you know, I did my A levels. It was strange, I actually chose maths, physics and politics, simply because I was looking at doing chemistry and our chemistry teachers weren't particularly great at the time. And in a way, I was really pleased I did, because you just learnt to see a lot of things in a wider context than just looking at it from the science and engineering point of view. And who'd have thought that thirty, forty years later I'd end up being Chief Scientific Adviser down at DfT, where literally you're thinking about science, technology and the policy all at the same time.

[00:05:36]

Yeah.

Really bizarre. But that wasn't planned, that was purely just because I felt I couldn't do chemistry.

No. Ah, well, we've jumped a bit ahead there. Just to step back for a bit. So at school then, they were local state schools, you said, the local junior school, the local comprehensive. Did you have inspirational teachers there, I mean mentors that fired you on?

Yeah. I mean my English teacher, Mrs Dickinson, she was very good at really trying to push, and whenever you wrote anything, try and challenge you to try and put more into it and express it better. My politics teacher, a guy called Dennis Harrigan [sp?], was really good, because he made you think about the bigger picture. And we had a fab physics teacher at A level as well that made it interesting and, you know, you just didn't learn the formula, you didn't learn, you actually understood what it meant in the real world, which I think was really helpful. Because I think one of the criticisms I sometimes have of some of the teaching I've seen, it's all the formulae, this, that and the other, but not the application of understanding what does it actually mean in the real world. And I think that's really, really important, because once people get what it means for them, they become far more interested in learning more about it. That's my opinion anyway.

Yeah, yeah. And you also liked building balsawood aeroplanes, I think?

Yeah, I think in the junior school we had a craft lesson and it was actually building, using all the little struts and then putting the skin on the aircraft and actually building it and getting it to fly. Yeah, that was good fun. At the senior school, you know, we had proper woodwork, metalwork classes where you did work in a forge or you built this and that. And, you know, to actually have that craft and that practical side was great. I mean I did A level – oh, sorry – O level metalwork and I built a little steam engine, you know, doing all the very delicate measurements and boring in a lathe to make the pistons and stuff like that. It was good fun. It blew up in the end and nearly killed us all, but it was good fun while it was there.

Oh, that's lucky, that could have been an early finish to things, a rather premature end to your career.

Who knows? Who knows?

So you had that practical engineering side as well as the physics and the theory of it all.

Yeah.

And did you come across technology, I mean did you have a computer or when did you first meet computers?

I think the first computer we came across was a ZX81, that little home computer, which had just a few kilobytes of memory. And you had this 16-kilobyte extension memory which was about the size of a big mobile phone, which you plugged in the back and then you could load programs from a cassette on. So that was my first experience of a computer, and my only experience until near the end of my time at university. I really struggled, not really knowing what I wanted to do at university. I knew I probably wanted to do something practical or something engineering, but you know, in those days it wasn't very clear what an electrical engineer or a chemical

engineer or a civil engineer or a mechanical engineer did. But in the end I chose electrical engineering and – electrical electronic engineering – and it's really bizarre. In the mid-seventies we got a colour TV and I used to love things like the James Bond films. I remember watching *Goldfinger*, which I think was actually made in 1964, so it was probably about ten years later, and there's a scene where James Bond and the sister of Jill Masterson, who was the girl that Goldfinger's henchman painted in gold and killed, were stalking Goldfinger's factory in, I think it was in Switzerland. And they're in the woods at night in the dark, and you just see this focus in on his watch, and he presses a button, and it's an LED watch, it shows the time in red LEDs. And that was 1964 – I probably saw it ten years later – and I just thought it was fantastic, you know, new technologies, and in a way that thing was always in the back of my mind and when I had to make a decision about going to university after my A levels in '81, that was one thing, I want to do electronics because I want to do cool stuff like that.

[00:10:02]

So that's what you did, and you went to Newcastle University?

No, I went to what was then Newcastle Polytechnic, Northumbria University.

Oh yeah. Yeah, yeah. And that was successful, you enjoyed that? Because you didn't stay on and do a doctorate, did you?

No, after my degree, which was a four-year, what was called a thin sandwich degree, we spent both summers in industry, I got involved with some research on road to vehicle communications using microwave communications, which was part of my project as an undergrad. Because in those days there wasn't any way for vehicle and roadside to communicate with each other and there were some interesting looking things like, what could be done for automatic tolling and road pricing. So I eventually got involved in a research team doing that, which was a joint project between Northumbria University and Newcastle University, and although I loved doing the technology stuff, I got more interested in I wonder what if, or all the applications that technology could be applied to in the transport field. So I kind of moved over to the

transport group at the university where I became their technology guru, although I wasn't really a technology guru, and looked at all these opportunities for new tech. And bear in mind we're talking about 1985 here, where technology was very expensive, clunky and largely didn't work, and there was virtually no communications, virtually no use of computers whatsoever within transportation at the time.

Yeah. So you then, you got your degree and you then straight- but you stayed at university?

I stayed at university working, doing a PhD, that was the theory, I never actually got round to submitting it because I'd just got so busy with the other stuff, and developing road to vehicle coms, microwaves for that. That's how I got known in the sort of transport field as one of the technology leaders. Interesting stuff, you know, we won a European project, which I wrote in the late 1980s for the first EU programme on transport technology, a thing called Drive, which started in 1989. And we won a project with industry from around Europe to look at the potential for developing this road to vehicle communications for automatic tolling so you didn't have to stop in a toll plaza and hand over money, and basically the ambition was to try and replace the toll plaza by just communications that would deduct money from sort of device in the vehicle without having to be in lane, without having to stop. And also looking at the potential for doing that for road pricing. At the time there was a real interest in the UK and in many parts of Europe to look at could road pricing be a way of managing traffic demand. In Hong Kong, in '85 they introduced a demonstration system of road pricing, which was basically inductive loops in the ground talking to a tag on the bottom of a vehicle, which was about the size of a, oh, a litre of fruit juice, and it just passed an ID code back to the ground and you could then charge on that. We wanted to look at what were the next generations of that, how they could be used for things like introducing road pricing in a big city or a complex city. We started that with, we won some money from the predecessor of EPSRC, which was known as SERC – Science and Engineering Research Council – and from the EU, and from what was then the Department of Transport, now Department for Transport, to develop a technology to do that, with the view of demonstrating it in the city of Cambridge. Because the then Director of Transportation in Cambridge was a guy called Brian

