

Science and Technology Committee

Oral evidence: [Closing the STEM skills gap](#), HC 853

Thursday 16 March 2017, Birmingham

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[Watch the meeting](#)

Members present: Stephen Metcalfe (Chair); Victoria Borwick; Dr Tania Mathias; Carol Monaghan; Derek Thomas.

Questions 1-77

Witnesses

I: Yvonne Baker, CEO, STEM Learning UK, Paul Jackson, CEO, EngineeringUK, and Philip Pratley, Director, Trade and External Relations, Leonardo

II: Dr Kirsty Clode, Chair, Women into Manufacturing and Engineering, Blossom Hill, BAE Systems' UK Apprentice of the Year 2016, and Mark Page, Your Life Advisory Board Member and Managing Partner, A.T. Kearney.

Written evidence from witnesses:

- [EngineeringUK](#)
- [Women in Manufacturing and Engineering](#)
- [Your Life](#)

Examination of witnesses

Witnesses: Yvonne Baker, Paul Jackson and Philip Pratley.

Q1 Chair: Good morning and welcome. Thank you very much indeed for joining this session of the Science and Technology Committee. This is our first evidence session of our inquiry on closing the skills gap. I am delighted that we have come up to see what you have been doing here at the Big Bang Fair. We have had big bang in Parliament; this is Parliament at the Big Bang, I think. Thank you very much for the invitation and allowing us to come here. Perhaps you could introduce yourselves and state who you are representing here this morning.

Yvonne Baker: I am Yvonne Baker, the chief executive of STEM Learning. We are the organisation that runs the National STEM Learning Centre at York, the network of science learning partnerships providing teacher CPD, the STEM ambassadors programme and the STEM clubs programme.

Paul Jackson: I am Paul Jackson, chief executive at EngineeringUK and at Big Bang Education. We provide labour market information in the EngineeringUK “State of Engineering” report every year. We support employers in their work in schools bridging the gap between employers and education, and we lead the Big Bang initiative.

Philip Pratley: I am Philip Pratley, the trade and external relations director of Leonardo UK, but I am here representing the advanced engineering sector in the engagement we have with education at all levels, from primary to postgraduate.

Q2 Chair: Thank you very much. Welcome. Just for the record, you should be aware that we are recording today’s proceedings and there will be a transcript, but it is not being broadcast.

I think we are all aware that there is a skills gap. There have been numerous initiatives, Government and otherwise, to try to bridge that, yet there still seems to be the STEM skills gap. Could you briefly explain why you think that is? What STEM skills specifically are we lacking that we need to do more to bridge?

Paul Jackson: The gap that we are seeing is in areas such as engineering, digital, physical science. There is not the gap across every aspect of STEM, and I think that is pretty important. In terms of the numbers, we have just produced the latest report, which draws on Working Futures as its core source material. We are seeing a gap of upwards of 20,000 graduate-type skills, so level 4 and above—maybe those could be reached by apprenticeships in the future, though—and a similar number at level 3. We do see a gap. However, public attitudes that have perhaps caused that gap are changing. The education system, though, is not changing positively in encouraging people to study science and maths through to 18.



Philip Pratley: We, as employers of engineers, find it increasingly difficult to recruit the skills that we require for the future rather than just for continuing the business as it is today. We do not believe that there is any lack of willingness among those who are in the pool of potential engineers at postgraduate level or at higher apprentice level and advanced apprentice level. The problem is the numbers who are able to enter that pool in the first place.

It occurs to us that part of the responsibility for closing that gap lies with the engineering employers to work more closely with education to ensure that the staff in the science and mathematics departments feel that they are properly supported, that they have the access to the illustrations, the case studies, of what engineers do and why engineering matters. We have a responsibility as the advanced engineering sector to engage more closely with education and we also have a responsibility to address the imbalances, particularly the gender imbalance. The hashtag #9PercentIsNotEnough carries a very important message. We do not have enough women in engineering and that is something that we, too, need to address.

Yvonne Baker: I agree with what has been said. I think there is also the productivity gap. We need to be more explicit, particularly with young people in schools and teachers, about what we mean by the productivity gap. I think it is a phrase that is used quite widely yet not really translated to what it actually means.

I would like to challenge Paul's statement a little bit about the education system not changing. There are issues of education, which we can come on to—and I will be glad to—but I would remind the panel of the PISA 2015 report, if I can read a quick statement, "Australia, Canada, Ireland, Portugal, Singapore, Slovenia and the United Kingdom are high performers in science. Their 15 year-olds hold strong beliefs about the value of scientific enquiry and larger than average proportions of students in these countries expect to work in a science-related occupation later on". I think progress has been made, but teachers and schools have an awful lot of other competing priorities. There are issues of curriculum and time for open-ended science investigation and of teacher CPD. I think we need to be prepared to give credit where credit is due a little bit as well.

Q3 **Chair:** Thank you. You talked about how we compare with other countries in the PISA table. How do we compare with other countries in the skills gap? Are they experiencing exactly the same problems?

Yvonne Baker: In the work we do across various international projects in education, very strongly many other countries, including the ones that you would not necessarily recognise—the Netherlands, Germany, South Korea, places like that—are all experiencing skills gaps. I think here there is a bigger gender gap that is well documented, and we have to look at education and also very much at media, social and cultural attitudes in this country. I speak as a female engineer of fairly decent vintage now. It



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is a sticky problem. The percentage of female engineers has not really shifted over the last few years.

The other issue is that I know in the latest figures for registration, for example, about 10% of new registrants for engineering registration, chartered engineer, are females, but there is a high attrition rate in their late 30s, 40s, when they maybe take career breaks. We are not holding on to them and that is a really big issue that we need to think about.

Paul Jackson: We have done some work looking at other countries, and looking particularly at the proportion of young women who go into engineering, and ours is the lowest in Europe. It ranges from our level up to a maximum of about three times in other countries. We looked specifically at Italy, Sweden and Ireland for comparison, looking at countries that had done a lot to encourage women to go into engineering and some countries that had done precious little. The key factor appeared to be that the broader education systems that run in pretty much every other country that allowed those young women to make a later choice about their career kept the possibility open. Our tracking of public attitudes has shown that when young women get beyond 16 and 19 they are more likely to see engineering as desirable and really see the context for it. Pretty much every other country you look at will have a better record on this than the UK does, which is a major contributor to our gap.

Q4 **Chair:** As a company that operates not just in the UK?

Philip Pratley: We have had to find ways of bringing first degree entrants into engineering from degrees other than straight engineering degrees. It is very important that we can draw on physicists, mathematicians and natural scientists and bring them into the engineering profession. Through our graduate scheme, which takes an individual through to chartered status, we have been able to do that working very closely with the IET. It means, for example, that although the percentage of female physics undergraduates is not great, it is better than engineering, it is better in maths than engineering and it is better in natural sciences than engineering.

By opening up the routes into the engineering profession to a wider range of first degrees, we can improve the number of applicants overall but we can particularly do something to address the gender imbalance. It is almost as if we have to accept that the structural imbalance in the engineering and computing science first degrees is something we as a sector have to live with and find ways of ameliorating the problem rather than going straight into the engineering faculties and trying to address it head on. We won't do it fast enough.

Q5 **Chair:** Thank you. I think it is pretty well established that we have the gap. In terms of filling it, is the pace of change for the skills required an additional challenge, that skills that you may learn now may not be the ones we need in the future? How do we get in front of that curve as opposed to chasing it?



Philip Pratley: We find that work-centred learning, the ability to take people across a career's worth of training and education and development, is fundamental to addressing the point that you have raised. It is said, perhaps anecdotally, that the half-life of an engineering degree is five years. In that case, my engineering degree went some way through a threshold verging on zero a while ago.

If we are to address this fact of the technology changing so fast that the half-life is five years, we can only maintain our credibility as a British engineering sector by taking through-life learning as an absolutely essential part of addressing the skills gap. We need to understand also that the types of very high-skilled tasks that we will require in the future to keep ahead of the advances in robotics and AI, artificial intelligence, will also require us to change what people do in their final year of a first degree and in their master's year. Increasingly, entrants into the profession at postgraduate level are master's rather than just first degree holders.

Paul Jackson: I think it is very important to think about the next industrial revolution, which is now under way, and making sure that we have the right skills that are available for that—picking up on Philip's point—digital skills, data. Engineering looks very different from what it did just 25 years ago, where it was much more about the hardware and what you would associate with traditional engineering skills on apprenticeships and degrees.

If you look at a modern motor vehicle or a modern train, the digital systems are incredibly important. The mechanical systems still need to work and the electronics need to be there and so on, but if a signalling system is going to be working effectively and using the capacity on a track, it is going to be digital. In a car, we are expecting it to be autonomous in the future; it is going to be digital. It is very important that we are preparing for the big change that is coming up and that we do not prepare the skills that would be relevant for 10 years ago but are preparing for what is needed in 10, 15 and 20 years' time and supporting through continuous learning as well with adults.

Q6 **Chair:** Did you want to add anything to that?

Yvonne Baker: Yes. It has been touched on, but I think there is a real issue with the speed of filling this gap about people who have trained as engineers and scientists and want to return to that profession. We could be talking about women and men taking career breaks for having children, but I think it is much wider than that as well. There are many people who have gone off and done an engineering degree and an engineering career. One of the reasons that it is so good for young people is that it opens doors to all kinds of careers because employers think that people who think in an engineering way are incredibly valuable. All of us have done that. What happens if you want to go back into frontline engineering and frontline science? Very often the technology will have



moved on and you have no way of retraining and going back into it. That is a major thing.

In terms of the school curriculum, what we need to be doing is focussing on investigative skills and open-ended investigation, which is the kind of thing that develops your teamwork, communication and problem solving, all the things that are transferable skills for the future.

Q7 Victoria Borwick: Do you think there is too much of a time delay when everyone sits around and designs the curriculum before it actually comes in? I think the problem is that the curriculum tends to be rather fixed—many of us serve as school governors, and maybe some of you are—and I am a bit concerned that there is not a system in Government that allows us to come up with something that is a bit more—not to say reactionary but a way of taking this forward. What is it that the other countries are doing that we are not doing? Are we being too reactive to your needs rather than proactive?

Yvonne Baker: I think there are two things about curriculum change. First of all, it takes quite a long time for change to come in. The other part is that there has been so much curriculum change over the last few years and what most of the teachers and the head teachers you talk to want is curriculum stability.

Victoria Borwick: Yes, I do accept that as a school governor myself.

Yvonne Baker: That then allows them to teach all these things within the framework of the curriculum but teach them in a way that develops investigation skills, thinking skills, all those things. I think it is the speed of change, but it is really about stability, getting to a curriculum that allows those things to be developed and then being stable.

Q8 Victoria Borwick: Do you get involved with curriculum writing? Not you personally but—

Yvonne Baker: Yes, my organisation helps advise on aspects of the curriculum, working with the scientific societies as well.

Philip Pratley: Perhaps the most prominent example of industry being involved in curriculum development was the change in the GCSE computing science curriculum that came in in 2014, which was a complete transformation of what had gone before, prompted by industry because of the concern that computing science had regressed into being engineering certain well known products of a large firm but not actually in understanding the basics of computing science.

