

Business, Energy and Industrial Strategy Committee

Oral evidence: Automation and the future of work, HC 1093

Tuesday 30 April 2019

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[Watch the meeting](#)

Members present: Rachel Reeves (Chair); Stephen Kerr; Sir Patrick McLoughlin; Albert Owen; Mark Pawsey.

Questions 196 - 274

Witnesses

[I](#): Kate Bell, Head of Rights, International, Social and Economics, Trades Union Congress; Lauren Crowley, Head of Equalities, Community; Ian Brinkley, Chartered Institute of Personnel and Development; Professor Tony Dundon, Work and Equalities Institute, University of Manchester/University of Limerick.

[II](#): Professor Tony Prescott, Director of Sheffield Robotics, University of Sheffield; Professor David M Lane, Director, Edinburgh Centre for Robotics; Professor Nick Jennings, Vice-Provost (Research and Enterprise), Imperial College London.

Examination of Witnesses

Witnesses: Kate Bell, Lauren Crowley, Ian Brinkley and Professor Tony Dundon.

Chair: Thank you very much to the four of you for coming to give evidence to the Select Committee this morning on automation and the future of work. Our first session today with the four of you is on workers and automation. Then we have a second panel looking more specifically at the issues of research and innovation. We have BEIS Questions, as you know, at 11.30 this morning and two panels to get through. Thank you for being here a little early so we can get started efficiently. Albert Owen is going to start with the questions this morning.

Q196 **Albert Owen:** Thank you. If I could ask colleagues from the TUC first, the Office for National Statistics has said automation could replace 1.5 million jobs. The TUC has suggested automation could lead to a four-day week. Should we be excited or worried about the future of work?

Kate Bell: Thanks very much, first, for inviting us to give evidence. Whether we are excited or worried depends on the policy choices we make. We think we can be optimistic about the future of work. In general, over time, work has improved. I do not think many people would choose the working conditions we saw in the first industrial revolution. The reason we now have shorter working hours, safer workplaces and better terms and conditions is that we made the policy choices to put that in place.

One of the reasons we wanted to talk about a four-day week is that we think we can be optimistic about the future of work. PwC, for example, says we could have a potential £200 billion boost to GDP by 2030 due to the introduction of new technology. The question is how we manage that transition and how we share the benefits of that transition, so we can benefit workers. We know that, over the last 150 years, we have seen working hours reduce from 61 to 32 hours on average per week. Again, that did not happen by accident; it happened through a lot of campaigning, through policy choices and through regulation. We will need to think carefully about how we manage this new transition so that we can be optimistic about it and ensure that workers benefit.

Q197 **Albert Owen:** You talk about reduced hours. There are many complaints and reports that hours are going up and people are working 9 am to 9 pm in many circumstances. What you were referring to is probably a unionised and standardised—if I can use that word—workforce, but it is more flexible now and people are working longer hours. Is what you are saying a little outdated? Can automation enhance that trend or can it be usefully done in four days?

Kate Bell: There are choices about how we do it. There is a huge issue at the moment about people's control over their working hours. It is not just long hours but knowing when you are going to be able or available to work. We have seen the huge rise in things like zero-hours contracts, where people are using not necessarily automation but technology to text



people and say, "You need to be at work tomorrow." That is the issue of control over your working time. The stats do now show there are more people worried about overemployment than about underemployment, but over the last 20 years you have seen working hours reduce. This trend has not ground to a halt yet, but it is something we need to continue emphasising, both through regulation and through trade union action in workplaces.

Q198 **Albert Owen:** Can I ask the rest of the panel to comment on the question with regards to a reduced working week?

Professor Dundon: The general evidence is that other countries have shown productivity increases with reductions in working hours. The point about whether hours have gone up or down is relative to the context. There is evidence that UK workers are working more hours relative to competitor countries, for instance. The context in which hours are worked relative to which benchmark is important to set. The historical trend of hours might be going down, but relative to competitor countries and to particular sectors and industries, alongside casualised labour, insecure work and precarious work, hours are very fragmented and disjointed across different sectors of the economy.

Q199 **Albert Owen:** You talk about the evidence for productivity, but what about pay itself? If we are going to reduce hours and people getting unstable hours or zero-hours contracts by the hour, how will it reflect on pay?

Professor Dundon: Pay should stay stable or go up with a reduction in hours. The idea is that the gains from automation and technology are societal gains. The gains are shared across society rather than skewed towards corporate or private enterprises. This is where the role of Government and the idea of a Committee like this allows those policy choices to be considered. These are choices that society makes to share the gains of technology and automation by maintaining living standards, maintaining wages or increasing wages. It is reported from evidence that many UK workers are not paid the minimum wage. This is now known from ONS and Labour Force Survey data. Wages are an important factor, time is an important factor and the policy choices are an important factor.

Lauren Crowley: I am from Community union, but we also co-run a commission with the Fabian Society, which is chaired by Yvette Cooper MP, looking at workers and technology. Part of what I want to say today is about the evidence we have gathered from workers on automation so far. It is clear that people can see the positive potential of tech, meaning they can spend less time on the parts of their jobs they enjoy least. In the long term, we would agree that these sorts of social benefits as well as economic benefits are considered, and how we share the gains across society. The commission also wants to focus on the short to medium term. That is what we would want to emphasise. That disruption is happening now and people are not necessarily ready for that change. Yes, we believe we can be excited about the future of work. There are



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opportunities for a future of better work, with more freedom and flexibility over work, and more shared wealth, as well as social benefits. But we are not doing anyone a service if we sit back and let the market decide what tech does to the economy.

Q200 **Albert Owen:** Mr Brinkley, are you excited?

Ian Brinkley: I am as excited as I ever get about these things. I think it is going to be a positive outlook. There is no evidence that we are going to face technological unemployment in the future, or at least the foreseeable future. The objective of a four-day week is perfectly feasible but the real sticking point is whether you have any productivity to dispute in the future. At the moment, our big problem is that we have lots of automation, lots of AI and lots of new tech, and its effect on productivity has been zilch. The productivity growth rate over the past decade has been zero. If you want to get down to a four-day week, you are essentially going to redistribute the benefits of productivity growth. Less of it will go on wages and more of it will go on reduced hours.

That is basically how you would share it out but, if you have no productivity growth in the first place, you have nothing to share. That is the biggest problem getting down to a four-day week. It is not whether it is feasible, because it clearly is; it is the problem of trying to drive up productivity, which is a more general one. There is an unresolved question, where the evidence base is quite weak: does cutting working hours per se drive up productivity? There, we have found it very difficult to demonstrate that at the workplace level or the whole economy level. There are lots of good reasons for why it might do, but it has been quite difficult to demonstrate it in practice.

Q201 **Albert Owen:** Are there not new sectors that are growing? Retail was one. That has now been automating. Leisure is another. You know the adage about the time for leisure. Tourism is the fastest growing industry in the world and in this country. Are there benefits from that? If people worked a four-day week, they would have as much money but more time to spend it.

Ian Brinkley: It would certainly help restructure some of the economy, because the leisure industry is clearly one that would benefit from that.

Q202 **Albert Owen:** Are there any others? I just cited that one. Are there any others that would grow?

Ian Brinkley: It depends. People would have more time, for example, to consume education services. We know there has been a big demand for that. More people could spend their time learning and developing themselves. You would also see the consumption of more high-tech services. People, again, would have more chance to consume the products of the media industry, entertainment industries and so on. You certainly get some restructure in the economy and some job generation just by virtue of the fact that people have more time on their hands, rather than being chained to a desk or factory floor.



Q203 Sir Patrick McLoughlin: I feel like asking almost everyone on the panel to tell me whether they work their 38 hours a week or whether they work more. I would imagine you probably all work more than 38 hours a week. I always find this question about how we are going to get the working hours down quite interesting, because nobody around this table works 38 hours a week. Sometimes it almost feels like we work 38 hours in two days. The Government's recent focus on automation has been financing research into robots, working on the so-called three Ds: dirty, dangerous and demeaning jobs. I first started working in a coalmine doing some very boring jobs that could easily be automated but were never automated, because it was easier to have a man watching it rather than letting the automation take over.