Aldridge [sp?], very larger than life figure, who'd come up with this idea of congestion metering, where you charge vehicles if they're in an area and they're contributing to congestion. So they're not just, the delay they create for themselves, but the delay they create for all the other road users on the network, and there's a cost associated with that, there's pollution costs and opportunity costs. So we developed a system for that and put it into Cambridge between '92 and '94, called the Cambridge congestion metering scheme. So that was the first ever demo of smart road pricing in the UK and indeed in Europe, apart from a couple of trials we were also involved in, our European projects in Oslo, Trondheim and Bergen in Norway at the time.

[00:14:46]

Sounds like you had some quite good opportunities to travel then, did you? Did you go to Hong Kong and did you go…

I didn't go to Hong Kong, no. I've been invited many times and never actually got there, but I did a lot of travelling. You know, we had a lot of European projects and I was also advising the European Commission on demand management of road pricing and I ran what was called, I was known as the Area One Chairman, which was demand management, running anything to do with automatic debiting, electronic payments for transport, whether that be tolling or pricing, or for cards for public transport. So I was in Brussels almost every week and travelling to somewhere in the UK to the point where you were just disorientated, you were travelling so much. But it was interesting, you know, advising at the very high levels of European Commission, giving presentations to the parliament. Doing things like, they used to, they had a senior officials group called SOGITSE – Senior Officials Group IT Standards Europe – and you were advising them on what frequency should be used for road to vehicle coms, because we'd all focussed in Europe on 2.45 gigahertz, which is the same frequency as our microwave ovens, which is known as ISM band – industrial, scientific and medical – which means anybody can use it without a licence within reason and within limits of how much power you use. But at the time, American company called Amtech were bringing in container tags using the same sort of frequency which were really dumb. As soon as they picked up a signal at that frequency it would reflect data back. So we made the case to move everything in

Europe from that 2.45 up to 5.85 gigahertz, which was another ISM band. And that's where all the tolling systems that exist and road pricing, vehicle to roadside coms for things like route guidance and connected vehicles all exist now. And that's because we put the business case together and the technical case for that, for example.

So you really were pioneering all this from Newcastle?

Yeah. And you didn't realise that at the time, you know, how much we were in the heart of all of this. It wasn't called intelligent transport systems at the time, it was originally called RTI – Road Traffic Informatics – then it came to ATT – Advanced Transport Telematics. And eventually across the world it was agreed that the term that would be used by everybody would be ITS. Yeah, we were right at the centre of it then and it was good fun, but you were so busy with all these projects and all these delivery and all the travel that you didn't quite realise how much we were at the centre of it at the time.

So that, we're talking now about into the 1990s are we?

Yeah, up to mid-1990s, I would say.

Yeah. And you, so you were raising so many, so much funding from these projects that you had a job, I mean did the university give you a job or…

In those days I was still a contract researcher, but I had about ten to twelve contract researchers, what we call research associates working for me. So I was very unusual as a researcher in that sense. The university saw the light in the end and I was appointed a senior lecturer in 1999.

Right. So, and then eventually you got a chair, I think, in…

Yeah, three years later, just before my fortieth birthday. And my head of school, he was a great guy and really supportive, a guy called Dave Parker, just for a little bit of amusement he'd made my promotion date 1st April 19… oh sorry, 2003.

So, just to recap then, so from staying on and not completing your doctorate, you basically just got involved in all these research projects and…

Yeah. And I dropped out of the university a bit, I was seconded into Philips research and a company called Saab Computate [sp?], which were the two companies really developing, taking what we'd done and developing the technology. I was also seconded across to the European Commission as the Area One Chairman, and then working on things like [incomp], the strategic assessment team, which really looked at what were the next generation of exciting things and challenges we should be trying to fund through European research in transport technology. So, a bit mixed, but essentially always attached to the university in one way or another.

[00:19:15]

Yes, in fact the background of the university as having previously been a polytechnic presumably really kind of lent itself to those commercial…

Oh, sorry, by then I'd transitioned completely to Newcastle University rather than Northumbria. I moved over there when we won the first European project in 1989. Although Northumbria was still involved, I'd by then moved into what was called, TORG - Transport Operation Research Group – led by a very famous transport professor called Peter Hills, who was the real driver behind trying to push the UK to think about road pricing. So from '89 I was essentially an employee of Newcastle University…

But they headhunted you from Northumbria then?

Well, we were working on joint projects and the two leads kind of had a big falling out at one stage and I became more interested in what you can do with technology rather than the actual techy bit of designing the technology myself, and that's why I moved to the transport group rather than the communications group I was in at Northumbria.

Yeah, okay. So I know you did an awful lot during those years and we can't go through every single project, but are there two or three that really sort of stand out before you- because you then obviously moved on to your role as Chief Scientific Adviser in 2015, I think, didn't you?