More generally, the curriculum is not particularly agile in using the engineering sector for its case studies. Again, it is a two-way responsibility but if we in industry do not really understand what the curriculum is doing and what the changes are about, we find it difficult to provide support to those members of staff who are looking for case studies to support the depth of the curriculum so that their 14 to 16-



year-old students can realise why something in the curriculum is more important than just the formula that may be in front of them on a particular day.

Q9 Dr Tania Mathias: If I could pick up on that two-way responsibility, I know in my constituency of Twickenham NPL, the National Physical Laboratory, goes in and does a rocket science competition for schools. We have a problem with not having enough people teaching maths and science. Do you think there is a role or is there a capacity for companies helping in the classroom, giving people time and sabbaticals to go into the classroom? Is there any thought on that?

Philip Pratley: I think there is considerable scope. Your reflection on NPL is interesting. I grew up in Twickenham, in Hampton, and the school I was at had a very strong maths and sciences basis, not least because of the relationship with so many parents who worked at NPL. The National Physical Laboratory exemplifies the passion for physics, maths, science and engineering and many companies now are able to do exactly that with their local schools. There is a limitation at the moment on what we can do by sending our younger, more recent graduates in to stand in front of a class rather than in to support an after-school club or give some sort of case study assistance to a class but not actually stand in front of it delivering the curriculum.

The question that perhaps occurs to us in the engineering profession is whether it is better to have someone who is a good, talented, young engineer whose communication skills can put the point across or whether it is someone whose teaching background is profoundly good but whose understanding of maths and science may not be as good. That is a direct reflection of the number of physics, maths and engineering graduates, especially physics and maths, who went into the teaching profession. It is lower than the education sector requires. Rebalancing that in the short term might be possible if we in the engineering sector can make younger graduates available to assist in delivering the curriculum rather than just in supporting STEM case studies.

Dr Tania Mathias: Thank you. That is interesting.

Paul Jackson: We have a piece of work going on at the moment in the postgraduate faculty of education at Bristol that is looking at this and following some employer work in schools. Unfortunately, we do not have a full report yet. We will have it in the next month or two. What they have been finding so far is that there is tremendous value or there can be no value if it is not relevant in supporting the teachers and supporting what is happening in the school. They found that it is better to have one really good piece of support than lots of support that does not do anything that is relevant. Maybe that should not be rocket science to work out, but there has been an assumption in the past that more must be better. The reality is that more would be better if it was good in the first place.



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In taking advantage of the willingness of companies to support their local schools, which is absolutely tremendous across the country in this sector, we need to get better at making the most of it so that it is giving schools what they need.

- Q10 **Dr Tania Mathias:** That is very helpful. Thank you. You have explained very well about companies bringing non-engineer scientists into engineering. With the upskilling, we also had the Committee talking about the fourth industrial revolution and a lot was about upskilling. Do you think there is a role of upskilling everybody every five years or every seven years? Do you see that in the workplace?

Philip Pratley: I would be reluctant to put too prescriptive a timescale on it, but if it is not within a five-year time band it is likely that the skills that people have will atrophy to the point that they are no longer relevant to the technologies that the companies require, particularly if they are competing in a global marketplace against the companies that come from the countries that Yvonne was mentioning that do put engineering at a much higher priority at an earlier stage of education. Without being prescriptive, I would sense that five years is about as far as you can go before the skills have atrophied to a point where they are not going to be current to the changing technologies.

Yvonne Baker: If I can go back to the point about people from industry helping in schools to teach, certainly we can learn things from the FE sector where a certain amount of that has gone on historically and there have been lessons learnt—some good; some not so good. I think there is real scope for it.

I also think it is worth bearing in mind that there is research around that suggests that non-specialist science teachers—for example, biology graduates who maybe teach physics up to 16—with the appropriate in-service subject training can be as effective as specialist physics teachers up to 16. However, beyond 16 is where your real in-depth specialist knowledge can make a difference. That is quite important to look at.

I would say as an engineer who has ended up working very closely with education that it is important that everybody knows what they are good at and what they do not know in that formula. There are some people who think all you have to do is put an engineer in front of a class to teach quadratic equations and it will all be fine. We have to make sure that those people are trained and supported properly and also that the teacher is trained and supported as to how to use them, otherwise it can become two alien species trying to communicate really hard but talking in different languages.

- Q11 **Dr Tania Mathias:** Thank you. What role do you think apprenticeships play in creating more prepared workers in the STEM sector?

Philip Pratley: That takes us into an area not only of apprentices but of pre-apprenticeship as well, the work in schools that would be pre-



apprenticeship, almost preparation for the workplace but pre-apprenticeship for finding some way of converging the educational strands that go up to the age of 16 and then the work that we in the STEM sector of engineering would wish to be able to do with education but we are not quite sure how to do. We do not understand the school environment or the recent changes in education well enough. Engineering moves very fast and technology moves fast, but education moves very fast. While we are busy trying to identify the next generation of AI, we are not concentrating on the way education has moved. I think the role for apprenticeships is also the role for pre-apprenticeship work in schools.

That then takes us into the split between the higher apprenticeships, which are really level 4 and above, on a par in terms of their application as professional engineers with first degree graduates, and advanced apprenticeships, those post-16, and the limitations that we have at the moment in the UK simply because of the numbers applying. It may be that it is the graduate engineer who can work more closely with the professional education sector, with the teachers, but the apprentice engineer is often the person who can come across most forcefully as a role model in front of the 14 to 16 year-olds saying, "This is a really good profession. I have a future and it is based on my qualifications and you, too, could be where I am." Often, the apprentice is the very best ambassador we can put in front of a class.

Paul Jackson: The apprenticeship now is both a major opportunity and a potential threat, in the sense that with the introduction of the apprenticeship levy what we are getting as feedback from companies, including Philip's company, is that it is difficult for them to be able to use the levy money on three and four-year apprenticeships as effectively as they would like. They can probably draw down only 25% to 50% of the levy funding and many of them would like to be able to reach into education and use that as part of the funding for the work that bridges the gap between employers and companies.

Engineering is the leading area for apprenticeships for young people at 16 at the moment. It is a higher proportion than pretty much anything else, which is really good. Of course, young people are studying the same subjects through to that age, so there is a possibility with the extension of apprenticeships that we could start to tackle some of the diversity problems. It is unlikely that will happen if that funding formula does not support it proactively. The risk that we face, which we must avoid—I know companies will want to avoid it—is the low levels of diversity that we currently have in apprenticeships, lower than we have in undergraduate courses, and we must not see those levels go into the graduate-level apprenticeships and drag down the result.

This is a really important time with the introduction of the levy and with the commitment to apprenticeships to make sure that we navigate appropriately through and use it as an opportunity. There could be a lost opportunity.



Q12 **Dr Tania Mathias:** Thank you. We might ask you to expand on that later. Do you get STEM talent within and outside the EU?

Philip Pratley: Yes, hugely.

Q13 **Dr Tania Mathias:** Is Brexit going to have an impact and in what way do you think?

Philip Pratley: I don't know. It presents a vulnerability to the engineering profession. The percentage of international students within the engineering first degree community is already significant but of special note is the very high percentage of international students at postgraduate level. As an engineering representative, I am not qualified to say whether it is going to be possible to sustain that; it would be speculation.

What we could say on the data already available—Paul mentioned the shortages that the EngineeringUK analysis has shown—is that we require, as a UK engineering sector, just over 100,000 graduate-level engineers per year at level 4. The figure that comes to mind is 101,000, but if I may, as an engineer, I will round it down to 100,000. Of that, the first 40,000 are UK nationals coming out of the higher education or higher apprenticeship sectors. The next 40,000, engineers working in the UK engineering sector, are international engineers. They are non-UK nationals. The 20,000 above that is the gap. Even allowing for the numbers that we currently take internationally, in effect they double the population of engineers entering the UK engineering sector every year. It goes from 40,000 UK nationals to 80,000 entrants and it still leaves us 20% short.

I think, Dr Mathias, that is as close as I would wish to get to a forecast, because other than that you should probably best ask a research behavioural psychologist rather than an engineer.

Dr Tania Mathias: That is very helpful. Thank you.

Q14 **Carol Monaghan:** Yvonne, I think it was something that you said when you were talking about keeping the curriculum broad and also developing skills that employers needed and you talked about a lot of countries. I was surprised you did not mention Scotland, because it keeps the curriculum broad much longer and a new curriculum was developed looking at the skills that were required by businesses. It is a frustration of mine that Scotland or the paths that Scotland has taken never seem to be considered.

Yvonne Baker: I could not really comment on education policy. We operate a network across the UK, including working with SSERC in Scotland. We see a lot of good stuff happening in Scotland that we then transfer through to teacher development in England, working with industry and various people. The scientific societies, the Royal Society of Edinburgh, SSERC itself, all work much more closely because it is in that area. Scotland also has some really interesting geographical challenges,



but that brings about things like SSERC, which is the Scottish CPD provider that we work with—Scottish Schools Education Research Centre is the full name. They make brilliant use of web conferences. Glow-meets is their actual term for primary teachers up in the Highlands and Islands talking to teachers in Edinburgh and things like that.

Yes, you are right. On the breadth of the Scottish system, I must admit that I do not know the numbers for female engineers, for example, going into degrees in Scotland. It would be a very interesting analysis and it is an analysis we should do.

Q15 Carol Monaghan: Those same challenges exist in Scotland as well. I am not suggesting that we have the answer to everything.

Yvonne Baker: I think that is interesting in that it still talks about the media, the social, the cultural, these attitudes about whether it is culturally what women and girls do.

Q16 Carol Monaghan: It is interesting that you mention SSERC because, of course, geographically they are perfectly placed there in Dunfermline. They have a hotel right next to them. Teachers do go and spend a few days there doing CPD. That has developed with business, usually with businesses throughout the central belt. I do not know if Leonardo is involved in SSERC. I wonder if that is something that can be more closely mirrored.

Yvonne Baker: We provide some funding from Project ENTHUSE to SSERC to do that in Scotland, and that mirrors what we do in York. We have a teacher centre in York that we have 3,000 teachers and technicians to each year to do subject-specific CPD practical activities. We have impact evidence of the impact that has on them and their students, on their careers awareness and things like that. The trick is making sure that we get that to all parts of the system, particularly to those schools that need the help most, those schools that are not lifting their heads up because they have much more fundamental challenges, first of all, about getting young people in the door and engaging them in day-to-day education.

I think it is how we use data to target those schools but then use solutions to their problems, rather than saying to them, "The problem we are trying to solve is more people to become engineers." It is solutions to their problems about achievement, attainment and progression that result in more young people doing STEM subjects.

Philip Pratley: There is something about Scotland that has taught us a lesson that we have been able to take into our English-based business units. This is speaking as a company with 40% of our electronics business in Scotland, based in Edinburgh. There seems to be a much closer degree of genuine co-operation between business and education in Scotland, perhaps because engineering never quite lost its status in Scotland in the way that arguably it did in England. There was a point in England where



manufacturing and engineering did not make it on to the priority list of careers, whereas in Scotland it never fell that far down the priority list. In England, when Chris Snowden became the vice-chancellor in Surrey, everyone was staggered that an engineer could be accepted as vice-chancellor of a Russell Group university. In Strathclyde, when Jim McDonald became the equivalent, no one thought it was odd at all. In fact, it seemed to be a perfectly natural progression for Strathclyde to be run by an engineer.