How do you see both industry and individuals being able to approach this? I like what Albert just said about having more time to spend their money in. I do not think people are shorting of time to spend the money they have in. It seems that it goes, whether you have the time or not. I wonder whether we are ready for this revolution. What do you think the consequences of it are going to be?

Kate Bell: In terms of planning where Government investment should be and managing this transition, which is a real question, we need a system that brings together business, workers and Government representatives to discuss that change. It cannot only come top down from Government; it needs a process of discussion. That is why, in our evidence and in our work on this, we have been calling for a future of work commission. If you look at how other countries have managed this, Germany, for example, ran a two-year process, going out and consulting with business, trade unions and other social partners and community groups to ask, "Where do we want to prioritise? What are the major challenges our country needs to meet where we can do so through investment in technology?", and, as you say, to think about where there are jobs that are still too dangerous, repetitive and boring. But, also, what are the major challenges? We have the major challenge of moving towards a lower-carbon economy. We have the major challenge of dealing with an ageing population.

We need to be thinking about how the new technological investment we are trying to deliver can help us meet those social challenges, rather than, as Lauren was saying, simply being driven by where there is possibly the most potential for quick profit. That process needs to be delivered with Government and workers, and needs to be delivered so we have a plan over the long term. Lauren and I were just talking about why some of this stuff feels difficult. It is because it is difficult for people to see where policy is going. It is difficult to say what this might look like in five years' time and what Government's vision is for how we use automation to make jobs better. We need that process, we need that permission and we need it to set out the major challenges that automation and new technology can help us deal with, and the plan for



us to get there over time. We think that kind of process would give people confidence that the transition can be managed well this time.

- Q204 **Sir Patrick McLoughlin:** I was interested in what you said about productivity over the last 10 years. I think you said it has basically increased by zero.

Ian Brinkley: Yes, pretty much.

- Q205 **Sir Patrick McLoughlin:** That is the truth of it. If we are getting more automation, we are not seeing the gains from it in productivity. Thus, is it creating extra wealth? We will need to find those jobs that are going to grow, in the care industry, which probably cannot be replaced by automation of any description.

Ian Brinkley: That is certainly true, but we have also seen quite a lot of reasonably well-paid jobs in higher value-added services. It is a mixed picture. In those high value-added service jobs, when the new technology comes in, it tends to complement what people do rather than replace what they do. You are absolutely right on care: not only would it be undesirable to have automation there; I do not think it is possible in many cases, although you can see how new tech might help in different ways. It might, for example, improve the efficiency of scheduling when people are moving round from patient to patient or client to client. You can see where it might help in some areas, but there are going to be large swathes of employment where it would be either not economically feasible or not be desirable to automate.

- Q206 **Albert Owen:** I want to return to the theme I started on with Mr Brinkley, with regards to new jobs. I will start with you, Professor. Would you agree with *The Economist*, which tells us that it will lead to new types to work and not a shortage of jobs? Is that the general theme? Are you confident of that, or is it going to lead to periods of unemployment and stagnation before we get into a pattern?

Professor Dundon: There is no single answer. What we know from the evidence is that it is quite complicated. The certain thing we know is that it is likely to change the tasks of jobs. Automation and technology are changing job tasks as opposed to whole jobs. We are unlikely to see the collapse of whole industries because of automation, but likely to see shifts and waves of unemployment and employment in new areas and declining areas. The key challenge is how to manage the interface between technology and automation, particularly digital technologies, and new sectors of the economy, such as the gig economy. There is a whole variety of organisational models about certain uneven and unpredictable rent-seeking behaviours of organisations, where they focus their investment on intangible assets. Intangible assets often require low-paid, cheap labour to deliver them, through a smartphone or digital application.

The nature of the job and the job task is changing considerably, but it is accompanied by waves of lower-paid tasks and jobs. Back to the policy



choices, the gentleman mentioned the care industry. We undervalue care work and we know from demographic changes that the population is ageing. We can shift gains into care work. We can provide training, jobs, upskilling and increasing pay and dignity in work in those areas that we know have been undervalued for some considerable time.

Q207 Albert Owen: Is that retraining older administrative and manual workers for this kind of work, as well as new entrants? Is that what you are suggesting?

Professor Dundon: A mixture of both. It depends on demographics. It depends on regional configurations. We know from research from the University of Manchester about a human development approach of considering the lifecycle, looking at things from zero to career, from zero to 19, rather than the early years of schooling, so the training and development goes on into the career pathway.

Q208 Albert Owen: Kate, you mentioned the managed transition. You have cited Germany as an example where there is a plan in place, or there was a plan in place and it is working now, between civil society, unions and management. Does the industrial strategy provide an umbrella for that to happen, do you think? Is it happening now or should it be accelerated? What is your view?

Kate Bell: We are pleased that there is an industrial strategy and it has set out some aspirations, but unfortunately it has not sought that approach of trying to involve all stakeholders. We have been mapping union involvement.

Q209 Albert Owen: In general or just on automation? Are you talking in general terms?

Kate Bell: I would say in general terms, but we have not seen a particular desire to engage unions in the process of talking about automation. The Government set out a number of sector skills councils. There are two or possibly three—I would have to double check the figures—out of about 15 where unions have been invited to sit on those. There has not been the process of consultation, engagement and planning that you would want to see if you thought that unions were going to be fully involved in that. To add to what Tony was saying, we know that jobs are going to change. The OECD recently said that 14% of jobs may be obsolete and around 30% subject to significant change, but we do not have to assume that that leads to unemployment. We need to think more ambitiously about how, as Tony was saying, we can plan for that job change.

I had a really interesting conversation with someone from the tech sector recently, who said that, 10 years ago, we could see what was happening in the retail sector, we knew we were going to see more sales going online and we could have been planning to think about how we use our high streets and how we deal with that process of change. Employment in the retail sector is shifting from being in shops to being in warehouses,



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put very crudely. We could have been planning for that to make sure those warehouse and distribution jobs were of good quality, to make sure people were transitioning in the skills and to think about how we were going to use our high streets in the future. That process of planning, consultation and engagement did not happen, meaning we have been left with a much more worrying picture.

Q210 Albert Owen: Community has seen some changes over the years in the steel industry and in various heavy industries. That did lead to unemployment. What is going to be different this time?

Lauren Crowley: What needs to be different is the willingness of partners to engage at an earlier stage. I can share an example of Austria, where they automated a lot of their steel-making processes. They were able, because they had the skills and knowledge, to engage with the union at an early stage, five years out, and identified that the workforce was going to be mostly automated. They retrained 90% to 95% of that workforce to be data scientists, mathematicians and digital experts, because they were willing to do it; they were willing to engage with the unions at an early stage. We have the capacity and ability to do that as well now.

If we look at other periods of industrial change, such as the removal of SSI from Redcar, where we lost thousands of jobs overnight, the Government promised regeneration of that site and up to 20,000 jobs. We are four years on and they are still arguing over who the land belongs to. The clean-up has not started. A lot of it is about willingness to engage, committing to make sure that these communities do not get left behind again, having plans in place, with a short to medium-term view of what the skills need to look like, and ensuring provisions are put in place to make sure that happens.

Q211 Albert Owen: Finally, you mentioned that the last 10 years have seen very little or zero growth in productivity, yet unemployment has fallen steadily. Is that just because of a low-wage economy? Is it growing in other areas? Do you envisage there being either unemployment or stagnation as automation takes over?

Ian Brinkley: If we get more automation, we will get more productivity. If we get more productivity, we will get more growth. That will help generate employment. In terms of the macroeconomics, we should not worry too much about it. Increased productivity would be a good thing if it happened because, apart from anything else, it would get real wages up at a faster rate than we have seen recently. That would be a great benefit. I would not worry too much about greater productivity leading to greater unemployment. It certainly has not in the past, and there is absolutely no reason to think it will do so in the future. On that point, I would be relatively relaxed.