Yeah, I did. Okay. Gosh, that seems like a long time ago now, I tell you. I think things, you know, the work we did on road pricing and the demonstration in Cambridge and the implementation of the road pricing in a whole bunch of countries across Europe for different use cases led to Newcastle University TORG being appointed to help the Department *of* Transport, as it was then, with the motorway tolling trials, which we were looking at in the late 1990s. I also got appointed to join a thing called ROCOL, which was Review of Charging Options for London, which was looking at how a new mayor being elected in London, the first mayor in 2000, which was either going to be Ken Livingstone for Labour, or… my word, can't remember the name of the guy. He was the Transport Minister for the Conservatives at the time. Sorry, his name escapes me. So we produced recommendations of how a road pricing system could be implemented in London within three years of the mayor being elected. And at the time, the sort of communications technology probably wasn't reliable enough for the sort of numbers of vehicles we were dealing with, and so we came up with a camera solution. So that basically is what, when the mayor was elected, he decided to take forward and deliver the congestion charging in London in February 2003. So, very proud of that, and I try and offset any travel I do, and I don't do a lot of travelling nowadays, against the carbon savings we have from congestion charging in London. I think, at the same time, I mentioned we were involved in a lot of public transport stuff, we were discussing with the Department of Transport and warning them that they really needed to think about national ticketing schemes, fare payment schemes, because a lot of the rest of the country was doing it. London had already signed a deal called Prestige, which was new ticket media for London, but the rest of the country were leaderless in terms of what to do. And so we worked with the Department for Transport to come up with the idea of a national specification for public transport smartcards – and bear in mind, this is quite an early stage for smartcards at the time – and that developed into what's known as the ITSO specification, which if you look at almost any fare payment card in the UK, that is still the standard that is used for interoperable fare payment. And that work on public

transport smartcards led me to be invited to join what was called the Government Smartcard Working Group, which was under the office of the e-Envoy, which was something that Tony Blair set up in '97/98 to really push forward technology and the use of computing and data. And that was really to look at the options for how smartcards could be used across government. And in that time I wrote the spec to introduce a smartcard for Newcastle University, and in there we had the public transport app, not just a student card. It was also used for voting, it was the first time in the UK that a smartcard had been used for voting anywhere. And I remember a number of ministers coming up to see that. So, quite proud of those achievements. And that led to me being invited by what was then known as Go Science, to lead on one of their foresight studies. These are these studies they do looking at maybe forty, fifty years about how technology should be, could emerge and how that could help a particular sector, and they set a study up on future intelligent infrastructure, foresight study, and I became the sort of lead adviser on that, pulling a team of academics and industry together to report on that. And we've reported on that and the potential for that in transport in 2006. And I think that's probably where I began to get that recognition at the more policy side of government, that I was someone that they could call on to do stuff.

[00:24:40]

Yeah. So I mean obviously our main focus at the AIT is about technology, is about, well, is about information technology, computers and so on. But you've been very clear that you were more interested in the applications. Was there a divide there, do you think? I mean, ideally theoretically they should be completely interconnected and integrated, shouldn't they, but…

Yeah, absolutely. And, you know, the whole point of, if you understand technology, if you understand what new technologies are coming along, which I think that's something I'm quite good at, to see something and think all the what ifs and opportunities around that, you can then think how that can be applied to solve problems. So in the intelligent infrastructure study we looked at things like smart sensors in infrastructure for condition-based monitoring to try and extend the life of the infrastructure, we looked at how data could be used to inform better on how

people, how smart traffic management could do things differently. And also what new technologies, what new use of data was coming along that could actually change and have quantum changes in how we manage transport, how we deliver transport and the like. So it's linking up that computing, it's linking up the IT, it's linking up all the other science and technologies coming along to look at what can it do now to maybe deliver a policy in a different way, maybe more efficiently. But also, all this stuff on the horizon that's coming, all the AI, machine learning, new sensing, new computing, smaller size of all of this, smaller cost, how that, if you nurture it well so it lands well, how that could lead to whole new paradigms in transport like an all-seeing, all-knowing transport network which potentially we had twenty years ago but never really exploited. The role that automation could play, the role of doing things that could help reduce vehicle emissions. And in those days, bear in mind twenty-odd years ago, decarbonisation wasn't so much on the agenda, but vehicle emissions as harmful to human health were, so how technology can actually sense the environment was a very, very important part of that and we won some big projects to look at pervasive sensing in that area too.

So it sounds like the UK did have quite a global lead. I mean I'm not saying the best in the world, but it sounds like we were up there with…. Were there lost opportunities then, did we lose our way, have things not fulfilled the possibilities and the potential expectations that you might have had at that time?

In the usual way, this is very typical of UK even now, is I think we are a nation of great innovators, great thinkers, great researchers, we come up with some fantastic ideas and innovations, and we take them so far up the TRL levels – technology readiness levels - but in terms of turning them into products and making global markets out of them, we're not so good. And it was interesting when I came into government in 2015, the innovation strategy was just coming into being, and that was a really important way of actually saying yes, we recognise we're innovative, we've got fantastic innovators in large companies and the universities, in the SMEs, how do we actually translate that into products and services that the UK can make money out of. And, as important, encourage inward investment and investment of companies to actually locate in the UK. And I think we were passionate that we're better than we were, but there's still a lot more we can do. I think Innovate UK has made a

difference to some extent in doing that. But I think one of the challenges is that the funding is always quite short term, you know, these SMEs having to bid for more money to take them down the TRL levels every year. So they're spending half their time doing the great research and innovation to take the product and the idea forward, and the other half of the time always bidding for more money. And one of the models a number of the CSAs that I was pushing in government which I would say, let's say you've got five years of money, we're not going to give you five years straight out, but if you can hit these gateway reviews so we can see this is what you've said you've done, that money's there for you to take you to the next stage, and the next stage. Rather than having to worry about pitching for it all the time, all you've got to do is deliver. And I still think that would work, but Treasury rules make that really, really difficult to give public money over those longer periods of time, and I think that does hold up the innovation.

[00:29:19]

So what, okay, so what made you take that leap then? Had you felt you'd got as far as you could get in the university environment or why did you want to become Chief Scientific Adviser?