As a company we have learnt lessons from Scotland and taken them to England. The modern apprenticeship scheme that we had been running in Edinburgh became the model for the one that we then put into our new plant in Luton and we immediately won awards for it in the English apprenticeship scheme. We did no more than copy what we had been doing alongside Skills Development Scotland. We believe that Skills Development Scotland is a body that is without parallel in the UK.

The somewhat unstable environment in which the Institute for Apprenticeships is being introduced at the same time as the apprenticeship levy at the end of this month means that we, as a company with a firm base in Scotland, look to that firm base in Scotland for the ideas and the way in which education and business can work together.

We spoke earlier of the idea of physicists entering the engineering profession. We got that idea from our site in Scotland, from our physicists in Edinburgh, who are engineers by profession, who said, "You should try this more widely in the company." That is where we got the idea from when we formed a UK-wide company known as Selex. Perhaps something about the relationships in Scotland has meant that there is more resilience in the way that education and engineering works together than has been the case south of the border.

Paul Jackson: In our experience, we work typically through the energy skills partnership, which is a partnership of five fellow education colleges reaching out into schools. The space in the curriculum for investigation and for project work works very well with companies wanting to get involved. I think there is a lot that could be learnt in the English system in creating that space rather than perhaps focusing so much on knowledge without that application that does fit well with an employer-supported model.

Q17 **Carol Monaghan:** What challenges do schools and universities face in using developing technology to enthuse young people?

Philip Pratley: It is very interesting that we see the odd phenomenon that some of our 25-year-old graduate engineers will listen to the 15-year-olds in the schools we go into. I then ask our mid-30-something engineers, "Would you have listened at that age to a 15-year-old?", and our mid-30-something engineers say, "Never." What is happening is that our mid-20-something engineers know that when they were in their mid-



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teens they absolutely got it. They got what the technology was; they were surrounded by it. They were the first generation of digital natives.

One of the corresponding characteristics of a digital native appears to be that he or she also knows when they are getting out of touch. They tell you they are listening to the 15-year-olds. I wonder whether some of the challenges that we see when our 25-year-old graduate engineers listen to a 15-year-old, the pressure on staff, quite young staff who may only have entered the teaching profession in the last four or five years, is that the 15 and 16-year-old will be ahead of them in this technology. That must be a tremendous challenge, because they are the teachers. It is all very well for a graduate engineer from a company up the road to say, "Tell me about Raspberry Pi." It must be very demanding for a teacher.

Q18 Carol Monaghan: Is there a barrier financially? Some of the technology that might enthuse young people is potentially very expensive and takes a massive big whack of a school's budget.

Philip Pratley: I would quite like to see us be able to use our apprenticeship levy to support CPD for teachers. Paul mentioned the sorts of figures that we thought we might get back and that 25% to 50% band is at the upper band, quite benign. We are recovering some of our money through continuing to do what we are doing at the advanced apprenticeship level, but it is going to be difficult to get more than 20% of our apprenticeship levy back through the scheme that appears to be in place from the beginning of next month. If we are putting 80% of our money into a pot, we would like to be able to put that into the supply chain with the very small companies who are relying on their understanding of latest technology in order to succeed and to develop the teaching staff to use the apprenticeship levy money for CPD. If we can do that, that would include being able to purchase some of the technology on which the staff can be trained. There is then, as you say, a further challenge for the schools themselves in order to buy that technology in sufficient scale for the students.

Yvonne Baker: I think you are absolutely right; there is a clear budget issue in a lot of schools. For example, the Teacher Development Trust did some research recently and found that there are 20,000 teachers teaching in schools at the moment—I think this was England, so excuse me—where there is no budget for CPD whatsoever, literally zero, and there is no ring-fencing of budget. That is why things like the ENTHUSE Trust are really important, because they can make that affordable through bursaries. Budgets buy kit but schools get sent quite a lot of kit—the Raspberry Pis. There is quite a lot of kit available.

Carol Monaghan: Sometimes just one.

Yvonne Baker: Yes, but also quite a lot of the time the real problem is that you find kit piled up in the back of the lab because the teachers have neither the skills nor the confidence to use it. I think this is a particular issue in primary. It sounds a little bit stereotypical, but when you look at



less than 10% of primary teachers in the English system having done maths or science beyond 16, then there is a massive lack of confidence. As you said, even in a primary school you are dealing with seven and eight year-olds who can probably program the family home on their parents' iPad or whatever. It comes back to teacher CPD and teacher training. We have done some work with Raspberry Pi, going in and providing CPD to teachers about what you do with them and how you use them. We know that makes it much more effective and much more likely to be used.

Paul Jackson: It is worth looking around the Big Bang project as we have today. It is interesting seeing where children have managed to use 3D printing and modern kit that does take some investment in both the hardware and in learning how to use it as well. It brings alive their learning because it means that they can generate things in the school. They can see them, touch them, feel them. That is a fantastic thing for them to do.

Q19 **Carol Monaghan:** Maybe that is something local companies could provide for schools. That might make a difference.

Paul Jackson: They certainly can do. It has been interesting. We have done a certain amount of work with a bank that is providing Fab Labs in local areas where they have branches that they have closed and very long leases on those branches. They open them up to the community once a week and they are using those with schools, which is fantastic. If that capacity could be found that is great, but some of it should be in the schools.

Q20 **Carol Monaghan:** I am going to ask one final question and I will ask for very brief answers before the Chair gets annoyed at me. In your opinion, who or what are the key influencers that will cause a child or a young person to go on and study engineering, physics, maths?

Philip Pratley: If I was to reverse your question and say, "Who are the key influencers who stop them, who will be discouraging them?" it is parents. The work that we are doing with schools is to address the question: how do we put something in front of parents? Teachers can be a most tremendous influence and we are seeing an increasing awareness among staff of the career potential that engineering and STEM provides. It often is parents and we work with schools to provide material into families days and careers evenings that gives the parents the confidence of knowing that engineering is a credible and genuine career with huge opportunity rather than perhaps the more stereotypical view they had before.

Paul Jackson: I would have to pick teachers in the English system because they influence on subject choices. Where we do not have sufficient maths and physics teachers, or the awareness of how those subjects are being used outside in industry, they have a very significant



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impact on the subject choice. We need to have a world-class science education system.

Yvonne Baker: It is both. It is parents and it is subject teachers. That is very clearly shown in research. We have worked with industry over the last couple of years to develop STEM insight placements, bursary-supported placements for teachers to spend up to two weeks with an employer. We have evaluation evidence that shows that the teachers can then go back and influence both the young people and their parents, because I think it takes away quite a lot of the fear factor around things like women in these roles and apprenticeships.

Q21 **Dr Tania Mathias:** Are parents given free tickets for the Big Bang Fair?

Paul Jackson: The simple answer to that is yes. The family day is free with the exception of one of the big shows that runs, but entry is free.

Philip Pratley: If you were able to come back on Saturday, the Saturdays here at the Big Bang are the most extraordinary few hours.

Dr Tania Mathias: I am so tempted but, alas, I will be in my constituency.

Philip Pratley: It is. I have stood on our stand and parents come up with questions that they can ask in a way that perhaps they do not feel able to ask elsewhere. One of the most extraordinary innovations about the Big Bang was the way EngineeringUK made the families day on the Saturday. A number of us wondered if we would just be standing there on our own. We could not have been more wrong. It is an extraordinary few hours.

Q22 **Derek Thomas:** I would like to take you to my constituency, which is west Cornwall—as far west as you can go—and the Isles of Scilly. What you have when you look out the window is fishing, farming, job opportunities in the public sector, tourism. That is pretty much what young people would see. We have already talked a bit about aspiration and how we raise aspiration and how we get more girls into science and STEM subjects. What more can be done to increase that opportunity and equality to far-flung parts of the United Kingdom?

Philip Pratley: If we take the position in Scotland, it is not dissimilar. There are parts of Scotland that are very rural, and really passionate members of staff at the local schools can have an impact out of all proportion to their numbers. Where we have been working in one or two cases with schools that have asked us to go to them, it has been down to those members of staff who understand the potential that they have. Some of them are quite extraordinary in what they have then produced.

Yvonne Baker: I think you can find people able to do that in any location. I will come back to teacher CPD and CPD for school technicians. We had a technician from the Isles of Scilly high school at York doing CPD a few years back and we would welcome another one in the not too



distant future. We also, for example, have STEM ambassadors on the Isles of Scilly. There is STEM in everything and I think that is what we have to make clear to young people. That is what they are not seeing a lot of the time. There is an enormous amount of science and technology in a lifeboat. There is an enormous amount of science and technology in anything if you look around; in buildings, in sewerage, in anything. There is an immense amount.

I was talking to a young lady out in the exhibition hall just now whose mother was made redundant from her job and has become an apprentice at Anglian Water. People forget to see things like water as having massive technology in it as well. I think it is opening young people's eyes to the fact that engineering is not all about—and I paraphrase—bridges and planes and great big things. It is also all absolutely around us and it is that kind of engineering that is vital because that is the bit that you will notice when it goes wrong.

Paul Jackson: In your constituency or around your constituency, you have some employers that you would recognise as being engineering. You have Terrill Brothers Foundry in Hayle. You have the waveguide makers up in Liskeard, a bit further away. You have some really good companies that have set up and taken advantage of a good workforce that needs those sorts of skills.

Picking up on Yvonne's point, you have terrible traffic problems that mean you have to be able to deliver. The logistics issues of servicing a place with infrastructure that is not ever going to support the full summer peak means that you need engineering talent to do that. Supporting the tourist industry, the science of the food industry and so on—it is amazing what goes on in your area.

Q23 **Derek Thomas:** Yes. I was playing devil's advocate a bit because we do have more renewable energy than anywhere else and, as you say, there is Goonhilly, Culdrose and so on. It is an interesting one in a rural area engaging teachers, which I will come on to in a minute. In terms of the whole of the UK, what are the pathways into a career in life sciences and how can we best raise awareness of employment opportunities within life sciences? How can we get young people to be inspired to pursue a life science career?

Philip Pratley: One of the things that the life scientists do particularly well is emphasise the variety and the ingenuity of their postgraduate research. They seem to be very good at giving the 16 to 18-year-old an excellent feel for what that research does, why that research matters and how they see that research around them in everyday life. The life scientists have it right but they do not have enough scale yet. It might be that the trick for the life scientists is not to do it differently but to do the good things that they are doing across some elements of the UK where they are finding it easier to engage and find a way of expanding that so that they engage more widely with the education sector.



Paul Jackson: Two things. One is looking at companies such as GSK. They spend a lot of money on outreach. They are absolutely here at the Big Bang Fair and they are putting life sciences in the broader context of the research, the testing, the manufacturing they need, the whole life cycle of the product that is very important to them.

We had a piece of work done for us pro bono by Boston Consulting Group looking at work in schools, which plotted very simply that at key stage 3, where we are looking at 11 to 14-year-olds, if we just get them liking science and seeing it in context, everybody wins. Rather than having the life scientists fighting with the mechanical engineers who are fighting with somebody else, we just need to have that level of interest that means we have a bigger pool of people who are interested and scientifically literate and see the context for the maths as well, and then the economy wins overall.