Q212 Chair: Can I go back to a point Professor Dundon made, that we need to ensure that care work is better paid? What reasons are there to be



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hopeful that automation, either in that sector or in other sectors of the economy, is somehow going to lead to higher pay for people involved in care? It might be what we would like to happen, but I am not sure I understand the process by which it will happen.

Professor Dundon: I am not outlining the process of how it would happen. I am outlining that there are principles of policy choices that we, as society, can make, where you distribute and redistribute the gains from technology so we can provide support systems to try to uplift wages, skills and dignity in care work, as an example. There are probably other examples in hospitality.

Q213 **Chair:** What would be the policies or strategies that a Government could pursue to deliver that outcome?

Professor Dundon: There are a number of frameworks from international practices, from the ILO and the OECD, that look at models of decent work and good work. They would follow a three or fourfold framework of, first, standards and rights, so you do not have bogus self-employment and you do not have zero-hours contracts. There is job creation, so you try to create and support high-quality jobs, rather than low-quality jobs. You have systems of social protections for people in work and out of work, and you have social dialogue, a meaningful voice. Democracy does not stop at the ballot box, the office gate and the factory. People want to have a say on the decisions that affect them in their work and how they do it.

Q214 **Chair:** I am very sympathetic to all that, but I do not see how it relates to automation. I do not see any process by which automation or more technology, either in care or in other parts of the economy, will have an impact on wages and terms and conditions in care.

Kate Bell: Pay in the care sector is primarily set by Government, in that they decide how much to invest in care. One of the reasons Government say they cannot invest in care is because of the cost. If we think that automation is going to increase productivity, we should be thinking it is going to increase our tax take. It is an indirect relationship. If we have growth in productivity and in corporate profits, for example, because of greater productivity, seeing the tax take go up and seeing Government choose to invest that in the care sector is not direct. It is not that automation leads straight to care, but it is about that long-term planning and Government setting out their priorities: "Okay, we want higher productivity over here, and here we want investment." It is that process of social dialogue that helps set out those priorities, which would help us get to that situation.

Q215 **Chair:** It is Ian Brinkley's point that, if we have more automation in the economy, it leads to higher productivity, higher growth, higher tax receipts and then Government could use that money to invest in other parts of the economy that they might regard as priorities. Can I ask another question? Is the problem in the UK economy for jobs that there is



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not enough automation or that there is too much automation? What is the biggest risk for the future of jobs in the UK? Is it that automation replaces jobs or is it that we are not automating enough, and therefore we become uncompetitive compared with other countries that perhaps are adopting AI and robotics at a faster rate?

Ian Brinkley: We are not going fast enough.

Q216 **Chair:** How do we compare with other countries?

Ian Brinkley: On things like use of robots, we are not even at the races; we are way behind most other leading OECD economies. I do not think we feature even in the top 10 markets for industrial robots, despite the fact that we have invested in other areas. We just do not seem to move there. It is a double problem. Not only is the rate not sufficient and we are falling behind on that, but when we invest we do not seem to be getting much out of it. There is a whole question about why these digital technologies for most companies are not boosting their productivity. It is both not enough and we are not getting enough out of it when we do make those investments.

Q217 **Chair:** I am sympathetic to that argument, but I am not sure what the TUC's view on that is.

Kate Bell: We agree with Ian. One of the reasons that, paradoxically, we do not either invest enough in technology or get the most out of it is that we do not value our human workers enough. Our workers are too cheap. The carwash example is the famous one. It is very easy to wash cars in an automatic way. We had cheap labour, meaning that more and more people think it is cheaper to get a person to wash your car. It is not an efficient way to do it but, because of the low wages and widespread exploitation in that sector, we are still seeing that. The failure to invest in wages and see wages rising reduces the incentive for companies to invest in technology.

Q218 **Chair:** You think that there is a possibility that automation leads to better-quality jobs because it automates some of those more routine and mundane tasks.

Kate Bell: Absolutely.

Q219 **Chair:** It might also lead to the higher growth we need to be able to invest in public services.

Kate Bell: The other factor is the lack of workplace voice and consultation in the UK. One of the reasons we are not getting enough about the technology is that people do not get asked. There is widespread evidence from the employer skills survey, in which many people said they have an idea for how to improve workplace practices and how to use technology in their workplace, but they have never been asked by their manager. We know it is people on the shop floor, factory floor or office desk who usually have the best knowledge about what will actually happen when you implement this piece of technology and how



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you can engage people in delivering it. Because of our poor practices of workplace consultation, we do not ask them and, therefore, we do not get the best out of that technology when we do invest.

Q220 Stephen Kerr: This is a very easy follow-on. This thing in *The Times* yesterday, highlighting the Deloitte "Global Human Capital Trends" report, says exactly what we are just talking about. This is 10,000 people across 119 countries, and it appeared that only 22% of British employees were satisfied with their company's use of technology, compared with 51% in Germany, and only 18% believed that their leadership programmes are effective at developing leaders to meet evolving business and economic challenges. There is quite a lot of damning statistical evidence that flows from that survey. Ian, in your written evidence to the Committee, you talked about employee engagement strategies for businesses that are automating. We are clearly not very good at this. What do businesses need to do differently as they look to automate?

Ian Brinkley: Particularly on automation, you really need to involve both HR departments and trade unions at quite an early stage when you are doing it. At the moment, there does not seem to be much in the way of systematic involvement. It tends to be rather hit and miss. It only really seems to be on the table when some new technology is going to cause a really big upset to the workforce. That is comparatively rare. Most new technologies are not going to do that; they are going to be incremental and come in on top of what is already there. Having some effective mechanisms would allow you to think more systematically about what the impact will be on work, on pay and rewards, and on productivity. Is it going to get jobs done better, rather than more of the same? All that needs a much more systematic approach.

There is a tendency to get mesmerised by the new tech and think, "If you just shove the new machines in, that is the job done. It all seems to work." It is a much more difficult process. You need to give a lot more thought to how the workforce might change and how changes in work organisation might increase productivity. That is an important part of what has been going on with the digital technologies. It is very easy to put the technology in. It is proving difficult to get much stuff out. A lot of that is to do with the human factors and firms not giving enough thought to workforce implications.

Q221 Stephen Kerr: Why is it that 82% of the employees in this survey from the UK considered there to be a lack of leadership planning and engagement? What is particularly not working in the UK context that is clearly working, for example, in Germany? There is a higher level of employee engagement. More employees in Germany, 51%, thought there was evidence of some leadership. What is it that is happening in the UK specifically?

Ian Brinkley: I suspect it is the lack of mechanisms. In Germany, you have the works councils, which cover most large companies, and you



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have a very strong tradition there of social partnership, which permeates a lot of the industrial sectors. We do not really have anything that is the equivalent of that. I would hope the sector deals, which are part of the industrial strategy, might be developed into something that could work in that direction. I also have the forum that the Government recently set up with the CBI and TUC to talk about skills. That is another potential mechanism. At the moment, these are very few and far between and there is certainly not a systematic approach. I suspect that has quite a lot to do with the differences you are picking up in that survey. There is a lack of institutional mechanisms to encourage these changes, compared to countries like Germany.

Q222 Stephen Kerr: It just seems to be common sense. In this survey, 84% believe there is a link between staff engagement and productivity. That is not rocket science, is it?

Lauren Crowley: There is a real lack of leadership from Government on this issue. When you are talking about the German Government, it is because it is led by Government. We have not strengthened consultation rights sufficiently or properly in quite some time. We cannot expect employers to do this on their own. If we do not want the evidence of inequality from automation to happen—

Q223 Stephen Kerr: When there is such a clear link between staff engagement and productivity, why would every employer in this country not be actively engaging with its workforce? It just does not make sense to me. Why would Government need to do that for a business? Surely, it is in the business's own self-interest to get engaged with its workforce.

Lauren Crowley: It is. Partly, there are cultural issues. Partly, it is a perception of working with trade unions. There is evidence that employers treat workforces, and are using tech to exploit workers, in a way that we would not think is common sense, but it happens. If it is not happening, the focus needs to be on how we get it to happen. Partly, the Taylor review touched on the ICE powers, but did not go far enough. We would ask Government to work with trade unions to make sure that any dramatic changes in work in the future are done in partnership with trade unions, workers and employers. It can be done as a tripartite thing. Government being absent on it is not good enough. It is not going to produce the changes that we need to happen to make sure this is fair.