Yeah, that's an interesting one. I'd been approached previously and it was the wrong time because my kids were young and there was no way I could dedicate that time to going to London. And also, not having a PhD, I always felt not worthy to do that and I had some serious conversation with people at DfT and at Go Science about that before I finally decided to put my hat in the ring at the beginning of 2015. And I was, I really didn't think I had a chance, and it was really bizarre, because from all accounts, after the interviews they made the decision very, very quickly. But in the usual government way, they'd all forgotten to tell me. So there were various CSAs that I knew, like John Loughhead who was at BEIS, or with DEC at the time, knew that I'd been appointed, but I didn't. So I'd phoned up the headhunters about a month after my interview to say, look, obviously I haven't been appointed, could you give me some feedback what I didn't do well. And the guy looked at me, astonished, but you were appointed, did the DfT never get round to telling you? I said no. So it was kind of like a bit of a surprise.

Classic, unbelievable.

It's, it doesn't surprise me at all. The more I saw the workings of government, that doesn't surprise me at all.

Oh dear.

So then…

So you did take the job though?

I did take the job and after a little bit of negotiation said, Phil, we want you here now, because if you remember in 2015 there was an election in June, new government in, we'd really like you to come now. I said, are you sure, because, you know, we've only been talking about this for a few weeks, we've got to sort all this out and I need to sort it out as a secondment so they would cover my travel and subsistence for the days I was spending in London, for example. And so when I arrived, because they said you need to arrive, well, the new government's here, so we can really get you embedded with discussion with our ministers, blah, blah, blah. There was nothing ready. I didn't have an office, didn't have a team, no one knew what science was in the department, so I kind of turned up there almost after the first week or two sort of suffering from toxic shock, thinking what have I let myself in for? I feel like just going back to the university for a quiet life. But I decided no, I've got to give it a go. So I spent a lot, lot more time working within the Department for Transport and within all the other government departments to really build up that profile of science and engineering and what a Chief Scientific Adviser could do. Because quite frankly, my department didn't have a clue what a Chief Scientific Adviser was, they hadn't had one for a number of years, they didn't have a Scooby-Doo what they wanted to do with me. So we spent a long time trying to work out exactly what you want. And my then line manager, he never kind of gave you an idea of what they wanted from a Chief Scientific Adviser, so you used to sort of try and give him some options and hopefully he would give you a steer forward. But he always played things with a complete poker face, so you were never quite sure what they were looking for. So

you just had to build your own role. But something happened quite early on while I was there and trying to build a team and build the profile of science, and that was we had the Volkswagen scandal later in 2015 where the EPA in the States had noticed that the vehicles performed one way during testing, and so they complied to emissions tests and whatever, but in normal driving they were emitting a lot more under certain circumstances. So it suggested there was some sort of gamification where when the vehicles were being tested they would work out that they were on a test route and would perform one way, and then they would perform a different way under other circumstances. So I was sent off to Washington about two days later, which was pretty tricky because I had to get my passport from Newcastle – I was in London at the time – and with my deputy CSA, who's a civil servant, and we spent a few days with the EPA understanding what they'd found. And they were saying, look, this is a real opportunity for Europe like it is here, that we can actually get under the bonnet of what the car companies do and actually make sure that it becomes a much more robust and fair testing system going forward. So, rushed back to the UK, like anything else in government there's a major panic when something like this happens, and there was a bunch of ministers called the ministerial group on clean growth, which looked after anything to do with green tech and emissions and whatever, and wanting briefings all the time. So it was a real opportunity because it meant I could bring a team together. Sir Mark Walport was Government Chief Scientific Adviser at the time, he said, Phil, whatever you need. So brought the appropriate CSAs from what was DEC, then BEIS, Defra and the like, and seconded in experts from government from all these government departments. So I had a proper science team, looking at this, getting the evidence together, writing reports for the Inter-Ministerial Group on Clean Growth, and the like, and it was really a great example of how you can bring that science and engineering expertise from across government together and actually deliver on something and understand it really quickly. And in a way, that really led to the role of science, the role of Chief Scientific Advisers having that much higher profile and being seen to deliver on really important things for government. So it was just fortune of timing that I had the opportunity to lead on that. And credit to my office who pulled together all these experts for me and to Sir Mark for supporting it so well.

[00:35:21]

Yeah. Sorry, that was Mark… who?

Walport, who was the Government Chief Scientific Adviser for my first two and a half years, and then he went on to be the first CEO of UKRI.

Okay, so then Covid struck, I suppose? Was that the next big thing that happened or…

Oh, there was lots of big things. We had the industrial strategy, so we had the four grand challenges, and through pushing with others we got future mobility to be one of the four grand challenges, along with big data and AI, green tech and smart health systems. And so we really pushed the agenda on automation, on electromobility and decarbonisation was really on the agenda then, on accessibility, on, you know, future urban aviation, you know, drones and flying taxis of the future. And that was a really good time because everybody was bought into that, and it really created a massive ecosystem in the UK. We had lots of other emergencies and reasons for holding SAGE and pre-SAGE meetings, on everything from drones over Gatwick Airport at Christmas, which ruined one of my Christmases, flooding, various other things I can't really tell you about, but it was an interesting time, the whole period. And then my last two years were really focussed on the Covid.

And then you decided to go back to university life after all?