Yvonne Baker: We need to make pathways clearer for every industry. We need in particular to make pathways clearer at maybe the technician apprenticeship end as well. You talk to young people and they are fairly clear about pathways into graduate routes, whatever the industry is, but it is much less clear what the options are for those who, for whatever reason, do not want to go off and do higher education. Across all industries, both within schools and within society, we need to make that much clearer because those are the young people for whom we are going to make a real difference to their life chances if we can give them those routes.

Q24 **Derek Thomas:** Can I bring you a couple more examples? When Tim Peake launched himself into space, into the space station, I went along to the Science Museum; fantastic atmosphere, 13,000 children. I then went back to my office and phoned 11 primary schools in my constituency and none of them had watched the launch, which I was really sad about because when I was young I remember the launches and they were good things. They triggered my interest.

Then you talked about parents. When I go home I spend a bit of Sundays at home with my family. I have a 10-year-old. He is coming home and badgering me continually about IT and apps and things that he wants to look at on my iPad, but this is not coming from school; it is coming from his peers. It is not coming from teachers; it is coming from peers. These are not necessarily things that I would not want to do. There are a lot of learning apps that he is getting hold of through his peer group rather than teachers. The question is: are we starting too late with our young people to get them engaged in STEM subjects?

Yvonne Baker: If I can start on that question, we have to start as early as possible. We have to literally start talking to young people through early years and all the way through primary, absolutely. The Science Capital research from what was King's and Louise Archer and has now moved to the IOE shows that very clearly. Young people will not necessarily choose what they want to do by the age of 11 and 12, but



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girls in particular will self-identify themselves out of science and out of things. I think that is absolutely crucial.

On primary schools, it is interesting what you say about Tim Peake. We ran a project with the Tim Peake mission with the European Space Agency. We had 1,500 primary schools working on that project, teacher CPD and so on. We are now doing one with the Polar Explorer project, Sir David Attenborough, Boaty McBoatface—that I am not allowed to say, of course—and we have many primary schools wanting to get involved in that.

I think there is an issue around primary education at the moment. Nobody is saying that the abolition of key stage 2 SATs in science were a bad thing per se, but unfortunately what that has done in some primary schools—I am not for a minute suggesting all, but in some—is relegate science in people's minds. It is not relegated in DfE's mind or in Ofsted's mind—sorry, Carol, to be England specific—but in the minds of the head teachers, in some head teachers' heads, it has been relegated down to maybe a science week, maybe at specific times. Part of that goes back to the need for continuing subject-specific development for primary teachers because a lot of them are not confident in those subjects.

Paul Jackson: I think that is the distinction that we would make in the work that we do. We focus on 11 to 14-year-olds and it is because there are 4,000 secondary schools across the UK. We can manage to work with employers to reach all of those. 10% of those schools will come to the Big Bang at the NEC this week. We cannot do the same with the 20,000-plus primary schools, so it is really important that we are using different mechanisms to get these messages into primary schools. It is going to be typically working through the teaching workforce to help them and give them confidence rather than a direct intervention with the young people that is part of what we do here. Having said that, at the Big Bang we will have more teachers attending than attending an education trade show just up the corridor from it.

Q25 **Derek Thomas:** Philip, you mentioned computing in schools. It seems that we needed to change something and there was quite a dramatic shift. My understanding is that the number of girls taking the subject now has dropped quite dramatically and that is a concern. What did we get wrong?

Philip Pratley: The view of an engineer may not be the best informed in this, because all we have done is reinforce the mistakes we have made to my certain knowledge for the last 30 years that I have been involved in STEM. We got caught in two characteristics. It may not be that we got them wrong but we got caught. The first is that computing was seen as something girls did not do. We come back to the primary schools. When we speak to the teachers of 11 and 12-year-olds, years 7 and 8, it does not matter whether you are speaking in Scotland or England, those teachers will say, "If I have lost that child before he or she is 11, especially before she is 11, I have lost them." They have been lost in



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primary school, which is why Primary Engineer is such a vitally important initiative. What we found was that computing was a subject that just did not appeal to young girls who had already been turned off the whole thing about science, and this was just an even more extreme form of science.

The second thing I believe we got wrong was that we did not get it across to the parents that this was the digital literacy of the 21st century. Arguably, this is the digital literacy that will equip those young people for whatever they do in the 21st century. The general practitioners of the future are going to have to have a level of digital literacy that is not the characteristic now of anyone but a small band of engineers. I am reluctant to say we got it wrong, but we did not understand the almost corrosive effect of those two characteristics as the new curriculum was introduced.

Paul Jackson: I think there is a broader point that perhaps the engineering community has wanted to take its own solutions out into education rather than listen to education the whole time. One of our experiences with the Big Bang is that we now have twice as many kids going to Big Bangs in their local area that are run by the community. They are all quite different. It is not that they are centrally controlled. They will have their local employers and a local flavour and a sense of ownership. Somehow we have to get the STEM community seeing that that community engagement is going to be the way in which we can bring about transformation on a big scale, really understanding our future, which is those young people and the teachers that are teaching them.

Derek Thomas: I think I might have run out of time. Thank you.

Chair: Just before we move on, Dr Tania Mathias has a very tiny question.

Q26 **Dr Tania Mathias:** Thank you; you are very generous, Chairman. Yvonne Baker, could I just check? I absolutely believe your facts; I just wanted to know where it is from and how up to date it is. You said that less than 10% of primary teachers have maths or science.

Yvonne Baker: Beyond 16.

Dr Tania Mathias: Beyond 16, so you mean A-levels, really? Do you know what year?

Yvonne Baker: Yes, beyond 16. That is from the DfE workforce survey. I can get the exact reference to you.

Dr Tania Mathias: Would you, and how old that stat is?

Yvonne Baker: Yes. I think the percentage was actually quite a bit below 10%, but I was being slightly generous.

Dr Tania Mathias: It is just whether it is 2010 or 2015.

Yvonne Baker: I will get that number to you.



Dr Tania Mathias: That would be fab, thank you.

Q27 **Chair:** It is obviously vitally important that there are those with a science background in schools inspiring, leading and acting as role models. This is quite a specific question. Do you think that schemes such as Researchers in Schools has encouraged more STEM graduates to go into teaching because it gives them a dual role? What can Government, we, universities do to support that more and to expand such programmes?

Yvonne Baker: Yes, I think Researchers in Schools has a fantastic role to play in taking those research skills into a school, people who are expert in a particular subject, and also allowing them to give other teachers and their students access to those research skills, particularly in deprived areas. I have been involved with a couple of schools that have benefited from it.

It is then about what career path do we give those researchers who have gone into school to act as teachers? How do we keep them within teaching? How do we give them career paths that are meaningful to them so that we retain them? I think everybody is beginning to realise that teacher retention is the single biggest challenge we have in the entire system at the moment. Researchers in Schools is all teachers. We know that giving teachers high-quality CPD does encourage them to be retained because they feel more confident and more motivated. We strongly support the Chartered College of Teaching because we think that will help raise the recognition of the professionalism of teachers and their own self-value as well. I think that is a really important thing.

There are also other ways that people can go in and act as role models. Philip has talked a little bit about the STEM ambassadors programme, which is 33,000 people from STEM backgrounds going in and giving their efforts free of charge to schools and to community groups, which is an important way to get to young people who can be disaffected at school. It is getting to them in a different environment. Evaluation evidence that we have shows that 90% of the young people who meet STEM ambassadors say that it has changed their view of what working in STEM might look like or people who work in STEM. Interestingly, a very high percentage of those who work as STEM ambassadors get improved job satisfaction for themselves, so that is a win to the employers as well. I think that is really important.

A lot of it—I think somebody talked about it earlier—is giving young people access to role models for whom they can see a connection, who are not so far beyond where they are themselves. I am quite regularly contacted by people saying, “I have talked to a head teacher in a school. They would like to get some Cambridge professors in. Would you like to arrange some through STEM ambassadors?” or whatever. It is like, yes, we will get some of those in, but if it is a school in a particularly deprived area or something with low aspiration, let’s also get some apprentices in, some new graduates, some people where those young people can see the leap. Things like the Wellcome Science Education Tracker show that there



is no difference in aspiration between young people in deprived areas and in more affluent areas. The issue is their ability to get from where they are to where they want to be. I think that is the biggest challenge we have in that sense.

Paul Jackson: I think it is worth looking in any of these schemes at the scalability and the sustainability. For example, the bursaries that are available for those going into teaching in schools that mean that there is a very significant payment that is made to them that they then do not see in the second and third-year salary, which is an issue for retention. Similarly, for the Researchers in Schools, how much that is scalable and how much that can be used and the applicability across the whole system where further education colleges typically cannot draw on these schemes, yet they are at the frontline, certainly with literacy and numeracy, with retakes of GCSEs in maths and English. It is very difficult for someone who has not got through their maths GCSE to come and do something productive within the engineering sector.

Q28 **Victoria Borwick:** Thank you very much indeed. It has been absolutely fascinating. I am taking us back to the industrial strategy paper because obviously the Government are trying to address some of the questions that you have raised, quite rightly. As we know, that put forward a raft of new measures with proposals for new institutes of technology, for example. What practical difference do you think those would make and will that help or not? I have a raft of questions so if you don't mind being reasonably—

Philip Pratley: It is a Green Paper, a consultation paper and it is quite long. The House of Commons Library briefing note arguably was a more concise and effective description of the options available to the industrial strategy when it emerges. There is a concern that the way the industrial strategy is developing will make it more difficult to take a view across advanced technology in the UK because it will be disaggregated into the various sectors in which it applies. The EngineeringUK report said—

Victoria Borwick: Too much specialism rather than—

Philip Pratley: Yes, and it makes it difficult to show where the coherence is necessary because it disaggregates it into groups that could be below critical mass.

There is enormous potential in the industrial strategy and I do applaud the ambition of the officials who are working with industry at the moment to try to ensure that none of that coherence is lost when everything goes into these stovepipes of sectors. I am not as confident as I would wish to be that it is heading in the right direction. If there is anything that industry should be doing to speak differently to Government, we have between now and 17 April to find it. We have not quite got there yet, so if I may use marks out of 10, it is possibly six at the moment. It would be very disappointing if the final industrial strategy when it emerges is still



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only six out of 10 in addressing the skills shortage and the potential of STEM.

Paul Jackson: I would like to pick up on that potential point. It is fantastic that an industrial strategy Green Paper has been published. It is a wonderful start. It was not so fantastic that the digital strategy was published a week after and the two were not linked together because that is going to be absolutely fundamental to making sure that we are riding the crest of the wave of the industrial revolution rather than being swamped by it.

On institutes of technology, it is welcome that the £170 million is not seen as putting up some shiny new buildings for photo opportunities. If that only provides the kit into existing further education colleges on a hub-and-spoke basis it would be a good thing, but the sustainability of those is important and having the right teachers to work with them. Getting to something that is much more comprehensive is going to be a challenge between now and 17 April or the time to follow up the consultation, but I think those things need to be knitted together. Somehow the industrial strategy needs to be built from the talent pool upwards because we, the population of the UK, are the talent pool that will make it work rather than perhaps looking in the stovepipes down. Hopefully that can be got across in the consultation.