Q224 Stephen Kerr: Does anyone want to make any further comments?

Professor Dundon: There is a fundamental distinction between the comparisons you are drawing. The likes of Germany and other European countries have a participative decision-making system. The UK relies on a permissive voluntarist arrangement. It is down to the employers and trade unions or other employee forums to make those decisions, whereas other countries provide the framework in which to support and facilitate that dialogue and engagement.

Q225 Stephen Kerr: I was 30 years in industry before I became a Member of



Parliament. It is common sense. If you are trying to bring about change in an organisation full of people, who are always described as the most valuable asset in a business, why you would not engage with them, listen to them and get their ideas is completely beyond me. Coming back to Ian Brinkley, what would you like to see in terms of better advice for businesses on how to automate? Who should do this, first of all?

Ian Brinkley: I would be looking for the bodies established as part of the industrial strategy, which brings employers, trade unions, where appropriate, and Government together, so they can frame what is going to work best for a particular sector. The advice or guidance you might want to give in, say, retail is going to be very, very different to high-tech manufacturing. That sector-based approach where you are trying to bring the different parties round the table together is quite a sound one and an attractive part of the industrial strategy.

The other thing to bear in mind is that most firms do not measure productivity in the sense that an economist would understand it. They think in terms of sales and control of costs, but they do not measure it in the way we think about it. Most of them think they are doing better than their competitors, in the same way that everyone thinks they drive better than the average person. Most do not. I suspect a lot of firms do not recognise they have a problem or, if they have a problem, they think, "Everyone is in the same boat as I am, or I am doing slightly better than they are."

One of the welcome things, although I am not sure it has gone quite as well as it should have done, was the Government funding for—I keep forgetting its name—"better business", Be the Business, or whatever it is called. An important part of it was trying to produce some reasonable metrics that a firm could look at, so it could measure its productivity performance accurately and see how well it really is doing. You have to start off with that very basic information. Small firms tend to get rather ignored in this debate and we tend to think about large firms, but the work we have done suggests that you will have to make quite a lot of investment in support for the people who run those small firms, if they are going to get up to even the very basic level of thinking about investing in either people or automation. There is a huge job of work to be done there, even to start engaging properly with the small firms sector.

Stephen Kerr: We have a very, very long tail of businesses in that category.

Q226 **Mark Pawsey:** We can all agree that firms intending to introduce automation should engage more effectively with their workforces. I am pretty sure that is one of the recommendations that will come out of our report. I want to focus on the ability of the workforce to adapt when those decisions are taken. Professor Dundon, you spoke about a need to provide training and upskilling. Who should be doing that?



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Professor Dundon: There is no easy answer to any of these things, but employers are not incentivised to provide training because they fear they would lose that investment. They invest in their human capital. They then fear they are going to lose that to competitors or people are going to move on. There needs to be an arrangement of some sort of social dialogue in which training is provided through partnership enterprises. There are a number of skills ecosystems that are available. I am not entirely an expert on the skills ecosystem, but in principle it provides a framework in which regional enterprises, as well employee groups and employer groups, can somehow map skills and provide some sort of partnership forum to focus in on skill areas in a sector, a region and an industry.

Q227 **Mark Pawsey:** Kate Bell, does the workforce generally have a positive attitude towards the introduction of automation? I have a great example from a manufacturing processor in my constituency, where I met a guy in his 40s who was doing an apprenticeship. He had previously been an operator, and he endorsed what you said about those on the shop floor having the best knowledge. He realised that, in time, his job was going to disappear because the process was becoming increasingly automated and he was going to start managing that process. Is his attitude the exception or is it the rule?

Kate Bell: Workers have a positive attitude where they know the support is going to be in place to help them get those new jobs. It is kind of ironic, or worse than ironic, that, at a time when Government are saying their primary priority is productivity, they have cut the funding for adult skills by around 40%. Business and individuals have a responsibility, but Government absolutely have a responsibility to be funding that training. Our call has been for an individual learning entitlement for every worker, another way of making sure people have the confidence that they can get the skills they are going to need to transition.

When we look at that flatlining productivity, the UK has historic underinvestment in skills, but the massive cuts we have seen for adult education and skills over the last 10 years have to be a factor in that, and have to be something we look at really, really seriously if we are saying we want to prepare for automation, we want to make the best of it and we want it to deliver higher productivity in the UK. We cannot do that without some investment in the adult workforce.

Q228 **Mark Pawsey:** Ian Brinkley, you said that businesses are not good at measuring their productivity, but if they can sense that there is going to be a productivity gain, is it not in their interest to make the investment in retraining, to make certain that the investment in automation reaps rewards and pays dividends?

Ian Brinkley: It is certainly in their interest, and those that do bring in automation often invest in training. Our problem does not rest with the firms that are doing all this stuff, because they do invest in training and they have all sorts of complementary investments in their workforce. The



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big problem is the companies that are not doing anything. They are not automating. They are not going for AI. They are not going for robotics and they are certainly not investing in their workforce. That is the bigger problem: trying to encourage firms that do not do any of this to move into that much more high-performance area.

Q229 Mark Pawsey: How would you create those incentives? Would you do it by carrot or by stick?

Ian Brinkley: It has to be a bit of a mixture. The apprenticeship levy was a bit of a stick and, as we know, it has faced some difficulties in trying to match its original objectives. There has to be a little bit of a stick there. We need to think rather more imaginatively about who has access to this training and how you deliver it. I would probably put more emphasis on getting help to individual workers rather than just relying on going through the companies all the time, because there you will face bottlenecks. I would give a lot more thought to the self-employed, who are now a very large part of our workforce. Who is responsible for making sure they get skills and development? It is no one at the moment.

I would be looking for mechanisms that are perhaps a little old-fashioned, but reach into the bits of the population that conventional measures do not. You think about Ruskin College or the Open University, institutions that are both under some financial pressure. I will be looking at whether we can give them some special support, recognising their wider role in society. Of course, the TUC education service has been a hugely underused resource over the past 20 years. Yet, people who have perhaps not had a very good experience with retraining, schooling and so on are going to respond much more positively if something comes through their trade union. They will trust the delivery of that.

Q230 Mark Pawsey: Lauren Crowley, I want to focus on people who are most at risk. We have some evidence that younger workers are more at risk but also particularly women, because of the fact that they often take time out of the workplace or are more likely to be working part time. What do you think could be done to prevent women in the workplace being at that kind of disadvantage?

Lauren Crowley: Can I quickly add to that point as well? One of the surprising findings from the commission is how positive workers are about their own prospects in facing automation. It could almost be complacency. Our concern would be that there is not so much personal agency to retrain and reskill, and that they might wait until things are a little too late or rely on the employer to do that. When we have had workers go through automation, the Unionlearn courses have been cited as the most helpful factor.

Q231 Mark Pawsey: You are suggesting that workers could be a little more proactive themselves.

Lauren Crowley: Yes, it could be a mixture, but something that is probably not being considered at the moment is that, if, like you say,



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workers are not considering that they might be at risk, reskilling and retraining does not necessarily happen.

In terms of women, we did some stats analysis of the ONS figures that said that women are more than twice as likely as men to have a job at a high risk of automation. This takes a broader strategy. This is not just about automation; this is about how we treat women in the workforce more generally. I am sure you know lots of the policy recommendations that are around that. If we are able to reap the benefits of automation, flexible working, for example, is one of those things, and a four-day week would be better for women to stay in the workforce. Looking at the types of jobs that are created, at the moment, if we are saying lots of the sectors that are growing are in retail and hospitality, those are the places where you get lots of women. Those are the places where we also have lots of poor conditions. It is about taking a holistic view of how we treat women in the workforce, not just automation.

Q232 Mark Pawsey: Those are workplaces where part-time working more easily takes place. It is easier to operate those businesses with part-time workers than manufacturing processors, for example.