Well, I'd signed up for three years, up to 2018, and in a weakened moment I signed up to be a CSA for another three years. When Sir Mark left as GCSA, Chris Whitty was interim GCSA before Sir Patrick Vallance took over that role in probably about 2019, I would think. 2018 or 2019. And Patrick was good because he was much more collegiate, he wanted to use the CSAs together. And one thing the CSAs had been very good at was being a network, at the very highest level of government to try and join departments together, all that science, technology and engineering. So there was a lot of work behind the background a lot people didn't see that the CSAs delivered on and helped join up between departments. And then, I think first week of

2020, I was up in Edinburgh, we'd stayed up there for New Year, my wife and I, and we'd been to the party in the park and the fireworks and that. And I think it was the second or third day of January, there was a pre-SAGE meeting called about some weak signals of issues happening in China, no one really had an idea what that was. Over January that got formalised. You can't hold a SAGE meeting unless COBRA has asked you to hold one, so that was why the first one was called a pre-SAGE. We spent probably two or three times a week down, physically in London, looking at the issues. Obviously I was looking at it from a transport point of view, what was needed, what data might be needed. And over time it became clear that this might become an issue. Clearly at the time the Chinese weren't telling us anything, they weren't saying that it was- they said it wasn't transmittable from human to human, even though the news pictures were clearly showing that it was. And people were trying to make judgements on what it was, was it some sort of flu? Because the National Risk Register around pandemics assumed it was going to be some sort of flu, and it wasn't. And, you know, trying to understand what was needed, what was the best approach to take. It was a really tricky time because the SAGE and other groups were trying to give advice based on really incomplete evidence, but at least something the government could use to try and make decisions. And I was talking to my counterparts around the world trying to find out what they knew, what they thought, to just try and understand whether we were all in this almost black hole of lack of information, and we were, we were. We looked at all the data sources, we got Royal Academy, Royal Society, others to do rapid reviews to see what people were publishing or what they were thinking, whether it was akin to anything else that had happened in the past. And yeah, it was a real time of uncertainty, and I've got to admit, I thought having Sir Patrick as GCSA and Chris Whitty had just been appointed Chief Medical Officer, prior to that he'd been Chief Scientific Adviser for the Department for Health, I think having those two fronting everything on the science side, being able to speak in a very clear way to politicians and to the general public, I think they were definitely the right people at the right time when we had, when that pandemic occurred.

[00:40:15]

Right. Okay, so then you're back at Newcastle, you're back into the world of intelligent transport, and to the transport of the future. So how has that, I mean that would be interesting to talk about in the context of how computer technology has revolutionised the possibilities. I mean it feels now like we've been talking about, for example, autonomous vehicles for quite a long time, which haven't come to fruition. So perhaps you could sort of talk a bit about that overlap again, between computer technology and transport and it's worked and has not yet worked and what the challenges are.

Okay, well, there's a number of areas I'm leading on up in Newcastle and automated vehicles is one of them. The north-east is a real hotbed of innovation in automation and we've got some big projects running around Nissan, the motor manufacturing plant, where we've developed a driverless tractor unit, which is electric, which can pull forty-ton loads from the logistics companies around Nissan into the Nissan factory. They've been developed with all the sensors to work out where they are on the road, they have a 5G connection and what we have to replace the driver is we have a teleoperator back at the logistics company, VANTEC, who keep an eye on the vehicle and if the vehicle, the automation, the computer works out it's not quite sure, maybe there's something parked in the way or something else, then the teleoperator can take it over and drive it remotely. You can only really do that with things like 5G where you've got very low latency in the communications. And one of the things my team's looking at is things like I try and understand the workload of these teleoperators to work out how many vehicles could they keep an eye on. And we use things like eye-tracking goggles connected to computer, so we can actually see where these teleoperators are looking, whether they're distracted, whether they're keeping an eye on a number of screens for a number of vehicles. And we're using that to try and inform on workload and whether AI and machine learning in the computers can actually improve that performance and whether you indeed in the future need a remote teleoperator keeping an eye on vehicles. But what's important from the logistics providers, people who are going to buy the vehicles, they need to know that they're reducing the number of drivers, because they can save a lot of money on that, which means they can invest in the technology. And that's where we are at the moment with

that, and I think that's really interesting. So we've got these projects running around Nissan on connected autonomous logistics. We're trying to set up a National Innovation Centre on Connected Autonomous Logistics – NICCAL – to do that, to bring all the computing science, all the data, understanding there, the communication. So we've been using terrestrial 5G around Nissan, we've now replaced that by using satellite-based 5G from Starlink as an alternative. In parallel with that we've just won a project last year to introduce a driverless bus in Sunderland, in the centre of Sunderland. Again, all the computing science and sensing around running a driverless bus in the centre of an urban environment is really challenging, so again, looking at that, looking at all the sensing needed, looking at what people would accept as driverless, you know, what their perceptions of that will be, looking at how it can be made more autonomous to the point where a smart software will take over from remote supervisors and the like, because I think that's the only way the business case will stack up, to put people, to get the investment. People challenge on that, saying, but what about all these poor drivers, they're going to be out of a job. Well, I don't think that's going to happen because there's a massive national shortage of drivers, whether it be for HGVs or buses, and you're still going to have some. Some will be driving vehicles, some might be teleoperators, but you know, for future productivity we need to move towards that automation, I think that's really, really important. And the other side of automation is you've got to make sure that your transport management and control infrastructure is fit for purpose.