Q29 **Victoria Borwick:** Some of it we have touched on before, but I just want to go back to the industrial strategy appears to want to increase the skills teaching done in schools and university. Obviously, we have touched on this with some of the questions. How are we going to amend that gap as you identified? How do we support the industries to articulate to the schools and universities how we address the current gap that you have identified?

Philip Pratley: The environment needs to be one that is conducive to business investment and the availability of a skilled workforce is key to that environment. If the industrial strategy appears not to encourage a convergence of industry and education, if it appears not to encourage industry to invest in through-life skills, if it appears to in some way penalise industry for investing in the higher level skills because the costs of doing so are greater than they were four or five years ago, then the industrial strategy will not have made the difference that its ambition should be telling it it must make. That would be a principal concern from a business perspective.

Q30 **Victoria Borwick:** I don't know how it has been promulgated or shared or that encouragement is being carried out in the absolute. I don't know how widely the Green Paper has been shared. How would you address the issue of getting industry to become more involved? Do you think universities are talking to businesses enough? How we could do it better is what we really need to know so that we can make proper recommendations to the right people.



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Paul Jackson: It has been shared very widely so it is well known and I think there will be a lot of response to the consultation. I hope some of that will come from universities. Certainly, we have had some feedback. I sit on the board of the University of Essex and we have had some feedback from them that funding expansion of their science park is a problem at the moment; they could put in more capacity. Issues like that need to be dealt with. The issues around skills need to be dealt with. We have touched on the apprenticeship levy and making that more usable for bridging this gap with education.

As a real fundamental, if Government can lubricate the work that the employers are willing to do in schools by giving every encouragement—the apprenticeship levy is one example, activities like the Big Bang that are not supported by Government at the moment—a bit of support would draw out more from business that could really help to drive the skills in the industrial strategy. It needs to be seen in that bigger context and then the connection to the digital we have touched on.

- Q31 **Victoria Borwick:** Going back to the skills and something else that you also said, do you think the Government are going back to those who are in employment? How do we thrive with the workplace? How do we also make the fundamental difference here? We are not just talking about the schools and universities but the next stage up with the workforce.

Yvonne Baker: One of the key things for me when we are talking about things like the institutes of technology and technical vocational qualifications is that we have to be really clear about parity of esteem and parity of value for schools, for example, in accountability measures and things like that. Schools are driven by accountability measures in the same way that every other organisation is. They want to do the very best for the young people they have in their charge, but there are other constraints as well. Funding for things such as T-levels and A-levels has to be looked at, for example. There is flat funding for all A-levels regardless of subject. If you are a head teacher in a school and you are struggling to get a specialist physics teacher or to pay for the practical subjects, where are the incentives? We need to have the incentives to provide more of these sorts of qualifications and things.

We talk about the industrial strategy a lot. We talk to employers. I am in the education/engineering sector. What does that mean to a school? What does it mean to somebody out in the public who might have been an engineer a few years ago and taken a career break? How do we explain it to them in words that will encourage them and incentivise them to come back and not just hope that they will get it through the ether?

- Q32 **Victoria Borwick:** Do you think that the Green Paper is sufficiently focused on training a workforce that has those adaptable skills, or is it too concerned with training people to work in specific sectors?

Philip Pratley: It is not that it is too concerned with the training in specific sectors at the cost of through-life development. It is that it does



not lay the emphasis on it that we might wish. If we were to see a hierarchy within Government, the industrial strategy would be at the apex of that hierarchy. The work that is being done by the Department for Education, the Department for Culture, Media and Sport, the work that would be done within the Department for Work and Pensions and the Department of Health would have the ability to derive their own plans from the industrial strategy.

Without that level of coherence it becomes more difficult to give the confident answer to your question that through-life development, through-life learning, through-life education, work-based learning is prominent. No one says that can't happen or writes a paragraph in the industrial strategy saying, "Work-based learning; forget it," but on the other hand we do not see that the emphasis is strong enough. We do not see that the coherence between different parts of Government is strong enough to survive what will undoubtedly be a very turbulent time for the high technology sector simply because the pace of technology changes so fast and the real gaps that the EngineeringUK report identifies have to be ameliorated. We cannot sit there and say, "Oh dear, we will do nothing."

Q33 Victoria Borwick: Are there any other missed opportunities—before we leave you to get on with the rest of your lives—in the Green Paper that you wanted to highlight?

Paul Jackson: I think connectivity across Departments, so that it is not seen as being just for the Department that has "industrial strategy" in the title. In some ways it is a positive in putting it in the title because it gets you a focus. In another way it means you are putting it in a stovepipe. Making sure that the link is there to DCMS, to the MOD where there is a very clear skill shortage, to the Department for Transport, with its year of engineering that it is proposing next year, let's really take advantage of that as a springboard for the industrial strategy rather than perhaps not all Departments getting engaged. This should be an opportunity across Government to do something that is different and that prepares us for the future.

Yvonne Baker: One of the things that we could do that would bring it alive to schools particularly is the link between the industrial strategy and social mobility. The OECD "Against the Odds" report in 2012, I think, states very clearly that science is more beneficial as a subject, as a skill, to disadvantaged pupils than their more advantaged peers in terms of their life chances. Making that link would bring it alive to a lot of people in sectors such as education that really want to help.

Chair: Thank you very much. That is a very powerful point on which to finish. Thank you very much indeed for your answers. We are going to move straight on to the next panel.

Examination of witnesses

Witnesses: Dr Kirsty Clode, Blossom Hill and Mark Page.



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Q34 Chair: Welcome. Thank you for joining us this morning for the second panel of our first session on closing the STEM skills gap. We are very grateful to you for giving up your time and coming before us. Just for the record, could you say who you are and who you are representing here this morning?

Dr Clode: My name is Kirsty Clode and I am representing Women into Manufacturing and Engineering.

Blossom Hill: I am Blossom Hill, representing BAE Systems.

Mark Page: I am Mark Page, the managing partner of A.T. Kearney, a consultancy. I am here representing Your Life, which is a corporate-led initiative to promote STEM uptake post-16.

Q35 Chair: Thank you very much. There have been a number of initiatives to tackle the STEM skills gap on a national level. Do you think there is something that we should be doing on a more regional or local level? Who would like to start with that?

Dr Clode: I can tell you that in the Humber we definitely have a problem with getting women interested in manufacturing and engineering. The organisation that I chair is business-led. It is led by a company, Siemens, and a smaller company called Airco that said, "We just do not have enough women applying for our jobs." It is something regionally that they spotted and said they want to do something about.

Mark Page: Some of the issues that we have also identified in our research are quite structural and national, or at least English, so it is probably important to tackle them in that way. I think you are right; with some of the conversations that were just being discussed about how employers engage with schools in a scalable way it is sometimes going to be more effective at a local or regional level.

One of the things that we find in the engagement, either the corporates involved in Your Life or the others that we get involved, is how you tackle the scalability issue. There are 4,000 secondary schools that somehow everybody needs to get into. There are only so many companies that are involved, so what are the ways that you can work through other organisations and perhaps through teachers and train the trainer type approaches? Those things are naturally going to work better at a local or regional level, I would think.

Q36 Chair: You talked about what has happened in the Humber in identifying the problem. What was the identified solution?

Dr Clode: We run the equivalent of, I guess, a mini Big Bang but focused on women and girls. We have used the WISE campaign research to make sure that the people at the event are women in the industry and they are talking about the jobs that they do to women and girls who come along. It makes a big difference because if I talk to a guy and the guy says to me, "You could build a wind turbine blade" I might believe him, but if I



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have talked to a lady who is doing that and she says, "You could do that too" I am likely to believe her and say, "I'll give it a go." There are lots of case studies now that say we have had women and girls who have come through our event and talked to the person who did that job and six months later they are there with them, doing that job.

Q37 Chair: Fantastic. Thank you. We are talking about STEM: science, technology, engineering and maths. Is that still the right definition of the skills gap? Do we need other subjects to be included? Do we need a clearer definition of what the problem is?

Dr Clode: I think there is a move definitely in the Humber to add an "A", STEAM, because of the design part in engineering. You do not want to put pupils off if they love art, but a lot of people who like art turn out to be great designers. They need to understand the engineering bit because it comes together. In one of the schools we are working with there is a guy, Stephen Logan, who is the deputy head, and he is pushing STEAM quite heavily because it makes sure that children are keeping their options open a bit more broadly and you are a bit more inclusive.

Q38 Chair: Blossom, do you have a view on whether those are the right subjects?

Blossom Hill: I left school only five years ago, so it is quite a relevant thing to me. I remember being there picking my options. I can never remember any girls that I knew feeling that they could not pick science or engineering. It was never an issue where I was and I am from the East Riding, so the Humber. I don't think I could answer that question, to be honest.

Q39 Chair: You are probably the one who can remember clearest what the options were five years ago when you were doing your A-levels. Could you tell us what your A-levels were, first?

Blossom Hill: Yes. I did business, accounting and German.

Q40 Chair: Were you able to have mixed that with art, for example? Could you have done maths?

Blossom Hill: I could have done but I can't draw to save my life, so it was never something I was interested in doing.

Chair: No, but that was not a barrier in and of itself? You could have done art, physics and maths in your school?

Blossom Hill: Yes.

Q41 Chair: One of the things that we have heard is that sometimes these are siloed subjects and that you cannot cross over, but that was not your experience?

Blossom Hill: No.

Chair: Good. Thank you. Mark, did you want to comment?



Mark Page: What we heard from the previous panel was a lot of talk about engineers, so I think you are right to broaden it out and say that there is more. Clearly, there is a substantial issue around engineering talent, and you raised the issue of life sciences and those different areas of research. There is also the analytics—I thought when you said “A” that you were going to go for analytics rather than art.

What is also interesting is that it is not just about certain sectors that need these roles, but increasingly within organisations the kinds of roles that people hire for, the vacancies that come up, require digital and require analytics. A while ago, to work in marketing in wherever, you had to be good at English and do copywriting. These days it is much more about analysing the customer research statistics, so the maths part becomes much more relevant.

One of the things that we also identified and that we are trying to work on—I can maybe talk about that in a little while—is trying to make the link between the actual jobs that will be available in the future and the subjects that one should study. It is very interesting. If you look at what people say they want to do when they are asked at age 15 or 16 and the companies that people aspire to work for, it is probably true that Apple hires some great designers for whatever the next piece of hardware is going to look like. They probably also hire some lawyers and some finance people, but they hire a lot more engineers, data scientists and so on. To the extent that we can make those links clear, then it is up to pupils and their parents and teachers to draw the right conclusions.

Q42 **Chair:** I think it is now widely accepted that whichever side of that divide you sit, maths skills are becoming increasingly important and underpinning many different job options. Do you think we have a problem with the teaching of maths in the UK? If you do accept that, what can we do to improve or bridge the skills gap, particularly for maths teaching?