Lauren Crowley: Those businesses are not averse to part-time working; it is an attitude towards part-time working. Part-time working is not necessarily always the answer for women, but there are policies towards women that can be implemented across all industries and sectors. It does not have to be just those.

Kate Bell: The hospitality industry has a lot of part-time working but very little control over people's hours, which is of course the most difficult thing if you are trying to combine work with caring for a family. I was talking to a hotel manager recently, who said that everybody in her hotel was on a zero-hours contract, they had no notice of their shifts and their shifts are cancelled at very short notice. Hospitality is a growing sector. We have seen 500,000 more jobs in hospitality over the last 20 years, but it is there that getting the basics right of how you invest in people, how you ensure people get the training and how you ensure they get decent terms and conditions is going to be really important if you want people to be positive about the future of work.

Q233 Chair: The Select Committee went to Japan last autumn. Ian Brinkley, that is a country that has very high adoption rates of new technologies, particularly industrial robots. One of the challenges they face are the demographic challenges. The population is growing older and is not replacing older workers with younger workers. We have spoken about some of the care challenges we face in the UK. Following on from Mark's question, one of the concerns is around people's ability to change and adopt new ways of working. Have any of you done specific work looking at how older workers can be encouraged to work with some of the new technologies and can be retrained for some of the new jobs that will be created?



Kate Bell: The union learning fund has a very strong record of engaging with workers of all types of ages. One positive thing that the Government are doing is the National Retraining Partnership, which Ian mentioned earlier, which is a partnership between the TUC, the CBI and Government. It looks at how to roll out skills training and access to skills training to people in jobs at higher risk of automation. The evidence around engaging older workers in training is that it needs to be tailored. People need to see the clear benefits for why they should invest in it. Again, it needs to be affordable. We can talk about workers taking the initiative to train but, if you think that Government have taken away funding for level 3 courses in further education, it is all very well taking the initiative but, if you cannot go on to progress because you cannot afford to do the course, you are not going to get very far. To harp on about it, that issue of funding for training is absolutely key, whoever you are trying to engage in that skills provision.

Professor Dundon: To pick up on something Ian said, I myself am the product of adult education and trade union education. The research that I know is that workers are highly resilient and adaptable but there need to be systems and structures in place for that to happen. One area of research we tried to look at was whether wage councils, for instance, or industry boards would be arrangements that might provide a platform for some sort of learning and education, as well as wage regulation. There is no definitive evidence yet. We just do not have the evidence to say that, but these are suggestions of areas of future research that could possibly be pursued.

Q234 **Chair:** Ian Brinkley, do you want to come in on this?

Ian Brinkley: No, everyone has covered it. I do not think I have anything to add other than the rather unhelpful observation that I would be less worried about young people and more worried about older people, because it is the older workers who seem to have suffered the biggest decline in their perception of job security over the past 20 or 30 years. The less-skilled older workers whose jobs are in line to be automated have very little to turn to. We have programmes and structures that are quite rightly focused on younger people, but if you are in your 40s or 50s in the midlands, with relatively low skill levels, and your job is going to be automated, where do you go to get retraining and skills? There is very little out there for them. That is the area I would be most concerned about. Obviously we want to be concerned about everyone who is affected by it, but let us not forget the oldies in all this, particularly the ones with fewer skills.

Q235 **Chair:** You touched on the skills point there. People with lower skills are more likely both to have their jobs automated and to perhaps have fewer options about what else to do. Sadly, they are also least likely to get training in the workplace. Are there other demographic groups or, indeed, parts of the country that you think policy makers should be concerned about, in this debate about automation and the future of work?



Lauren Crowley: Can I add to that? The other factor, to build on what you said before, is that self-employment is growing fastest in the over-55s and, again, there is no training provision at all for self-employed people. The other thing I would highlight is geographical differences. We talk a lot about regional differences and disparities in education provision and employment provision. This is something we can learn from the past on, in making sure we empower local and regional bodies to support employment in their areas and ensure communities are not left behind where employment is taken away and there is not alternative employment for a particular area.

Kate Bell: There is some OECD research showing the kind of regional disparities, with former industrial areas being most subject to the employment impacts of automation. To go back to my earlier point about why we need a Government planning approach, the opportunities for people in those areas are going to be determined not only by their access to training but by whether there are new jobs in those areas. Thinking about where we want our new low-carbon technologies might be one way in which we start joining up these dots, in thinking that there are opportunities for employment expansion here. There are also opportunities for employment expansion through new industrial digitalisation. Jürgen Maier has done work showing the prospects for new jobs in advanced manufacturing, but there needs to be thought about where those new jobs are located and whether they can be near where industries or individuals are most at risk.

Chair: Thank you to all four of you for coming to give evidence to the Committee this morning.

Examination of Witnesses

Witnesses: Professor Tony Prescott, Professor David M Lane and Professor Nick Jennings.

Chair: Thank you very much to the three of you for coming to give evidence to us this morning on research and innovation. We have BEIS Questions at 11.30, so we are going to try to get through this so we all get a chance to go in and ask questions in that. Stephen Kerr, we will start with you.

Q236 **Stephen Kerr:** Are there any particular areas of automation where the UK could become a world leader, Professor Lane?

Professor Lane: That is a great question. All areas of service robotics are areas where the UK could do very well. On industrial robots in manufacturing, largely what you have been talking about, we missed the boat to a large extent. We are catching up. In other aspects, such as service robotics in hazardous environments, surgery, healthcare, agriculture, construction and food automation, these are all areas where



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the UK has capability in its universities and the potential with start-up companies and businesses to have success.

Stephen Kerr: That is an encouraging first answer.

Professor Jennings: I would agree with all that. The great advantage we have as a country in this area is the excellence of our research base in our universities. AI and robotics are things that the UK is good at and demonstrably good at. That bedrock really does let innovation flourish. There are a whole load of robotics areas where we can lead. Non-hardware-based automation—so, automation in the service sector—is also an area of strength where we can lead the world.

Stephen Kerr: Did you have anything to add, Professor?

Professor Prescott: If you look at the number of tech start-ups in London, it is more than Berlin and Paris added together. If you look at the strength we have in healthcare, although there are issues about getting tech into that sector, having that large customer base in the National Health Service means a big opportunity for AI and robotic systems in healthcare in the UK.

Q237 **Stephen Kerr:** Would these new technologies that you are describing, where we might have the potential of UK world leadership, be replacing or creating jobs?

Professor Prescott: It is a complicated picture. They will be, on the whole, creating jobs, but they will be displacing some jobs. Some will be low-paid, low-skilled jobs, but high-skilled jobs will be displaced as well. They will create a lot of new opportunities and new classes of jobs. They will, in some sectors, create opportunities for professionalising the sector. That can be a benefit for workers.

Professor Jennings: They will also enhance jobs, as in changing the type of activity that is done, as technology has done throughout the ages. We will see some jobs disappearing and new jobs appearing. My personal observation is that I think we will see AI and automation mostly in terms of changing and augmenting jobs, rather than replacing them entirely with entirely new ones.

Professor Lane: You will see robot operators become robot programmers. Upskilling and increasing pay is a possibility. Skills development, to the points you were talking about earlier on, is key. Colleges, further education and HNDs—I could wax lyrical about that—are one of the areas where we could be investing to allow the training to take place.

Q238 **Stephen Kerr:** We are definitely going to come back to skills later on. Are the challenges of commercialisation any different for the products that arise from automation than they are for anything else? We have evidence about the so-called valley of death, for example, where new products have failed to commercialise. New products failing to



commercialise is not unique to automation. Are there particular barriers to the commercialisation of automated products?

Professor Lane: If you are developing a new product or a service, it is very important to work with your potential customers because they will tell you what they need. That is probably part of the barrier. A lot of venture capital investment is a bit of a punt, and that does not always take place. In areas such as smart procurement, large organisations, including Government but also large companies, can play a key role, getting into relationships where, on the one hand, the people in the company understand what their requirements are and what they are trying to do, which the technologists do not understand. The technology people can also inform the companies. Smart procurement is one of the ways that you can do that.