[00:44:50]

So we were really lucky at Newcastle University because our regional urban traffic management and control centre, run by Newcastle City Council on behalf of Tyne and Wear authority is actually based at the university, so we use it as a research tool. But that means all the data on every single, all the CCTV cameras around the whole transport network of the north-east is brought into the university. So we do lots of deep learning and AI on that to actually understand all the patterns that occur in traffic management, how that can be used to support automation, but also how it can be used to support smart traffic management. So have this, what we call cognitive ITS, where the traffic lights and vehicles literally talk to each other, and if you're a priority vehicle like a freight vehicle, travelling from, say, Nissan to the Port of Tyne, we're

looking at how the lights can be turned green so you don't have to stop on that route, so you've got more guaranteed journey time, but you also, because you're not stopping and starting, you're potentially saving fifteen to twenty per cent of fuel, and it's almost a linear relationship between fuel burn and emissions like NO_2 and CO_2, etc. We've already got a couple of corridors running in Newcastle, one for Express buses coming in from Northumberland, and another one for passenger transport ambulances along what's called Heaton Road, Chillingham Road, to the local hospital where they get smooth journeys because they don't have to stop. Joining all that information together into a really smart computer system with really smart algorithms that understand the patterns I think is where the future of traffic management will be. And as we have more automation, that will become more to the fore. You see Waymo in the States, you see Google playing with all this, but I think there's been quite a lot of investment from Department for Transport and there's quite a lot of investment from the local authorities to try and make this happen, I think this could be one of the next big things. And if you get it right it also contributes really significantly towards decarbonisation as well, because even while you've still got ICE, you know, petrol and diesel vehicles on the road, you can get them to drive at the most optimal speeds which reduce fuel consumption and emissions. So that's one of the areas I'm doing at the moment, looking at that automation and the smart traffic management. But the other area, and the one you mentioned at the beginning, is we were very fortunate, middle of last year, to be awarded the DARe hub, which is the national hub looking at Decarbonised, Adaptive and Resilient Infrastructure for Transport. And that's where the big data and the models really come in, because there's a lot of work on decarbonising transport systems and services and decarbonising infrastructure to some extent. Not so much on the resilience. So trying to put the two together is really interesting, because what you may think is good for decarbonising infrastructure and decarbonising transport systems such as electrification, may not actually be very good for resilience. You know, I think if you have electrification, resilience of the transport system may be less if you're relying on just one fuel source which isn't as distributed as fuel stations where you collect petrol and diesel, for example. So, got a big project just started on that. Big hub – not project, I get told off if I call it a project – where we're trying to bring together all the expertise in the UK on top of the four universities that form the hub themselves, which is ourself, Cambridge, Heriot-Watt University in Glasgow and all the

stakeholders, we're trying to bring the whole of the university expertise – sorry – the whole of the UK expertise together to actually understand this field and provide that advice to government. And I think that's really, really important, you know, particularly looking at developing these models at different scales: macroscale, microscale, some might be looking at agent models of how people walk and use cycling and other things for decarbonised transport, others might be looking at weather, you know, and we've got a weather model which you can look at a region or a city and actually predict what the extremes of weather might be like in ten, fifteen, twenty, thirty, forty years ago – er, sorry – forty years' time. So what are the extremes of weather, what's that going to do to the infrastructure, how do we transition to that more resilient infrastructure now. And it kind of begins to ask questions about can we keep that infrastructure there or is it likely that the weather extremes in the future will be so bad that it's not worth keeping that infrastructure, we need to build a replacement. And maybe some of these railway lines and roads close to the sea may be examples of that, I don't know, we're still trying to work through that. Can we make these infrastructures resilient? We know we can't protect them from all extremes of weather, but if they do fail, can they fail quickly and can they recover quickly so we only take an economic hit for ten days.

[00:50:02]

But what does that mean to society, what does that mean to government. Or, is this infrastructure so important that we have to design it in a way that it's resilient even to the worst extremes of climate change, within reason of course. If you do that, how much is that going to cost. And so there's some really sophisticated models looking at this. There's a whole bunch of sensing, trying to understand our infrastructures better, trying to understand the infrastructure's interaction with things like flooding, heat, wind, snow and the like. And that's really focussing a massive team of academics and industry at the moment. And this is where the IT of machine learning, big datasets, collecting data at big scales, regional scales, even national scales as well as local scales, and putting this all together to actually form a picture of the future. It's really, really important. We couldn't have done this twenty years ago. But I hope that will help us, help us make the UK more resilient to the future challenges of climate change and provide evidence both on where investment should go in the

future, and also how decarbonising the infrastructure can actually maybe reduce the impacts of climate change through less heating of our planet overall.

Yeah. These are huge things and I mean when you look at, once politics gets involved, I'm just thinking of HS2, for example, and the slow speed, the fact that it's been cut back, the fact that its budget has mushroomed, it must at times be very demoralising just to think, you know, how long are these things going to take and will they ever happen.

Well, that's a challenge with government. In a democracy where governments change every now and again due to the electorate there's always going to be changing direction. I think in the UK it's probably more extreme than other places where- you see in Scandinavia that you have very different politics, but there's a consensus on a lot of things in the middle like education, infrastructure and the like, that don't change very much between one government and another. We're not so good at that in the UK. We need to think more long term, clearly, the challenge of decarbonising and making our future, infrastructure of our future systems and services resilient is critical, we can't give up on that. But clearly, there's only a limited pot of money and government has to make decisions on where that is apportioned. And all we can do is give evidence, give the computer models, give the data of where we are now and where we think we'll be in the future, so where you can make the smartest decisions on investing on that infrastructure, and investing on all these systems and services to deliver the best in the future. So that whole futures thing, thinking about the future in both the short-term decisions that have to be made, the medium-term and the long-term are critical and quite often we're not set up particularly well in this country to do that, but we hope, the hub, which has got massive support from government, the DfT send numbers and numbers of people to all our meetings and the arms-length bodies like that are really affected with ground transport, rail, Network Rail, HS2 and National Highways are very much involved in trying to understand this. Because they've got all these questions that need to be answered and I hope we can answer those and also deliver the tools that help people test it and model it and understand the what ifs going forward.

Are you, you're also looking at hydrogen-based vehicles, I believe. That's another technology that's been in the background for a very long time. I remember when I was on The Sunday Times *in the 1980s we once wrote a piece on the car that runs on water and we were totally inundated with people who wanted to know more. It's been around a long time.*

It has.

Yeah. What's the situation on that?