Dr Clode: I don’t have the evidence to say whether it is yes or no to the teaching of maths. I think there is a glitch between what maths takes you to in your career. If you do maths at GCSE and A-level, what can you do with that? I have heard lots of children come up and say, “I like this particular subject but I don’t know what”—one guy said, “I love geography. What can I do because I love geography?” There is no easy way for the schools at the moment to help a child who likes physics and maths. What can they do with that? It is huge, it is broad, and if you give a child the options of 25 things to do, it is a bit more difficult than just saying, “Be a lawyer, or be a firefighter.” They are tangible, but if you say you want to be an engineer, what sort of engineer? It broadens up. I don’t know if it is maths per se; I think it is what you can do with maths, because it is vast.

Mark Page: In the research we published last year, “Tough Choices”, we looked at research that had been done by both King’s College London with about 30,000 students in England and University College London with approximately 30,000 pupils in the whole of the UK and tried to



figure out from all of those different pieces of analysis what the factors are that turn people off STEM. You are right to say that the curriculum issues and their sense that it is too abstract, theoretical, not clear how you would use it, was relevant. It was actually only in fourth place in terms of the order of priority.

What was most surprising—although, I think you were suggesting it as well, Kirsty—was that in the first place many pupils did not think that STEM had career relevance. Many of the members of Your Life and the people who you are hearing from talk about this a lot, so I am sure it must be very frustrating, but sometimes, as we all know, just because you say something it does not mean the message lands. That may also perhaps be one of the reasons why we see a proliferation of A-levels that have a more nominal vocational tie, the ones that you did, for example, that have that sense of a vocation. Maybe that is one of the challenges that we need to get over.

The other two, just to complete the picture—I told you what was first and fourth—are lacking confidence in the ability to do well in those subjects, which was partly based in fact because they are harder and partly a self-confidence issue among girls. The final one was, as you heard before, parents and teachers, so adult encouragement or lack thereof.

Q43 Chair: Thank you. Blossom, do you want to tell us about your experience of learning maths?

Blossom Hill: I enjoyed doing maths at school and I think it was because of my teacher. Every lesson we went into he would say, "Give an example where you can't use maths." Everyone would try to think of something, say random things, and he would be like, "Yes, but what about the diameter? What about the circumference?" and things like that, and you would always have to realise that you are going to use maths every day. That was the way he tried to engage us.

Again, I think it is more relevant how you link it into a career. One of my friends is at the London School of Economics doing a maths degree now and everyone used to say to her, "What are you going to do with it after?" It is the link between subjects and careers, I think. I agree with Kirsty.

Q44 Derek Thomas: I have questions for you, Blossom. A long time ago I had older brothers and sisters who went to university. I lived and still live in west Cornwall. I chose to do an apprenticeship because I could earn money and go to the beach. I wondered if you had a more profound reason for going down the apprenticeship route rather than the uni route.

Blossom Hill: I would have been going to uni about three years ago. The costs had gone up to £9,000 a year. For my parents, although they have good jobs, obviously it would have gone on their income and not outgoings, so the amount of grants and things I would get would not even cover the cheapest accommodation available at university. I did not



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really want to put that strain on my parents to try to support me throughout. Even though I would get a part-time job, it still would not be enough.

I always had the aspiration to go to university. I was always going to be the first in my family to go and do it, and then I sat and thought about it and I thought, "What am I going to do after? Am I going to get a job? Am I going to have that stability in a job that I really want to do?" I remember bumping into people who had done degrees and they were like, "Now I work in Wetherspoons." I did not want that to be me, so it was just why go and get into £40,000-plus debt and be stuck not in the job that I really wanted to do?

I started to look into apprenticeships and other routes, getting a full-time job and maybe doing a degree while I was working. I thought the standard of apprenticeships have improved greatly now. In my apprenticeship I have had so many opportunities to do great things. I got to work in Germany for a couple of weeks. I go into schools to be a STEM ambassador and try to inspire children into the STEM subjects.

I did business, so it is not just about the engineering as well. I work for a massive engineering company, but you need so many different talents within that company to make it all work. I do cost and planning, so I would not be able to do my job without the guys building on the shop floor and they would not be able to do their job without me. It is all about the link. I am an engineer technically but not a typical engineer, and I think that is the message that we need to get across.

Q45 Derek Thomas: Was there any particular influence that made you choose engineering or was it just that that was the apprenticeship available?

Blossom Hill: I went on loads of different websites and I do like numbers. I have studied business and accounting and I really wanted to do something like numbers. I did look at banks. I looked at other companies and it was BAE that I got into. I like the products that we build as well. Seeing the Red Arrows you can't really—

Q46 Derek Thomas: If you think about your peers, are you able to say what you think the main drivers are that influence young people's choices of science, technology, engineering and maths? Do you know what is making them go down that direction?

Blossom Hill: Out of my bunch of friends, out of the five of us, three of them went on to do biology, chemistry, physics, maths at college. They chose it because it is something they enjoy doing. My dad really wanted me to do chemistry and physics because I could go and get a good job and everything and I was like, "I don't want to do it. It doesn't interest me." I think it is all on personal preference, isn't it? If business and accounting and German is what gets me going, then it is personal, isn't it?



Q47 Derek Thomas: It sounds to me then, and probably to us, that there was something in your school that already whet your appetite and your friends' appetite for those kinds of subjects. It seems like the school is geared up for—

Blossom Hill: Yes. The teachers were always really good. We had STEM days where people from within the industry would come and meet us. I remember companies like Croda coming in. There is Drax power station near where I used to live, so Drax used to come in. We always had career days and things like that. There would be people from different industries coming in and talking to us about it. I think that is really what schools need.

Q48 Derek Thomas: Do you think the apprenticeship route, particularly the degree-level apprenticeships, is beginning to attract people who would not otherwise have gone to university and done a degree? Is it just taking people from the university route or do you think it is actually opening it up, making it more accessible to more people?

Blossom Hill: I don't think many people know about the degree apprenticeships. Being at the Big Bang at the minute there are some young people, but the 16-year-olds and 18-year-olds who are coming to the stands, when you say, "We have advanced and higher apprenticeships" they are not surprised but a bit like, "Oh, I can." I know what you mean by you can go and do a degree instead of university but I don't know, I think it needs to be promoted a bit more—you don't just have to go to university to get a degree; you can do it in another way. I am being supported for my degree now and I didn't do a higher apprenticeship.

Derek Thomas: I did an apprenticeship with a Cornish mason; that was slate and stone. What you are saying is that we need to demonstrate clearly that there is a pathway now that takes you to maybe a similar route but through an apprenticeship rather than university.

Blossom Hill: Yes.

Q49 Carol Monaghan: What do you think are the main barriers to women, and probably those from a less affluent background, entering STEM careers?

Dr Clode: What we have found is that manufacturing engineering does not have a great reputation. It is not that it is a bad place to be; people don't know what it is. Part of what we do in our events is bring in a blade that Siemens build, or a boiler that Ideal build, and show people what manufacturing actually is and get them to show their jobs. Sometimes it is that people do not understand what it is. Sometimes it is that women do not believe there are other women in those industries because we necessarily take a bit of a lower profile, and getting the ladies who are already in those industries to step forward, be on the TV and have their photographs taken and be role models and visible in schools, takes a bit of oomph. But we have to do that because otherwise the pupils currently



in schools think that there is no one like them there. There is a phrase that the WISE campaign uses, “People like me”. They have to be able to see someone like them there in that industry. If they can’t see themselves being happy there, they don’t want to join and their mums and dads don’t want them to join, either.

Mark Page: It is definitely the identification with the roles and the stereotypes that seem to apply with those roles. I suppose you are in a bit of a chicken-and-egg situation there, if that is indeed what the profession currently looks like.

There was an additional point that came out from some research done by University College London that was about the self-confidence of girls in taking maths and physics. They gave a test to boys and girls and they got exactly the same results—surprise, surprise. They asked them how well they thought they had done. More than half of the boys thought they were above average—surprise, surprise. There were far fewer of the girls; most of them thought they had performed below average. That is coming through particularly because the message that comes through from schools, and also from parents and from older pupils, is that studying STEM, at A-level certainly, is harder than other subjects.

There are a number of different components that come into this. One of them is that there has been some research that shows that technically it is true. I think the DfE is working to try to fix that. The difference between a physics A-level result and a photography or media studies result was a grade and a half difference, so they are miscalibrated to that extent. That result is a few years old. There has been some more recent work looking again at physics and media studies and the gap is still there, so that is a bit of an own goal that probably needs to be addressed.

There is some of that going on but then there is also this sense that people are steered towards going to where the grades are going to be higher and clearly you do not want to push people to where they are going to get very bad grades, but there is a mix issue, certainly in the A-level system—you were talking about the Scottish system being different. We force people to narrow down to three or four subjects. We put on offer a huge range, and maybe for budget reasons that will end up being culled a bit, but it is still an enormous range of subjects that people can take, and then there is not very good information about how they link to careers. I think there is certainly a structural issue in how we have set up the A-level choice system and the information that goes into it that is causing a barrier.

One of the things that also comes out loud and clear—and I think the Government’s Green Paper recognises this—is that the careers advice, as people choose at around 15 or 16, is not adequate.

Q50 Carol Monaghan: You have talked about these subjects being more difficult but for me those subjects were the easy ones; it was English that was difficult for me. I would imagine that is the same for many



engineers, male or female; that they are there because they found them quite straightforward. Is there a role, in order to tackle this obvious skills gap, for making these subjects worth more? You have said the DfE is looking into that. Is there a role, for example, for getting more points for a physics A-level that might encourage more to take it rather than take something that is possibly of less use to the country? I am being controversial, sorry, Stephen.

Chair: No, no.

Mark Page: Yes. I would always start with better information. That is always a good starting point: let people make their own choices. Then you have to consider how pupils, schools and employers are viewing these things. Could you steer it and make it more attractive for pupils? There may be various different ways you could make it more attractive for them. One of them would be just reassuring people that they are on a level playing field in exams. That would be a good starting place. You could go even further and try to skew it.

It is interesting that if you look at people—again, I am going to use an English example—who get a B in GCSE maths or physics, only about one in seven of them will then go on to study it at A-level. It is a much higher proportion if it is English. Technically they should not really be harder and so the extent to which you phrase to people, whether you give people additional coaching around some of the subjects—there are different ways of encouraging people, saying, “Because you got a B in maths or physics does not mean it is all over; there is still a lot to play for. And by the way, if you think a few years out in terms of the jobs, you might be happier and better off if you stick with it.”

Q51 **Carol Monaghan:** But that message needs to get through to parents. If something is viewed as worth more, then that is a very blunt, clear signal to parents.

Blossom, if you knew that physics and maths were going to be worth more points for university entrance—and I know you decided not to go the university route—would that have been an encouragement to take them?

Blossom Hill: No, it wouldn't, purely because I was good at science but it just didn't interest me. Honestly, I think it goes back to personal preference. I know plenty of girls who have gone on to do science, maths or engineering because that is what interested them. If you make physics and maths worth higher points, then in 10 years' time you are going to have a skills shortage in something else because everyone has gone to do physics and maths and you are back on the circle again where you have to get people to go and start doing history and geography. Do you know what I mean? I don't think it would be fair ever to weight them differently. If you want to do it, you will do it.