Q239 **Stephen Kerr:** When you work really closely with a large company and you are innovating or creating something brand new to be commercialised, there is a risk, as we heard from other places including on our trip to Japan, that those innovations get snapped up and sometimes stifled by big companies. That is not a particularly unique risk to automation, is it? Is it something you have come across?

Professor Lane: I have not personally come across it. It can happen. That is not a reason not to do it, if you understand, because when it works well it works very well indeed. It gives the new businesses, the nascent businesses or the SMEs in the supply chain, the oxygen that allows them to grow and develop in a way they would not otherwise.

Q240 **Stephen Kerr:** Is there a danger with ideas like business incubators, for example at Stirling University and other universities, that working too much in isolation and not collaboratively will lead to an increased level of incidence of the valley of death?

Professor Lane: Yes. It is not good at that stage in incubation to be working in isolation. Successful incubators and, indeed, accelerators are ones where you have that ecosystem of talent, money, business and technical knowledge working together. I would absolutely advise against working in isolation.

Q241 **Stephen Kerr:** Professor Jennings, do you have anything you wish to add? Does the valley of death have more of a preponderance in automation than any other sector of innovation?

Professor Jennings: Can I answer one of your earlier questions? Then I will come to that. One of the things about particularly the software side of automation is that software can be developed relatively easily and relatively quickly. If you contrast it to something like drugs or life sciences, where there may be a 10 to 20-year lag before you can put something in front of patients, software is not like that. Software can be done very quickly. We have examples from Imperial of a couple of our undergraduates who formed a company on graduation and three years later were bought out by Twitter for over £100 million. That is a massive



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and very rapid change. Automation can be done, because it is software-based, in a very quick manner.

In terms of innovation, if I look at what we do at Imperial, we run an incubator at our new White City campus. About a third to a half of that is Imperial spinouts; the rest is open to all-comers who want to be in it. We incubate about 20 to 30 companies a year. It really is important that, although it is done under an Imperial College banner, it is far from closed in that sense. Successful innovation and entrepreneurship need to be done with everyone.

Q242 Stephen Kerr: It is fantastic to hear about a couple of graduates who set up a business and then a few years later got bought out, but is that not part of our problem? We do not have any large British businesses. We have not grown anything in this sector that you could point to. You mentioned Twitter, but there are many other examples. Is that not a failing?

Professor Jennings: The two individuals are quite happy with that as an outcome.

Q243 Stephen Kerr: I bet they are. In terms of the national picture and our national economy, that is not particularly encouraging.

Professor Prescott: You can point to companies like Arm Holdings, which has been bought out but was very large at the point that it was bought out by SoftBank. We do create these large companies.

Stephen Kerr: But they get bought out.

Professor Prescott: Eventually they may get bought out and taken over, but the same happens in other sectors. I do not think AI is especially unique for that. We are catching up, particularly with the US, on having a spinout culture in universities. There are still barriers inside universities to having successful spinouts and understanding the breadth of possible business models. You might have a round of spinout that might differ from the traditional idea where a professor works in a lab for 10 years, comes up with a new drug and somebody comes in and commercialises it. In the US, there has for some time been much more of a culture where anybody at any level from a student upwards can have a bright idea and get support to try to explore a spinout.

Q244 Stephen Kerr: Have you seen any evidence of a change in that culture or mindset?

Professor Prescott: Yes, there is a change. Certainly in AI robotics, there are more and more universities realising the potential for impact and for university research via that route. It is taking some time. It is benefiting from Government help but there can be more incentives in that direction.

Professor Jennings: Imperial students set up 40 companies last year. We have seen that grow from 10 to 20 to 40 over the last three years. It



is central to what they do. We have 40 student companies and 10 academic staff-based companies. There is that real sea change in fantastic students who really want to do that.

Q245 **Stephen Kerr:** Is that sea change among the academics as well?

Professor Jennings: Yes. It is a central part of what our academics do these days. We talk about our research—

Q246 **Stephen Kerr:** They are not standing aloof.

Professor Jennings: No. At most of the top universities now, the third leg, making an impact from the research you do, is valued and put alongside the education and research you do. It certainly is at Imperial.

Professor Lane: There has been a 10-times increase in the amount of venture capital going into robotics companies in the last two to three years. In the last two years, we have done about £200 million to £250 million of VC investment in the UK into start-ups in robotics. That is a big increase. However, to put it in perspective, in February alone there was £4 billion worth of worldwide investment in this area. In the UK, to Professor Prescott's earlier comments, as a result of the start of the industrial strategy, the policy of eight great technologies, David Willetts and all that, we have made a great start. The Government support has been very important to that. It is work in progress and it is a journey. We are catching up. We are doing well but we have to keep at it. All the points that Professor Jennings makes are absolutely right.

Q247 **Chair:** Where did that £4 billion go, Professor Lane?

Professor Lane: It goes into series A and series B investments in companies all over the world by investors.

Q248 **Chair:** Where are we in the league table?

Professor Lane: We are still quite a long way down, but we are a relatively small country compared to the rest of the world. As I said, on the comparative numbers I have, we have done £250 million in the last two years. Do not quote me on this but, last year, worldwide, it was of the order of £10 billion. You can see the ratio is not in our favour at the moment, but we are improving. That is the point.

Q249 **Stephen Kerr:** We are the fifth or sixth biggest economy in the world and you are encouraged by it. I find that quite challenging.

Professor Lane: I am encouraged because we are making progress. To Professor Prescott's point, there is a culture of innovation around. We are seeing larger-scale investments. I am aware of three series A investments this year at the £5 million to £10 million level in the UK. There is probably more in robotics. That is a step in the right direction.

Q250 **Stephen Kerr:** That is lots of scope for leverage of our universities' reputation globally.



Professor Lane: There is more to do in getting the best science into the best companies in the UK. We are doing it. It is work in progress. We must not stop. The industrial strategy has been a great help in making that happen.

Q251 **Albert Owen:** You mentioned that you are not working in isolation. That is good to hear. How much of your work on automation is collaborative with business and other universities? To the three of you, are you in competition with each other or do you work together?

Professor Prescott: We are in competition and we work together.

Q252 **Albert Owen:** Explain that, then. Break that down.

Professor Prescott: We compete nationally for funds, but we also collaborate nationally to build consortia to solve large challenges. Particularly robotics is an area where you cannot, even in a large centre like Sheffield, Edinburgh or Imperial, be good at everything. You have the things you are good at and you team up with other partners nationally to address a large challenge. In robotics, you have hardware and software. You have to think about safety and the people in the environment. It is really an interdisciplinary challenge, so you have to build big teams.

Our advantage in the UK is that we have lots of good universities geographically close to each other. We are also a community that knows each other. There is a real opportunity and the hazardous environment hubs that have been funded recently are demonstrating that. There are opportunities for more of that kind of thing where we bring together big teams to address these societal challenges and work closely with industry.

Professor Jennings: In Imperial's active grant portfolio, we have grants with 60 UK universities. That is spread all around the country. Collaboration and partnership are absolutely central to doing great science and engineering, particularly in areas like automation where you have a large amount of infrastructure. Where there is a common infrastructure, building it once and sharing it is routine in the way we operate now.

Q253 **Albert Owen:** You have this all over the country. If a business was to come to you and say, "We are interested in developing something with you", would you suggest a location in the United Kingdom?

Professor Jennings: We have companies from all over the world coming to us that want to work with us. We will then partner appropriately, nationally and internationally, with those that have facilities that the research requires that we do not have. Absolutely, that is intrinsic to big science and tackling big societal problems in science these days. It is routinely what we do.

Q254 **Albert Owen:** Professor Lane, before you turn on to this, you mentioned venture capital being attractive. With regards to—and it has not been



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mentioned this morning—the B word, Brexit, what are the expected impacts of leaving the EU on research projects, whether in your own institution or in collaboration with other universities?

Professor Lane: The biggest impact is people. It is very hard to recruit the right talent, for some of the reasons we have heard about actually, that people go overseas.

Q255 **Albert Owen:** Why are we not producing our own?