[00:54:17]

Okay, that's interesting. When I was Chief Scientific Adviser I was working with the CSA from BEIS who was looking at the future energy strategy for the UK, and they could see hydrogen being used for things like heating homes and cooking, for large industrial processes, and for agriculture, a number of other sectors as well. And that made it interesting for transport, because when hydrogen had been looked at individually for transport over the last thirty, forty years, people had been looking at it for one use case, one application, and the like, and the numbers in terms of generation of hydrogen, distribution of hydrogen, burning it, or using it in fuel cells, it didn't stack up. But once you realised that other sectors within government were interested in hydrogen, then looking at it from transport again, I think was really, really important. At the time within the DfT there was an absolute laser focus on electromobility, electrification of virtually all ground transport. And it took a long time for the department to be persuaded by myself and my team and others that hydrogen had to be considered as part of the mix, not for necessarily for cars and small vans, but for the larger vehicles, HGVs and buses in some cases, off-road vehicles, some trains, potentially quite a bit of maritime and ultimately aviation, could benefit from hydrogen. And so we collected a lot of data to show that. It was actually quite hard, because although there's a lot of hydrogen industry in the UK, it was quite fragmented. We do, we've got world leaders in designing electrolysers, in designing fuel cells and the drives, for example, but it wasn't really well joined up. And I think one of the challenges was, you know, in 2009, 2010, there was this move in transport to move down electrification route - and there was a leap of faith there

because the electricity generated in the UK was quite dirty, almost a thousand grammes of CO_2 per kilowatt hour generated, the cost of one kilowatt hour of lithium ion battery storage which are used in electric vehicles was about $1500 in 2009. So it was a real leap of faith that they could become a technology fit for purpose. But with the leadership from government, which meant the investors, the innovators, the venture capitalists, went into the electromobility field, you're now seeing that one kilowatt hour of battery storage is less than $200, the electricity in the grid's less than 180 grammes of CO_2 per kilowatt hour. Hydrogen's at a cusp where I think it could do that. I think the innovation potential is there to really improve the efficiency and reduce the cost of everything. But unfortunately, government hasn't come out clearly to say hydrogen has a really role to play in transport, in big industrial processes, in homes, etc. And without that confidence from government making a bit more noise in that area, I think there is a reluctance to invest in all the aspects of hydrogen in a way that was done for transport, for electromobility fifteen years ago. But I think we've got all the pieces there and I feel it has a role to play, and also, from a resilience point of view, having a number of different fuel vectors, energy vectors for transport I think is actually a safe thing to do.

Great. So are there other technologies that we haven't mentioned, particularly those that are connected with IT that you think would be worth highlighting?

Well, I think within government, things like quantum computing is seen as a gamechanger for quite a lot of really mega processing, which is what government needs. They need things to join up lots of different aspects of government in a way that makes some sense. I think this whole idea of things like the blockchains and the homomorphic algorithms that can be used to credibly identify pieces of data and its origin I think is really, really important, for a whole bunch of stuff around financial transactions and just the validity of the data. I think the whole area of position navigation technologies are – PNT – position navigation and timing, are really, really important. I know government's looking at some ground-based versions of that to back up GPS, because so much of what we do now, so much of our computing systems, our transaction systems, our financial systems, rely on those signal timings from GPS. That's quite vulnerable. We need alternatives, both for commerce and the timing signals, but also potentially for navigation in the future. And we're seeing, I

think, technologies that can jam communications, jam signals from satellites, are becoming mainstream primarily because of the innovations that are happening around the Ukraine war. And I think we need to be cognisant of that, because transport relies so much on navigation, so much on communications and information and so much on the whole PNT signals, so it's pretty critical.

[00:59:53]

I see, yes. So, looking into your crystal ball then, can you make a few thoughts as to, share a few of your visions for what are likely to be the main developments over the next ten years or so?

Well, I think we've got the potential, and we have essentially got an all-seeing, all-knowing transport system which knows broadly what your journey's going to be from your habits, how you like to travel, what you're willing to pay, what journey times you're willing to have, what modes are you willing to use. And, you know, with that you could make a really optimal transport system that could be much, much more efficient. I think we're going to see more rollout of electromobility. I don't know whether it's going to be as fast as government's hoping for, but I still don't think they've solved that well enough to the public to meet their 2035 agenda that all new vehicles will have to be zero tailpipe emission by then. I think there will be a role for hydrogen in transport, I think there'll be a role for e-fuels and drop-in fuels. I mean one of the reasons that Rolls-Royce and others have been arguing for small modular reactors is they could be used to generate e-fuels by sucking carbon out of the air and turning them into aviation fuels, and fuels for lorries and ships as well. I think we're also going to see automation, particularly for logistics, and possibly for public transport, where the gamechanger will be if you can make it work, if you've got the data and the smartness in the system to make it work, the business case will only happen if you can replace the driver. So in public transport we talked to rural operators saying we'd love public transport with driverless, we accept you wouldn't put it on the road if it wasn't safe – well, there's a discussion there – but can we have a community person in the vehicle so there's someone in there that can look after the passengers, for example. I think we're going to see some really interesting stuff with urban aviation as well. We're seeing drones being used for delivery, we're seeing a