Mark Page: I think it is fair to say with any heavy intervention—we also decided it would be beyond our scope to get into the question of whether



you should have such narrow A-level choices—you have to think through all the different consequences. What you say is one possible adverse or unintended consequence if you go down that route. But with the numbers, you have quite a special group of friends because certainly in England only 3% of girls at 17 and 18 are studying maths and physics for A-level, so it is quite a dramatic number.

Carol Monaghan: Which is really quite damning.

Mark Page: Yes.

Carol Monaghan: Kirsty, did you have anything to add there?

Dr Clode: I think you do have some special friends. We would love to have a lot more girls really interested in maths and physics.

There is another part that one of the previous panellists mentioned. We talk a lot about enticing children to come into our industry; I think we have lost a lot of ladies from our industry for lots of different reasons and the industrial strategy that I have read does not talk about getting them back. It talks a lot about school kids. I don't know the numbers and I haven't got the data, but my personal experience is that there are lots of ladies out there who have engineering and science degrees that they are no longer using because they can't work out how to come back into the world of work when they may be 40 years old.

When we ran this event—the last one we did was on Saturday—although we did have schoolchildren there, a lot of people were between 35 and 50 and they wanted to swap careers because they had had poor careers advice and they loved socket sets and they really wanted to do engineering but they did not get that advice at school. For some, the kids have flown the nest and they want to do something different with their lives and they really did enjoy maths and physics but they never did the O-level at the time.

There is a company, Siemens, in our area where their jobs do not have any qualification requirements. They do a vocational sort of test of how you think and your values and behaviours, then they do a practical test—can you do X, Y and Z—and they train you for the rest. It doesn't matter what O-levels, A-levels, GCSEs or degree you got. They have hired 800 people, 97% from Humber.

Q52 **Carol Monaghan:** What is the male/female ratio of that?

Dr Clode: They started at 3% women. After the event we ran with them last year, it got up to 10%. I don't have the latest figures, because we only ran the next one last Saturday, but it is an amazing difference. I have never seen another company think that way before, where they say, "We have to get 800 to 1,000 people and they have to be from the local area." That was part of the remit of them coming to the Humber and to do that they have to think differently. They took away the O-levels, A-levels, degree requirements for the majority of their jobs—not all of



them—and they have managed to hire the right people and train them themselves.

Carol Monaghan: Excellent. Okay, thanks.

Q53 **Victoria Borwick:** Can we go back to the Your Life campaign that you touched on earlier, Mark? Tell us a bit about it; set the scene. What challenges has the campaign faced in changing young people's perception of the STEM subjects?

Mark Page: There was some Government backing to set the campaign up, but it is employer or corporate funded with some large corporates. We have only made one intervention into the policy space, which is publishing the "Tough Choices" report that I was quoting from.

Victoria Borwick: I am going to come on to that.

Mark Page: Most of what we do—and there is a small team—is working with schools. Making it easier for school trips to happen was a starting point. Then from the scalability perspective, we realised another way was to take something called the Game Wagon, which goes to schools so that more people can go through it in the course of a day. All those events get very good feedback. About half the people say they are more likely to study STEM beyond A-level, which is the objective of the campaign, after they have had it and most of the others say they are unchanged, so we are not putting people off.

Then there is a very large digital component, again in terms of reaching out to people. Content is put up to enthuse or inspire people about how they can use the different subjects and how things in life can apply, similar to some of your examples with maths. You can look at what is the maths of Pokémon or what is the science or physics of ballet—they are some of the most popular bits of clips. What we are finding is that we are now in brand awareness among 16-year-olds at about one quarter. That feels reasonably good in terms of where we would like to get to. We do, of course, realise that there are a lot of different organisations working in this space and we try to team up with them and think about funding.

We think about how we can do something distinctive about bringing in the employer perspective. What we are launching in May will be a Your Life app that will take sets of information, some from UCAS on how your A-levels or hires match to jobs, some from the National Careers Services on what jobs there are and some from the Commission for Employment and Skills on where the jobs are growing and what pays a bit better—also to your incentives point—and try to bring that together.

People will be able to go in and ask the question, "If I study these things, which maybe I like or am good at, what could I do later?" or, "I want to be X; what do I need to study now?" for those who have academic flexibility, or, "I am completely open. These are the sorts of things in life that I like. What can I possibly do and what subjects should I take?" There is going to be some testing in the Big Bang, tomorrow I think, for



some of the pupils just to try it. We will also make that available for parents and teachers so that they can do the same and hopefully we will build this up to be more powerful.

- Q54 **Victoria Borwick:** How do you evaluate what you are doing in schools, universities and industry in order to check that you are generating interest?

Mark Page: For the schools, we have commissioned research. We are looking at what the impact is post an intervention of some sort, a trip or visit, and also how many people know, how many people think, they are more likely to study or that their opinion has been changed. We do have that. In seeing the ultimate objective—that would be people making the choices—of course we would have to look backwards in time. That is something that will obviously take a little bit of time to filter through. We are focusing very much on schools and not so much on universities.

- Q55 **Victoria Borwick:** Do you need to get the universities and the industries involved in order to drag that interest up?

Mark Page: Well, yes. In addition to the corporate backers, we have a whole set of other businesses that are ambassadors, because clearly not everybody can go to BAE for a school trip, because otherwise they would not be able to do anything else. It is trying to get, also with that local sense, more businesses involved, whether that is pupils going there or, like some of the examples we heard before, people from industry going into the schools for STEM days and so forth, that mobilisation effort. There are a number of organisations that do that and we are certainly one of them and we work with the others.

- Q56 **Victoria Borwick:** This combines my next two questions. Going back to your “Tough Choices” report, as we can see today there is massive enthusiasm here at this age but then, as you say, the interest decreases each year. Is that because people have other things in their lives? How do we put initiatives in, or what should we do, in order to make sure that we have these young people who are energised and committed here today actually taking up careers in all the broad range of STEM subjects we have heard about today? We have heard a little bit about not only the pupils but also the teachers and the parents. Perhaps you could think about that.

Mark Page: Yvonne in the previous panel quoted the PISA research that said people are interested in science in above-average levels here. What we find from the research is that of people going from primary to secondary, three quarters say they really enjoy science. Then when you ask them a couple of years later, a different slice of pupils being asked the question, “Can you see yourself in a career in science?”—and a wide choice including medicine—suddenly the numbers for girls starts to drop and for boys it carries on.

Then you ask a couple of years later again, as they are in the year when they are going to take their GCSEs, “What do you think you are going to



study?" and again you see a drop as all the thinking about jobs, "What am I good at?", which is perhaps a legitimate thing to question, but also, "How is the grade thing going to play out? What is hard? Do I like the subject? Is the curriculum still engaging?" and you lose people there. Then perhaps the most startling is if you look at pupils at that 15 to 16-year-old point, just before they make their A-level choices in England, there are 47% of boys and 38% of girls still saying, "Yes, a couple of STEM A-levels, that is where I am going," yet just one year later half of the girls have not done that in fact. It is slightly better on the boys' side.

- Q57 **Victoria Borwick:** You have clearly iterated the problem but, as Blossom said, there are people who manage to buck that trend. What is your recommendation to us? What do we need to do in order to make sure that those people who have an interest and some skill, as Blossom does and others, buck that trend? What do we need to do?

Mark Page: If we talk about the different constituencies involved, we see from the employer perspective that our job is to make transparent those links with careers. That is the best thing we can do. The second thing is to be working with schools to provide practical examples in the course of the education about how what people are studying is going to be relevant. I think that is what we can do.

From the Government's side, there is the issue of the availability of teachers, the flow of qualified teachers. As you heard before, the Institute of Physics says there is a gap of 4,000 physics teachers. It clearly makes a difference if you are thinking about how a subject is taught, and then also whether you are going to enjoy studying at A-level, whether you think you are going to have a good teacher. That must be playing a role in some people's minds.

- Q58 **Victoria Borwick:** On the issue of parents not having an understanding of the requirement of the modern workplace?

Mark Page: Employers, Government and schools need to be informing the parents, and the parents need, I am sure, to have an interest and so should be reaching out.

Victoria Borwick: Buy into it?

Mark Page: Buy into it. It may come as a surprise to some parents but when surveyed most 16-year-olds said the people they listened to most were their parents, on this particular topic anyway.

Victoria Borwick: Well then, it is even more important that we get the message out. Thank you.

Dr Clode: The one other thing to mention, though, is the way that you talk about careers. What WISE have worked out is that the words that you use to talk to a boy about a career are very active—"What are you going to do?"—and the way you talk to a girl to keep them enthused is that she needs to understand why that job is important, not just what it



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is but what difference it will make to the world. If you do not include that she doesn't always think that it is worth her while.

Victoria Borwick: I think you are quite right. If you say you save the world and have safe water, it is an entirely different concept.

Dr Clode: Absolutely. She will be up there with you.

Victoria Borwick: Exactly, and I think Blossom made it very clear when she said that her maths teacher said, "Okay, what can't you do with maths?" and I think that should be our strapline for today, in that sense. I thought that was very powerful. Thank you.

Q59 **Dr Tania Mathias:** A quick question to Blossom Hill. What was the name of your maths teacher?

Blossom Hill: Mr Smith.

Dr Tania Mathias: Mine was Ms Hill; she was very good. The names do not really demonstrate how amazing they are.

Can I ask Mark Page, with the GCSE reforms of 2008, triple science coming in, do you think that has made any difference, either positive or negative, to the STEM skills gap?

Mark Page: What we see in the research is that those who are streamed into double science feel that that is it and there is no possibility to carry on. We understand that some schools do have that as a rule, and of course anybody who has perhaps done double science and been good at it is going to have a bit of work to catch up with their peers who have done triple science, just from a curriculum volume perspective. From a funnel perspective, yes it has, to the extent that of course it is perhaps a good deployment, if there is limited teaching capacity, of perhaps how you focus on some of the 15 to 16-year-olds and 18 year-olds. It may have had benefits there; I am not sure.

Q60 **Dr Tania Mathias:** For everybody, Mark, Blossom and Kirsty, I am interested in what you think about the Government's approach to the T-levels—the technical level qualifications—as well as A-levels.

Mark Page: With the idea of streamlining into clearer routes and apprenticeships—the example of Siemens—you have to think that some of that German heritage must be coming through. It is certainly welcome in giving more structure and also recognition that these are important. It does not necessarily fix our issue of STEM graduates going into some of the advanced skill roles that we also need, but clearly we do have to upskill the entire economy, the entire workforce, and in that sense I think it is very welcome.

Q61 **Dr Tania Mathias:** What do you think, Blossom, if you had had T-levels as well as A-levels?

Blossom Hill: I don't really know what T-levels are.



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Dr Tania Mathias: It is an idea of the Government to have technical levels, so less academic and more technically oriented. It could be the kinds of skills you may be using right now in the workplace. A T-level would be as good as an A-level but it is not academic.

Blossom Hill: Obviously A-levels are academic, aren't they, and then you have your BTECs?

Dr Tania Mathias: T is for technical.

Blossom Hill: Yes, and then you have your BTECs, don't you? I think there is always the stigma, if you go and do a BTEC, that you are not as brainy as an A-level student.