Professor Lane: We are, but we do not produce enough, and they go and work in the US, Europe and all over the world, so we export our talent. We have seen a big drop off in the number of EU applicants for research positions and, indeed, for engineering positions in start-ups. There is a reluctance to come to the UK from Europe at the moment. We would quite like Brexit to be resolved from that point of view. There is also a feeling that Government, as far as research funding is concerned, might replace the funding that was originally coming from the EU. What Government cannot do is replace the scientific relationships we have with our colleagues around Europe in different research institutes and, indeed, companies as well. That is a concern.

Q256 **Albert Owen:** What percentage of your international collaboration is with European countries?

Professor Lane: It has changed. If you had asked me that question five or six years ago, I would probably have said 80% was Europe. With the advent of the industrial strategy, all the recent funds that have come down to the hubs Professor Prescott mentioned and other activities, it has probably flipped now. It is 80% UK and 20% coming from Europe.

Q257 **Albert Owen:** I do not everyone to answer the same question because I am conscious that the Chair is talking about the time factor here. On attracting funding, where is the funding coming from? Are the Government helpful? You mentioned venture capital but are the Government targeting the right kind from their funds with the industrial strategy, for instance?

Professor Prescott: Increasingly, they are.

Q258 **Albert Owen:** The initial round was some £90 million. Has that been well spent?

Professor Prescott: Yes. There certainly could be more. In the robotics area, the follow-through has been somewhat delayed. Brexit has been part of that. We are still waiting for robotics to have a leadership board. Professor Lane has been very involved in developing that. We are waiting for progress in relation to that from Government and for leadership on that. We have been benefiting from a lot of EU funding from the framework programme. That will be a huge gap. We do much better than some other European countries in winning EU funding, as I am sure you know. We also win a lot of the ERC fellowships, which recognise the really



high quality of research in the UK. It is vitally important that we negotiate membership of future framework programmes after Brexit.

Brexit could produce an opportunity, if we can build some collaborative programmes with countries like the USA, Canada, Japan and so on, because at the moment there are relatively few funding arrangements that allow us to work with partners. Particularly in the US, we are missing a lot of opportunities, because there is no direct way to have a funded research project across both countries.

Q259 **Albert Owen:** Do you share those thoughts, Professor Jennings?

Professor Jennings: Yes. I can give you some figures from Imperial: 12% of our research income is from EU sources; of that, 60% is European Research Council and Marie Curie. That is where we sit in terms of funding. The networking and ability to collaborate is really important for us. We are really keen to have associated status to the future Horizon and Europe programmes, so we really can benefit and continue to benefit from those. They really are central to us being leaders in what we do. It is not just the money; it is the people, networks and infrastructure.

Q260 **Albert Owen:** Professor Lane, with regards to what I raised with Professor Prescott on the Industrial Strategy Challenge Fund and Innovate UK, do you have good access to that? Is it sufficient and is it well targeted?

Professor Lane: Yes is the answer. We have, in the Centre for Robotics, ORCA Hub, which is £35 million. It is £15 million of Government and about the same again of industry. It is doing exactly the smart procurement thing that I talked about earlier on, in the offshore energy industry in this case. That is going well. We have four spinouts coming out from that already. There are examples of that. It is good. I wanted to come back to your earlier comment about what happens when industry comes knocking on the door of a university. My experience has been that sometimes, when they come, they want you to solve their immediate problem: today's or this month's problem. Universities at the moment are not very well set up to do that.

We are moving—and in particular I would highlight the National Robotarium in Edinburgh—to an ecosystem where you have the traditional university research and skills development going on. You have incubators and accelerators, but you also have a catapult-like activity that can be very responsive in the short term to those sorts of industrial requests. Across the UK in places like Bristol, Sheffield, Edinburgh obviously, and here in London, I am seeing more of those sorts of ecosystems and enterprises coming together where you have the whole piece. Industry can come with its strategic requests. I had some just this week from people in Aberdeen asking me where we are going in the long term. Also, you have these short-term requests, which can also be about skills. The relationships between universities and further education



colleges are quite important to be able to service that need the industry has.

Q261 **Albert Owen:** I have a final quick question. Bill Gates advocates a robot tax. This Committee heard when it went to Japan that innovation is the way forward, with incentive grants. Which one?

Professor Prescott: I do not think a robot tax is appropriate yet. It might be in the far-distant future. At the moment, we do not have enough robots to tax. There may be a need to shift the burden from income to wealth in terms of tax. People in our community are thinking about the societal impacts, how we mitigate them and ensure that people benefit. Robotics and AI will boost productivity and make everyone richer, but the reality is that that wealth is being shared unequally right now. That is something that can be fixed so other people can benefit.

Professor Jennings: I would say pretty much the same. It is important that wealth is shared around and that there is equality of opportunity in this space. The previous session about training and retraining is really central to making the most of what we can do in this area.

Professor Lane: I was struck in the previous session by the discussion about why robots are not being adopted. Professor Prescott and I were commenting that the lack of skills development in management might be one of the areas to look at. If you have a robot tax, that is a disincentive in an area where what we need is more incentive. Maybe in the future, but now it would definitely be a backwards step.

Q262 **Stephen Kerr:** In terms of the development of new automation technologies as a UK industry, are there any regulatory barriers? It has come up in evidence we have received already that there is a delicate balance here between regulation and innovation.

Professor Lane: There is. Having the right regulatory environment in different sectors can be the thing that gives us a competitive advantage. I was in China recently. Companies such as JD, which is like Amazon, are doing drone deliveries and self-driving car deliveries now in China because they have the right regulatory environment. In some cases, we do and in some cases we do not, here in the UK. In drones, for example, we are moving towards BVLOS, beyond visual line of sight. Steps are being made. It probably needs greater effort and scrutiny across a range of sectors in order that we make the most of that, because it will be one of the things that give us competitive advantage over other nations.

Professor Jennings: I very much agree with that. Regulation, good governance and ethics around this is really important. If we do not get it right, it absolutely has the potential to stifle what we want to be able to do and ruin the opportunity we have to really lead within it. I do not think there is a generic way of handling it. It is very sector specific. What you want to do with transport might be very different to what you want to do with health, which might be very different to what you want to do with



advertising and insurance. Working with the regulators and making sure they have a call on sufficient expertise and understanding of the art of the possible is really important for this. With good regulation and the base we have, we can lead, but we really need to get it right.

Q263 Stephen Kerr: These are potential barriers. I have heard about these potential issues we need to deal with as they come along. We need to be ready to be able to do that. Are there existing barriers that are holding us back right now?

Professor Jennings: We spoke about some of the drone things and some of the work in autonomous vehicles or autonomous cars. There is quite rightly regulation around them. Regulation is not inherently a bad thing. The ability to explore and do experiments in the wild is sometimes hindered by what you can and cannot do with drones or with robots and autonomous vehicles.

Professor Lane: I have some exposure to what is happening in the nuclear industry and in offshore energy. Dialogue is starting with the regulators to try to develop this, because there are certification procedures that have to be gone through. They are not geared towards using robots at the moment. Dialogue is underway. The real question is whether it is happening fast enough. The answer is probably not. I am not an expert in drones but I have some exposure to it, and there is healthy dialogue going on. There is some quite ambitious thinking going on about how airspace should be regulated in the UK at the moment. We have to get on with that, because other countries are doing the same. Increasing scrutiny and energy in that area of regulation across sectors, and certification also, is important to concentrate on. Move faster.

Stephen Kerr: Professor Prescott, have you anything to add?

Professor Prescott: We are still working out what regulation is needed and how to do it. There is a risk in overregulating. It needs to be a discussion and a partnership, because we need to look ahead and research this, to try to say what will happen in 10 years and begin to regulate now for the inventions we are going to have.

Stephen Kerr: There needs to be dynamic engagement. That is very clear.

Professor Jennings: Having relevant expertise in the regulator, so it can understand the potential, the limitations and the implications, is really important. Sometimes, when you start speaking with regulators, it is not an easy conversation to have.

Q264 Stephen Kerr: You are having to educate.

Professor Jennings: Yes. Having a bit of their own expertise or access to their own expertise is really important for regulators.

Q265 Stephen Kerr: That is a very good point. The industrial strategy centres



on AI a lot. Is that the right approach or should there be a broader focus in terms of automation?