whole bunch of trials and demonstrations on two-person drones, flying taxis, flying cars, etc. And I could see over the next ten to fifteen years a real consideration about what could near vertical take-off, zero carbon or very low carbon urban aviation deliver. Could it deliver a hundred-plus passenger aircraft flying from city to city in the UK? That could have interesting things for the business case for HS2 and for trains, could have a really interesting business case for Network Rail – sorry – for National Highways, because if you don't have vehicles, if you have cars that are flying above the road rather than on the road, your maintenance may be much, much less than it is at the moment. So there are a whole bunch of challenges around that. The smart traffic management for 3D traffic management in cities is really interesting. So the AI, the machine learning, trying to mimic what the National Air Traffic Service does in a city. All the issues of civil engineering and power for buildings that might want to refuel these drones with electric or something else on the roofs of buildings, making those buildings more solid and the roofs more solid to take the weight. Ah. Putting better soundproofing on all these tall buildings, because drones are a rather noisy thing, you won't want those flying past. But joining all that together so the transport system is joined, because one of the things within the department that I challenged them on from the early days was, the department's divided into [incomp] so you have roads and cities, you have rail, you have big rail projects, and you have HS2 – that's where most of our money goes – and then you have aviation and maritime. They're all in different directorates, they don't really talk to each other, they don't tend to share data, and the opportunity to bring all that together into a much more efficient system in the UK that's joined up is important. And my mantra down at DfT, and I even got some of the ministers using it by the time I left, was de-silofication, trying to bring transport out of the silos, looking at the opportunities that digital connectivity and data could do to make it a one transport system, and making sure it delivers for all. So I think that's where we could get to. Whether there's a real ambition to do that and… is yet to be determined. But the UK have some fantastic innovations in this space, we just need the opportunity to bring them to market and to demonstrate them at scale so that other countries and other parts of the world can learn from us and take some of our ideas and implement them there.

[01:04:54]

Wow, well, that's a big challenge isn't it? So for young people, because we're partly targeting our audience here with these interviews as to whether this area would be one that you would encourage young people to go into, and especially those who are interested in IT already, is there a role for them, do you think, and is it a promising area where you think they would have an exciting career?

Absolutely. As I mentioned, when I was deciding to go to university, hadn't a clue about transport technology and what might happen, but there's so much to do in this space. What's now badged as future mobility, bringing science, technology, computing, communications, AI and everything else to solve transport problems is massive. As an engineer, what we do is we bring the science, we bring the maths and we turn it into solutions. We actually build the solutions that you see, every building, every house, every car, every ship, everything you see, it has been engineered. So, my advice if you really want to make a difference, come and do engineering. The diversity of the career paths you can have, working on the technologies, working on the applications, developing whole new solutions for cities, delivering on the solution for decarbonisation, net zero and making sure we're resilient in the future is really important. Also, transferring those skills to other countries that are less fortunate in terms of funding and the like and trying to solve the problems elsewhere in the world are really important. Only engineers can do that. And the one thing is that as an engineer you're trained to solve problems, think logically, it doesn't matter what engineering skill you've been trained in, you can bring ideas, work out the problems and the challenges and deliver that into solutions. And I think that's really, really important. Because I think in schools, unless you've got people whose parents are engineers or if the teachers really understand that broader aspect of engineering, you're not going to be told that, you're not going to realise that once you've got that skill, think about the bigger system, think about the wider context and go and solve those problems. And that's what engineers can do. You can go and do environmental science, and environmental science will give you great data and tell you what the problems are, won't tell you what the solutions are, the engineers will find the solutions for you. That needs data, needs a whole bunch of skills on understanding data, using data, how AI can be used, but also those softer skills of engaging with the

wider community, the wider project team and understanding what you're doing, what context that means for the community, for society, for the individual, for government, and for the economy, because at the end of the day, if it's not generating money and doing stuff, people are not going to fund it.

And is there, what would you pick out as your proudest achievement during your long career?

I think it's the fact that I see a lot of my students, I run a Masters degree in transport where we have modules on future mobility, it's seeing those students move out of academia to work in local authorities, work in industry, work in government and the like, and actually implement these solutions. But have in the back of the mind, I've told you what's coming in twenty years' time, how can you use that now, how can you plan for that now, and actually deliver. And just seeing all those smart people with the energy and the ambition to move forward. And as I say, transport, because everybody uses transport, everybody has a view on transport, if you didn't have transport you wouldn't have an economy, you wouldn't have a society. Okay, it's really, really important, but it's going to have to change to meet the demands of decarbonisation and net zero and the resilience of the future. With the urbanisation putting more people into cities, that puts a whole bunch of different challenges on what transportation means. So you're never going to be out of a job, but the opportunities to make a real difference to society are massive. And I'm proud of my students. I'm also obviously eternally grateful to my wife and my kids for supporting me through this, particularly in those years where I spent a significant proportion of my time down in London.

[01:09:26]

And is there anything that you would have done differently, would you have taken that Chief Scientific Adviser job earlier?

Yeah. As I say, I was so busy with projects that I never finished my PhD, that's always been a regret. The fact that people still recognised that I had a value and hence even being appointed as CSA without a PhD, I think is a really important point.

But I wished I'd been… I'd moved away from the projects, moved away from being asked to do all the stuff and actually got the PhD under my belt. Because I think that would have given me a lot more confidence to go forward both in academia and in other spaces as well. But, no, personally I think the time I was CSA from 2015 to 2021 was probably the right time for me. Delighted with my successor, I think she's doing a brilliant job, and she's very lucky at the same time because I put all the structures in place to make her job a lot easier than it was when I moved in, but that's life. And CSA, as a whole, I think is a, it's a unique role in the UK. If you ever aspire to that for any of the departments, work hard towards it, because it's worth it, it's the hardest thing you'll ever do, but it's rewarding, you're right at the heart of decision making of government as well.

Well, that's been absolutely fascinating, Phil. Thank you very much for sharing all your thoughts and experiences, so many thoughts and experiences, I know there are an awful lot more that we haven't had time to look at. But it's been really interesting to hear and well, we'll continue to watch and see how many of these forecasts come true in the next ten years.

Okay, and just thanks, Jane. You know, you've given me a chance to revisit a whole lot of things that I'd even forgotten, at the back of my mind when we started this interview. And maybe it didn't cover the IT and computing as much, but everything, you know, at the back of it all is the IT, the communications, the data. But at the end of the day, that's useless unless you can find useful applications for it.

That's great. Well, thank you.

And make a difference. Thanks Jane, appreciate it.

[end of recording]