Q62 **Dr Tania Mathias:** Because it is a BTEC?

Blossom Hill: Yes, it is a BTEC. I guess if you can promote the technical levels in the same way that A-levels are promoted—they are the same level, you are brainy enough to go and do a T-level—then definitely, because everyone learns in different ways, don't they? Not everyone is suited to A-levels; some people who do A-levels aren't suited to BTECs. I think to get the right balance between A-levels and T-levels would definitely be beneficial.

Q63 **Dr Tania Mathias:** Thank you. That is interesting. The politicians have not talked about the BTEC, but that is very important. Thank you. Kirsty, what do you think?

Dr Clode: I think technical skills are amazingly important. A-levels are fine, if that is your bent, but if your bent is more practical skills, why force someone to try to do A-levels when what they really want to do is go and build things that everybody needs? You need a mixture of skills.

One of the things we don't teach in schools, and we don't teach in universities from what I can work out, is continuous improvement, the kaizen methodology, and that is hugely important to getting productivity up in the UK. When I worked in Korea and in the US, there was a lot more of that kaizen stuff going on. Sometimes in the UK we try to copy what other people have done and kaizen tells you not to do that because you have to go along with your own culture and work out where you are starting from now. We don't really teach that until you get into industry, and BAE is pretty good at kaizen—Toyota is the classic. I think that is something that is missing, that if you wait until you are with your employer before you really understand it, you have missed out on one heck of a lot of time problem solving. That is what it is—solving the real problem—and we miss it big time.

Q64 **Dr Tania Mathias:** But you say some companies are doing this methodology?

Dr Clode: Absolutely, yes. BAE is big into it.



Blossom Hill: All the apprentices go through something called ELLA, which is the Engineering Lean Learning Academy. You have one-day events, two days, two weeks, and it gets you to know about all the different continuous improvement methods that BAE uses, what goes on outside, how we can use it, and how we can take it back as apprentices into the workplace to the people who might have worked there for 10 or 15 years, when we go in as a fresh pair of eyes and think, "You could do this a bit more quickly and do it this way." Yes, we do it at BAE.

Dr Clode: It is a fabulous methodology that stops someone who thinks they know the answer, the senior person, from imposing their answer when the people who are on the ground know what the real answer is and the best way of doing it. It is a way of forcing that through the system. It works brilliantly if you get the right people and the right methodology, but we don't teach it in schools and I don't think we teach it in universities.

Mark Page: It applies, as well, for how most digital and internet firms would work. In any given day, there might be hundreds of versions of a website, all with slight differences, and then you learn which ones are the most effective for whatever the website is trying to achieve. They advance that and then the next day they will do some more and some more and some more.

Q65 **Dr Tania Mathias:** Right, and I guess with our previous panel, it goes back to the 25-year-old listening to the 15-year-old.

Dr Clode: Absolutely.

Q66 **Dr Tania Mathias:** I think you have answered my question about how to encourage people to retain and upskill during their working life. It is those kinds of methodologies in the workplace.

Dr Clode: It is, because it empowers people. I have worked for BP for a long time and it empowers the person at the frontline who maybe can't always get their voice loudly heard at the top, because shouting at the bottom ends up as a whisper at the top. If you give them this methodology, and say, "We want you to solve 15 problems this year; you choose the 15. Here is the money; you choose the most important 15 to you," that gives them the methodology and the kudos to go and solve the problems that are causing a pain for them. You don't have to put a dollar or a pound amount on it. They will find the money savings and it helps your productivity amazingly, and they own it because they solved it.

Dr Tania Mathias: I have just had flashes of Back-Benchers and Cabinet. Thank you.

Chair: That is enough of that talk.

Q67 **Carol Monaghan:** If I could pick up on Tania's question first of all before I ask my own. I have some issues with this idea of technical subjects because I have just had a look at some of the ones that are involved.



There is childcare, hair and beauty, hospitality; these are not going to solve the skills gap that we are talking about. These are definitely skills-based subjects, but I worry slightly that we are confusing real technical subjects that we need people to go into with skills-based subjects where there may also be requirements but—

Mark Page: Vocational really, isn't it? They should be V-levels, probably, yes.

Carol Monaghan: Yes. Or S-levels for skills, and that would cover everything. Is it the wrong word, to call these technical?

Dr Clode: They don't sound technical.

Q68 **Carol Monaghan:** Okay. That is interesting. I will move on to my own question. We know that there are many primary schoolteachers who lack confidence when teaching science. How much of a problem is this, if we are trying to show youngsters that science is something everybody can do when the teacher is having difficulties? Maybe Kirsty would like to answer.

Dr Clode: I do think it is a problem. We have to give them something they can use as a tool. One project I am helping with is Project Blyth by the Greenpower Education Trust, which is out in the venue now. They do a thing called the Goblin Challenge, which is effectively a kit car that the primary school kids put together themselves and then they race it. There is an equivalent for the secondary school kids.

I have only seen it at the Guides. I did a two-day job with the Guides, building an electric car, and the Guide leaders—I guess the equivalent to maybe not quite primary, a little bit older than that—the amount of kudos they got, the amount of empowerment they felt and the amount of excitement they saw from spending just two days of their half-term learning how to use a ratchet, learning how to use a rivet gun. At the start, one of the kids was not even strong enough but she wouldn't give up. It was amazing what you saw, that change in just two days. If you can give the same to a primary schoolteacher, who probably felt as unable to do that but within two days could get the confidence by helping their kids build a car and it works, I think that is amazing. It has just given them—

Q69 **Carol Monaghan:** We don't need them to be teaching quantum physics, but we do need them to be teaching basic investigative processes.

Dr Clode: Absolutely. If you give them a relatively set-up scenario that they can use—and to me that Goblin car is an exciting example—that is tangible at the end, and it can be redone, reused. Sometimes they get mesmerised by having to always learn something new but that thing can be taken apart and put back together.

Q70 **Carol Monaghan:** Blossom, did you do science at primary school?

Blossom Hill: Yes.



Q71 **Carol Monaghan:** How was your experience of it?

Blossom Hill: I can't really remember, to be honest.

Carol Monaghan: That maybe answers the question.

Blossom Hill: It is just working with the teachers on confidence, rather than the subject itself. Surely if the knowledge is there and it is just the confidence they are lacking, it is more of a confidence workshop or whatever that is needed to get them there.

Q72 **Carol Monaghan:** I think the lack of confidence comes about as a result of their lack of knowledge; that is what is happening. Mark, any thoughts?

Mark Page: I recall in the previous panel there was a question about putting more technology and using technology in schools to be able to teach the new subjects. I think all the other panellists immediately jumped in their minds to the number of pupils multiplied by the cost of laptops equals unaffordable.

First of all, I don't think that is necessarily how you would have to set it up. There are ways, if you think about it, of how you would distribute content. Not everything needs to be one on one; then you could think of using technology more to put content into classrooms. The teacher is effectively teaching with, or teaching alongside, something where there is expertise. You can also think—probably not in primary schools but at older levels—of having modules that are more self-taught, in the way that some of the universities are already starting to move to as a lower-cost or more efficient way of reaching more people. I think bringing in the technology to help and support and not just be a threat would probably be a good thing to explore.

Q73 **Carol Monaghan:** I am going to ask a final question, because I am aware that time is going on. There are no standardised tests for science, at primary level anyway. What incentive is there for schools to offer science?

Dr Clode: None.

Q74 **Chair:** Should there be?

Dr Clode: Absolutely, because all the stuff that I read says that it starts at primary school, if you get the kids interested. There is a thing going round the social media at the moment about a bookshelf—have you seen it?—where you hit the video and it says this is the number of books on the bookshelf and this is the number that have a girl in there as a princess, take those out, and it goes down and down and down. They ask the questions and you end up with about 10 books left out of 100. That is what the girls have been shown all the way through their lives in primary school, and then you wonder why we end up with people who think that some sort of prince is going to come and save them.



Q75 **Carol Monaghan:** Without putting more pressure on the teachers to test something else, how do we incentivise science at primary?

Dr Clode: That is a hard one.

Mark Page: I think it comes back to one of the points made before about looking not only at the grades or test scores that are coming out, but at the richness of the subjects, at least in the foundational subjects, at all stages of education, frankly.

Q76 **Carol Monaghan:** It almost needs a mission statement for a school.

Dr Clode: It does. It is like the values and behaviours of the school; they have to be getting the kids ready to be a person in the world, not just to pass an exam.

Mark Page: Which is what I am sure they want, so you are probably removing barriers rather than necessarily having to start something new.

Dr Tania Mathias: I will just do a plug. Inventor Trevor Baylis, in Twickenham, has no qualifications but he is a great inventor and to see him with primary schoolchildren is the most wonderful thing. There are just jaws dropping with him showing them what he invents.

Q77 **Chair:** Thank you. Finally, the purpose of all inquiries is to send messages to Government, to make recommendations to them. Very briefly, what one recommendation would you like us to be sending to the Government?

Dr Clode: I read the industrial strategy and it says that you want 20% women in the transport sector, but it is sort of a recommendation. I would like it a bit harder than that. If the Government employ any contract on any of the rail networks or whatever jobs you have going, one of the things in that contract is you will have 20% women in the engineering and manufacturing part of it, not in the administration, and you don't get the contract if they are not there. That would make them plan long term. It would ask them then to go into schools and they would have to plan 10 years out. If they wanted to work on the HS2 contract, 10 years out they would have to be in primary schools making sure that girls were part of that, making sure that continued into secondary, and then they would be given apprenticeships, valued apprenticeships, all the way through, so they ended up with that contract for HS2.

Blossom Hill: A bit controversial there; surely it is who is best for the job. Go into the primary school and then just encourage from there, not if you are a boy or a girl. That is my personal view; go into the primary schools and start there for science and engineering, not as a, "Let's get girls; let's get boys."

Mark Page: One of the elements of the Green Paper is to have a full review or redesign of the careers advice strategy. Definitely make sure that survives through into a White Paper and has a high priority and



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really looks at what is available, cracks the issue and thinks creatively about how to deal with that.

Getting back to the issue of subject mix and grades: how can we make sure that what schools are held accountable for balances those two things? Then, clearly, which I think is already recognised, focus on maintaining the flow of good, qualified STEM teachers for the STEM subjects. Through the Brexit we may find it harder to attract people in, whatever is going to happen on that side of things, but clearly let's do whatever we can to make sure. It may be bringing people in; older ages has been suggested earlier on. There are all sorts of ways of doing it, but think also about how they are deployed, perhaps even being split across two schools. Be creative about what effectively is a workforce issue. We need a few thousand more and that should be crackable, I would have thought.

Chair: Fantastic. Thank you. A final comment.

Victoria Borwick: A very quick point: things such as Transport for London's Crossrail Tunnelling and Underground Construction Academy, and some of the others, are quite innovative, but I think that does not cover some of the amazing other innovation we have seen today. We have to broaden the spread so it is not just TfL. I have judged women in engineering competitions and every single one of those women who, for example, drove the Crossrail tunnelling machines on some of the most precise points were women who were not educated in this country. That is what I found so staggeringly dire.

Chair: Thank you very much. Thank you all for your attendance today and for your contribution to our inquiry. It is much appreciated. Thank you very much.