Professor Lane: There is a broader focus in the Made Smarter Review. I know you have had some discussions about that. The Minister Chris Skidmore announced last month the Robotics Growth Partnership, which is growing, which is equivalent to AI. There is a difference between robots and AI. They are not the same thing. They overlap, but robotics is very multidisciplinary. It involves physical effects in the real world, which AI does not necessarily, and a much broader set of skills to develop systems. Those are healthy developments. This Robotics Growth Partnership in particular is a direct outgrowth of the original work we did with David Willetts in the RAS 2020 strategy. We are looking forward to launching that later this summer, subject to Brexit and all the other political effects.

Q266 **Stephen Kerr:** You are in favour of a robotics sector deal.

Professor Lane: Absolutely.

Q267 **Stephen Kerr:** Who should be designing that?

Professor Lane: We have a nascent group that has grown from the community, both industrial and academic. It is me on the academic side and Ocado, Paul Clarke, on the industrial side. Ocado, one of our most successful companies, is, you think, a grocery delivery company; it is actually a robotics company. Maybe you have been; I do not know. It is a great exemplar of good practice we could use and are using to try to demonstrate to other industries and sectors what the art of the possible is.

Professor Prescott: There is a great opportunity now, which to some extent is being missed, to increase automation in British companies. The barrier has been the installation costs of putting in robots and the knowhow to programme robots for your production line. That barrier is reducing. The cost of robots has come down a lot. The robots are increasingly user-programmable. It is about communicating to industry about the opportunity. It is about facilitating. It is about having a robot system integrated so you can work with companies to solve their problem.

This is something where universities can help. We have a big push around what we call collaborative robotics or cobotics. We are working closely with the Advanced Manufacturing Research Centre to build some demonstrating systems so that people can come in and see what is possible. We are working with companies to see how we can automate their particular setup. We do not need to invent new AI to make this happen; the technology is already there. It is about deployment.

Professor Jennings: A lot of the AI sector deal is targeted at automation, even if it is not targeted directly at robotics. I see automation as being related to AI and to robotics, but you can certainly have non-robotic-based automation. A significant amount of the AI



research in the sector deal is targeted at non-hardware-based automation.

- Q268 **Mark Pawsey:** The evidence we have had in this session and with the previous panel has been rather disappointing. We have heard lots of expressions like “opportunities being missed”, “not happening fast enough”, “the UK is not doing enough”. That is the message I am taking away. I focused with the last panel on skills and the ability of the workforce to adapt and respond. As academic institutions, are we generating enough people to go into this sector? Professor Jennings, you told us about the two superstars who made loads of money by creating something and selling it on, but that is the tip of the iceberg. What we need is a broader range of skills spreading itself throughout our industries more generally. Are you satisfied that we are generating enough people, with the right calibre and skill level?

Professor Jennings: You have a slightly different lens on the responses than I do. You have had quite upbeat, positive responses to your questions; that would be my initial thought back to you. In terms of the skills and wherewithal to do work and exist in this sort of environment, we could always have more people appropriately qualified. Over time, we really need to get data literacy and problem solving all the way back to primary school. There is a much bigger piece to understand computing and data literacy. Everyone should do that.

If I look at what goes on at Imperial, we run a whole number of competitions. The AI and automation competitions are always the ones that are massively oversubscribed. We have hundreds of undergraduate teams who want to get on to our innovation programmes. We have also opened up our skills, in terms of running online courses. Last week, we announced we are doing a machine learning and AI online course through Coursera, which we think helps to democratise and provide access to these sorts of skills for people all round the world who are interested in it.

- Q269 **Mark Pawsey:** Professor Lane, I was struck by your remarks a few moments ago that one area of skills training needs to be the skills of management. I was struck by a concern that Stephen Kerr had when we were being told about businesses not investing in or collaborating and working closely with their own workforces in the introduction of robotics. You have just told us that, when you engage with businesses, they are much too concerned about the short term, rather than looking at the long term. Are there ways that the UK can address that, in your view?

Professor Lane: That is true. It is through the process of dialogue with companies at all levels and of all sizes, and the kind of hub approach that we have in the UK at the moment. I mentioned the centres in Edinburgh, Bristol, London, Sheffield and elsewhere. Public support is going through the universities and catapults to create the ecosystem that all the companies in the region can then go to.

- Q270 **Mark Pawsey:** The catapults have been very successful. Is there, in your



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view, a view among industry that, if industry now wants to access research and development, it needs to go through a catapult? Is that not happening? That is encouraging.

Professor Jennings: That is certainly not our experience at Imperial. We have 500 companies that we do business with, which give us about £80 million worth of funding.

Q271 **Mark Pawsey:** Do you agree with Professor Lane that businesses are too focused on the short term when they come to engage with you?

Professor Jennings: It is interesting. You get a mix. We have had partnerships that last 30 years with companies that really understanding the importance of fundamental research. It is baked into their business. In trying to get to the 2.4% target of GDP in research and development investment, we need to reach out to companies that have engaged less with R&D. There is an education piece to be had, but there are a good range of companies in this country that really understand and engage well with the ecosystem.

Q272 **Mark Pawsey:** Professor Prescott, universities usually train people and then they go off into the world of industry. Do universities spend enough time with people who are already in work, retraining existing workers and management? Does that happen enough?

Professor Prescott: I do not think so. We could do more. It is a role that universities could take more of a share of. A lot of people who are going to do the future jobs that are going to be created have already left full-time education. We need to think about lifelong learning. We have a general challenge around education from primary school up. We need to show children and adults what robots are, what AI is, teach them what it can do and what it cannot do, as importantly, and get them excited about it.

We do a huge amount of public engagement in Sheffield. We always get a positive reception for robots, but people are often surprised at what a robot is, because they see robots in science fiction movies and think of factory robot arms, and they do not know about all the other kinds of robots there are. There is a big communication job and a big education role. If you look at girls in primary school, they are being put off STEM subject by the age of seven, but there is positive evidence from the US that, if you go in with an intervention and have a four-week short class on robotics, you enthuse those girls to think about themselves as being future engineers.

Q273 **Mark Pawsey:** Professor Jennings, in your evidence you spoke a lot about—and you mentioned it just now—the need to encourage more young people into STEM subjects at an early age. Going back to the catapults, my understanding is that one of the roles of the catapults was to encourage people to go in and see what the new world of work is all about, because there is this perception that, in education, you have to get on and, if you do not do well, you will end up stuck in that factory.



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We need to encourage people to get into the factory. With the greatest respect, most people do not go anywhere near a university until they have filled in their UCAS form and they go and have a look round. How can you encourage people to be more ambitious at an earlier age?

Professor Jennings: That is a somewhat dated view. We do an awful lot of outreach. We run a science festival that 20,000 people attend. The main demographic is people with young kids under 10. We go into primary and secondary schools and really extol the virtues of science and engineering. We might mention Imperial along the way, but it is mainly for the discipline. There is that real engagement piece. We are opening a new campus at White City. We go into the community there, which is a very socially deprived area of London.

Q274 **Mark Pawsey:** Imperial is a national resource. How many of my constituents, 100 miles up the M1, would be likely to come on to your campus and engage with some of these activities? Are universities, more broadly across the piece, doing enough?

Professor Jennings: One can always do more. You are probably right that, however fantastic Imperial's science festival is, you are probably not going to travel 100 miles to come to it. There are a number of universities doing similar things. I can talk about Imperial because that is the one I know best, but it is far from unique in its engagement and what it tries to do. There is a crisis in terms of getting the appropriate number of students interested in science and engineering. That is something we as a country face. It is incumbent on universities and those with the skills and vision to engage more broadly, so we get more people into our field.

Chair: Thank you very much for your evidence this morning. I had a couple of questions, but Mark and others have picked them up so they will not be needed. That was really fascinating and I really enjoyed hearing what you have had to say. Good luck with enthusing the next generation. Maybe we will have some women professors of robotics in the future.

Professor Lane: We have a women in robotics and engineering society.

Chair: Thank you very much for your time this morning.